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3

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Azadi Ka
Amrit Mahotsav

Agriculture and Allied Sciences

Restructured and Revised Syllabi of Post-graduate Programmes

- Basic Veterinary Sciences
- Veterinary Clinical Subjects
- Veterinary Para-Clinical Subjects
- Animal Production Sciences



Education Division

Indian Council of Agricultural Research
New Delhi

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त्रिलोचन महापात्र, पीएच.डी.

एफ एन ए, एफ एन ए एस सी, एफ एन ए ए एस

सचिव एवं महानिदेशक

TRILOCHAN MOHAPATRA, Ph.D.

FNA, FNAsc, FNAAS

SECRETARY & DIRECTOR GENERAL

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली 110 001

GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION
AND

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
MINISTRY OF AGRICULTURE AND FARMERS WELFARE
KRISHI BHAVAN, NEW DELHI 110 001

Tel.: 23382629; 23386711 Fax: 91-11-23384773

E-mail: dg.icar@nic.in

Foreword

THE ICAR has been continuously striving to bring necessary reforms for quality assurance in agricultural education. The Council has appointed National Core Group and BSMA Committees for revision and restructuring of Post-graduate and Doctoral syllabi in consultation with all the stakeholders to meet the challenges and harness opportunities in various disciplines of agriculture and allied sciences. It has been observed that a paradigm shift is necessary in academic regulations to comply with various provisions of National Education Policy-2020. It is heartening to note that the respective Committees have taken due care by following flexible, multi-disciplinary and holistic approach while developing the syllabus and academic regulations. The students are given opportunities to select the courses to support their planned research activities, to register for online courses and to pursue internship for development of entrepreneurship during Masters' programme. Further, the Teaching Assistantship has been introduced to provide experience to the Ph.D. scholars on teaching, evaluation and other related academic matters. This is an important part of doctoral training all over the world and it is expected to address the shortage of faculty in many institutions/universities. By intensive discussion with the subject experts and based on the feedback from the faculty and students, the syllabus of Masters' and Doctoral programmes in 79 disciplines was restructured and new courses were introduced. The syllabus has been revised suitably with the view to equip the students to gain knowledge, enhance their employability and skill sets to mould towards entrepreneurship and build themselves to prepare for global competitiveness. The opinions and suggestions invited from the concerned institutions, eminent scientists and other stakeholders were also reviewed by the Committees.

The Council sincerely thanks Dr Arvind Kumar, Chairman of the National Core Group and its members for the guidance to develop the syllabus in line with contemporary and projected national and global agricultural trends. The Council acknowledges the dedicated efforts and contribution of all the Chairpersons and members of 19 BSMA Committees for preparation of the syllabus. It gives me immense pleasure to express profuse thanks to the Agricultural Education Division for accomplishing this mammoth task under the guidance of Dr N.S. Rathore, former DDG and Dr R.C. Agrawal, DDG. I compliment Dr G. Venkateshwarlu, former ADG (EQR) for his sincere efforts and overall coordination of the meetings. Special thanks to DKMA for bringing out the entire syllabus in six volumes.

(T. Mohapatra)

Date: 13th August 2021

Place: New Delhi-110 001

Preface

THE curricula development is a part of the continued process and effort of the ICAR in this direction for dynamic improvement of national agricultural education system. In this resolve, the ICAR has constituted a National Core Group (NCG) for restructuring of Master's and Ph.D. curriculum, syllabi and academic regulations for the disciplines under agricultural sciences. On the recommendations of the NCG, 19 Broad Subject Matter Area (BSMA) Committees have been constituted by the ICAR for revising the syllabus. These Committees held discussions at length in the meetings and workshops organized across the country. The opinions and suggestions invited from institutions, eminent scientists and other stakeholders were also reviewed by the Committees. The respective BSMA Committees have examined the existing syllabus and analysed carefully in terms of content, relevance and pattern and then synthesized the new syllabus.

The revised curricula of 79 disciplines has been designed with a view to improve the existing syllabus and to make it more contextual and pertinent to cater the needs of students in terms of global competitiveness and employability. To mitigate the concerns related to agriculture education system in India and to ensure uniform system of education, several changes have been incorporated in common academic regulations in relation to credit load requirement and its distribution, system of examination, internship during Masters programme, provision to enrol for online courses and take the advantage of e-resources through e-learning and teaching assistantship for Ph.D. scholars. As per recommendations of the National Education Policy-2020, the courses have been categorized as Major and Minor/Optional courses. By following the spirit of Choice Based Credit System (CBCS), the students are given opportunity to select courses from any discipline/department enabling the multi-disciplinary approach.

We place on record our profound gratitude to Dr Trilochan Mohapatra, Director General, ICAR, New Delhi, for providing an opportunity to revise the syllabi for PG and Ph.D. programs in agriculture and allied sciences. The Committee is deeply indebted to Dr R.C. Agrawal, DDG (Agri. Edn), and to his predecessor Dr N.S. Rathore for their vision and continuous support. Our thanks are due to all Hon'ble Vice Chancellors of CAUs/SAUs/DUs for their unstinted support and to nominate the senior faculty from their universities/institutes to the workshops organized as a part of wider consultation process.

The revised syllabi encompass transformative changes by updating, augmenting, and revising course curricula and common academic regulations to achieve necessary quality and need-based agricultural education. Many existing courses were upgraded with addition and deletion as per the need of the present situation. The new courses have been incorporated based on their importance and need both at national and international level. We earnestly hope that this document will meet the needs and motivate different stakeholders.

G. Venkateshwarlu
Member-Secretary

Arvind Kumar
Chairman, National Core Group

Overview

A National Core Group has been constituted by ICAR for development of Academic Regulations for Masters and Ph.D. programmes, defining names and curricula of Masters' and Ph.D. disciplines for uniformity and revision of syllabi for courses of Masters' and Ph.D. degree disciplines. On the recommendations of the members of National Core Group, 19 Broad Subject Matter Area (BSMA) Committees have been constituted for revising the syllabus. These committees have conducted several meetings with the concerned experts and stakeholders and developed the syllabus for their respective subjects. While developing the syllabi, various provisions of National Education Policy-2020 have also been considered and complied to provide quality higher education and develop good, thoughtful, well-rounded, and creative individuals. Necessary provisions have been made in the curricula to enable an individual to study major and minor specialized areas of interest at a deep level, and also develop intellectual curiosity, scientific temper and creativity.

I express my gratefulness to Dr Arvind Kumar, Vice-Chancellor, Rani Lakshmi Bai Central Agricultural University, Jhansi and Chairman, National Core Group under whose guidance the syllabi for Master's and Doctoral programme is completed. His vast experience in agricultural education and research helped in finalising the syllabi. I wish to place on record the suggestions and directions shown by Dr N.S. Rathore, former Deputy Director General (Education) and Dr G. Venkateswarlu, ADG (EQR) and Member Secretary, National Core Group throughout the period without which the present target could not have been achieved. I am extremely thankful to 19 BSMA Committees for their stupendous job in restructuring and articulating curricula in the light of technological developments and employability prospects in agriculture and allied sciences. I also appreciate and acknowledge the efforts made by Dr S.K. Sankhyan, Principal Scientist (EQR), Dr S.K. Singh, Project Director (DKMA), Mr Punit Bhasin, Incharge, Production Unit (DKMA), Dr Kshitij Malhotra and Dr Sumit Saini, Research Associates to take up the work of editing, proof reading, finalizing and bringing out these six volumes of BSMA in this shape.

I also take this opportunity to express a deep sense of gratitude to Dr Trilochan Mohapatra, Secretary, DARE and Director General, ICAR for his guidance, cordial support and valuable input throughout the revision of the syllabus by BSMA, which helped in completing this task through various stages. The support and help extended by all Deputy Director Generals and the staff of Education Division is also greatly acknowledged.

During this comprehensive exercise of upgrading the course contents, the much-needed academic support, hospitality and participation rendered by Hon'ble Vice-Chancellors of CAUs/SAUs/DUs is greatly acknowledged. My deep sense of gratitude goes to Deans, Directors, Professors, Heads, faculty members and students at the universities who contributed by their effective participation and interaction.

R.C. Agrawal

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Common Academic Regulations for PG and Ph.D. Programmes

1. Academic Year and Registration
2. Credit requirements
 - 2.1 Framework of the courses
 - 2.2 Supporting courses
 - 2.3 Syllabus of Common Courses for PG programmes
 - 2.4 Mandatory requirement of seminars
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5. Advisory System
 - 5.1 Advisory Committee
6. Evaluation of research work
 - 6.1 Prevention of plagiarism
7. Learning through online courses
8. Internship during Masters programme
9. Teaching assistantship
10. Registration of project personnel (SRF/ RA) for Ph.D.
11. Compliance with the National Education Policy-2020
12. Definitions of academic terms

1. Academic Year and Registration

- An academic year shall be normally from July to June of the following calendar year otherwise required under special situations. It shall be divided into two academic terms known as semesters. Dates of registration, commencement of instructions, semester end examination, end of semester and academic year, etc. The Academic Calendar shall be developed by the concerned University from time to time and notified accordingly by the Registrar in advance.
- An orientation programme shall be organized by the Director (Education)/ Dean PGS for the benefit of the newly admitted students immediately after commencement of the semester.
- On successful completion of a semester, the continuing students shall register for subsequent semester on the date specified in the Academic/ Semester Calendar or specifically notified separately. Every enrolled student shall be required to register at the beginning of each semester till the completion of his/ her degree programmes.

2. Credit requirements

2.1 Framework of the courses

The following nomenclature and Credit Hrs need to be followed while providing the



syllabus for all the disciplines:

	Masters' Programme	Doctoral Programme
(i) Course work		
Major courses	20	12
Minor courses	08	06
Supporting courses	06	05
Common courses	05	–
Seminar	01	02
(ii) Thesis Research	30	75
Total	70	100

Major courses: From the Discipline in which a student takes admission. Among the listed courses, the core courses compulsorily to be taken may be given *mark

Minor courses: From the subjects closely related to a student's major subject

Supporting courses: The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her overall competence.

Common Courses: The following courses (one credit each) will be offered to all students undergoing Master's degree programme:

1. Library and Information Services
2. Technical Writing and Communications Skills
3. Intellectual Property and its management in Agriculture
4. Basic Concepts in Laboratory Techniques
5. Agricultural Research, Research Ethics and Rural Development Programmes

Some of these courses are already in the form of e-courses/ MOOCs. The students may be allowed to register these courses/ similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/ she may be permitted to register for other related courses with the prior approval of the Head of Department (HoD)/ Board of Studies (BoS).

2.2 Supporting Courses

The following courses are being offered by various disciplines (The list is only indicative). Based on the requirement, any of the following courses may be opted under the supporting courses. The syllabi of these courses are available in the respective disciplines. If required, the contents may be modified to suit the individual discipline with approval of the concerned BoS:

Code	Course Title	Credit Hours
STAT 501	Mathematics for Applied Sciences	2+0
STAT 502	Statistical Methods for Applied Sciences	3+1



Course Code	Course Title	Credit Hours
STAT 511	Experimental Designs	2+1
STAT 512	Basic Sampling Techniques	2+1
STAT 521	Applied Regression Analysis	2+1
STAT 522	Data Analysis Using Statistical Packages	2+1
MCA 501	Computers Fundamentals and Programming	2+1
MCA 502	Computer Organization and Architecture	2+0
MCA 511	Introduction to Communication Technologies, Computer Networking and Internet	1+1
MCA 512	Information Technology in Agriculture	1+1
BIOCHEM 501	Basic Biochemistry	3+1
BIOCHEM 505	Techniques in Biochemistry	2+2

2.3 Syllabus of Common Courses for PG programmes

LIBRARY AND INFORMATION SERVICES (0+1)

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines, etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/ Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

TECHNICAL WRITING AND COMMUNICATIONS SKILLS (0+1)

Objective

To equip the students/ scholars with skills to write dissertations, research papers, etc. To equip the students/ scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical (Technical Writing)

- Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.;
- Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);
- Writing of abstracts, summaries, précis, citations, etc.;

- Commonly used abbreviations in the theses and research communications;
- Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations;
- Writing of numbers and dates in scientific write-ups;
- Editing and proof-reading;
- Writing of a review article;
- Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks);
- Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription;
- Accentual pattern: Weak forms in connected speech;
- Participation in group discussion;
- Facing an interview;
- Presentation of scientific papers.

Suggested Readings

1. Barnes and Noble. Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*.
2. *Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India.
3. *Collins' Cobuild English Dictionary*. 1995.
4. Harper Collins. Gordon HM and Walter JA. 1970. *Technical Writing*. 3rd Ed.
5. Holt, Rinehart and Winston. Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
6. James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
7. Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
8. Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
9. Richard WS. 1969. *Technical Writing*.
10. Sethi J and Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.
11. Wren PC and Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (1+0)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National



Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

1. Erbisch FH and Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
2. Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.
3. *Intellectual Property Rights: Key to New Wealth Generation*. 2001. NRDC and Aesthetic Technologies.
4. Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
5. Rothschild M and Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.
6. Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; The Biological Diversity Act, 2002.

BASIC CONCEPTS IN LABORATORY TECHNIQUES (0+1)

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

- Safety measures while in Lab;
- Handling of chemical substances;
- Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vascupets;
- Washing, drying and sterilization of glassware;
- Drying of solvents/ chemicals;
- Weighing and preparation of solutions of different strengths and their dilution;
- Handling techniques of solutions;
- Preparation of different agro-chemical doses in field and pot applications;
- Preparation of solutions of acids;
- Neutralisation of acid and bases;
- Preparation of buffers of different strengths and pH values;
- Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;
- Electric wiring and earthing;
- Preparation of media and methods of sterilization;
- Seed viability testing, testing of pollen viability;
- Tissue culture of crop plants;
- Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

1. Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.



2. Gabb MH and Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (1+0)

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

1. Bhalla GS and Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
2. Punia MS. *Manual on International Research and Research Ethics*. CCS Haryana Agricultural University, Hisar.
3. Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.
4. Singh K. 1998. *Rural Development - Principles, Policies and Management*. Sage Publ.

2.4 Mandatory requirement of seminars

- It has been agreed to have mandatory seminars one in Masters (One Credit) and two in Doctoral programmes (two Credits).
- The students should be encouraged to make presentations on the latest developments and literature in the area of research topic. This will provide training to the students on preparation for seminar, organizing the work, critical analysis of data and presentation skills.

3. Residential requirements

- The minimum and maximum duration of residential requirement for Masters'



Degree and Ph.D. Programmes shall be as follows:

P.G. Degree Programmes	Duration of Residential Requirement	
	Minimum	Maximum
Masters' Degree	2 Academic Years (4 Semesters)	5 Academic Years (10 Semesters)
Ph.D.*	3 Academic Years (6 Semesters)	7 Academic Years (14 Semesters)

*Student may be allowed to discontinue temporarily only after completion of course work

In case a student fails to complete the degree programme within the maximum duration of residential requirement, his/ her admission shall stand cancelled. The requirement shall be treated as satisfactory in the cases in which a student submits his/ her thesis any time during the 4th and 6th semester of his/ her residency at the University for Masters' and Ph.D. programme, respectively.

4. Evaluation of course work and comprehensive examination

- For M.Sc., multiple levels of evaluation (First Test, Midterm and Final semester) is desirable. However, it has been felt that the comprehensive examination is redundant for M.Sc. students.
- For Ph.D., the approach should be research oriented rather than exam oriented. In order to provide the student adequate time to concentrate on the research work and complete the degree in stipulated time, the examination may have to be only semester final. However, the course teacher may be given freedom to evaluate in terms of assignment/ seminar/ first test.
- For Ph.D., the comprehensive examination (Pre-qualifying examination) is required. As the students are already tested in course examinations, the comprehensive examination should be based on oral examination by an external expert and the evaluation should cover both the research problem and theoretical background to execute the project. This shall assess the aptitude of the student and suitability of the student for the given research topic. The successful completion of comprehensive examination is to obtain the "Satisfactory" remark by the external expert.

5. Advisory System

5.1 Advisory Committee

- There shall be an Advisory Committee for every student consisting of not fewer than three members in the case of a candidate for Masters' degree and four in the case of Ph.D. degree with the Advisor as Chairperson. The Advisory Committee should have representatives from the major and minor fields amongst the members of the Post-graduate faculty accredited for appropriate P.G. level research. However, in those departments where qualified staff exists but due to unavoidable reasons Post-graduate degree programmes are not existing, the staff having Post-graduate teaching experience of two years or more may be included in the Advisory Committee as member representing the minor.
- At any given time, a P.G. teacher shall not be a Chairperson, Advisory Committee (including Master's and Ph.D. programmes) for more than five students.



- The Advisor should convene a meeting of the Advisory Committee at least once in a Semester. The summary record should be communicated to the Head of Department, Dean of the College of concerned, Director (Education)/ Dean PGS and Registrar for information.

Advisor/ Co-guide/ Member, Advisory Committee from other collaborating University/ Institute/ Organization

- In order to promote quality Post-graduate research and training in cutting edge areas, the University may enter into Memorandum of Understanding (MOU) with other Universities/ Institutions for conducting research. While constituting an Advisory Committee of a student, if the Chairperson, Advisory Committee feels the requirement of involving of a faculty member/ scientist of such partnering university/ Institute/ Organization, he/ she may send a proposal to this effect to Director (Education)/ Dean PGS along with the proposal for consideration of Student's Advisory Committee (SAC).
- The proposed faculty member from the partnering institution can be allowed to act as Chairperson/ Co-guide/ Member, SAC, by mutual consent, primarily on the basis of intellectual input and time devoted for carrying out the research work at the particular institution. The faculty member/ scientist of partnering institutions in the SAC shall become a temporary faculty member of the University by following the procedure approved by the Academic Council.

Allotment of students to the retiring persons

Normally, retiring person may not be allotted M. Sc. Student if he/ she is left with less than 2 years of service and Ph.D. student if left with less than 3 years of service. However, in special circumstances, permission may be obtained from the Director (Education)/ Dean PGS, after due recommendation by the concerned Head of the Department.

Changes in the Advisory Committee:

- (i) Change of the Chairperson or any member of the Advisory Committee is not ordinarily permissible. However, in exceptional cases, the change may be effected with due approval of the Director of Education/ Dean PGS.
- (ii) Normally, staff members of the university on extra ordinary leave or on study leave or who leave the University service will cease to continue to serve as advisors of the Post-graduate students of the University. However, the Director (Education)/ Dean PGS may permit them to continue to serve as advisor subject to the following conditions:
 - (a) The concerned staff member must be resident in India and if he/ she agrees to guide research and must be available for occasional consultations;
 - (b) An application is made by the student concerned duly supported by the Advisory Committee;
 - (c) In case of a Ph.D. student, he/ she must have completed his/ her comprehensive examinations and the research work must be well in progress and it is expected that the student will submit the thesis within a year;
 - (d) The Head of the Department and the Dean of the College concerned agree to the proposal;



- (e) The staff member, after leaving the University service is granted the status of honorary faculty's membership by the Vice-Chancellor on the recommendation of the Director (Education)/ Dean PGS for guiding as Chairperson or Member, Advisory Committee the thesis/ theses of the student(s) concerned only.
- (iii) In case the Chairperson/ member of a Student's Advisory Committee retires, he/ she shall be allowed to continue provided that the student has completed his course work and minimum of 10 research credits and the retiring Chairperson/ member stays at the Headquarters of the College, till the thesis is submitted.
- (iv) If the Chairperson/ member proceeds on deputation to another organization, he/ she may be permitted to guide the student provided his/ her new organization is at the Headquarters of the College and his/ her organization is willing for the same.
- (v) The change shall be communicated to all concerned by the Head of Department.

6. Evaluation of research work

- It is highly desirable for Ph.D. programme and this should be done annually as an essential part of research evaluation. The Student Advisory Committee shall review the progress of research and scrutinize annual progress reports submitted by the student.
- Midterm evaluation of Ph.D. (to move from JRF to SRF) is a mandatory requirement for all the funding agencies. Hence, the second review of annual progress report need to be done after completion of two years. The successful completion enables the students to become eligible for SRF.

6.1 Prevention of plagiarism

- An institutional mechanism should be in place to check the plagiarism. The students must be made aware that manipulation of the data/ plagiarism is punishable with serious consequences.

7. Learning through online courses

- In line with the suggestion in new education policy and the initiatives taken by ICAR and MHRD in the form of e-courses, MOOCs, SWAYAM, etc. and also changes taking place globally in respect of learning through online resources it has been agreed to permit the students to enrol for online courses. It is expected that the provision of integrating available online courses with the traditional system of education would provide the students opportunities to improve their employability by imbibing the additional skills and competitive edge.

The Committee recommends the following points while integrating the online courses:

1. Board of Studies (BoS) of each Faculty shall identify available online courses and a student may select from the listed courses. The interested students may provide the details of the on-line courses to the BoS for its consideration.
2. A Postgraduate student may take up to a maximum of 20% credits in a semester through online learning resources.
3. The host institute offering the course does the evaluation and provide marks/ grades. The BoS shall develop the conversion formula for calculation of GPA and it may do appropriate checks on delivery methods and do additional evaluations, if needed.

8. Internship during Masters programme

Internship for Development of Entrepreneurship in Agriculture (IDEA)

Currently, a provision of 30 credits for dissertation work in M.Sc./ M.Tech/ M.F.Sc./ M.V.Sc. programmes helps practically only those students who aspire to pursue their career in academic/ research. There is hardly any opportunity/ provision under this system to enhance the entrepreneurship skills of those students who could start their own enterprise or have adequate skills to join the industry. Therefore, in order to overcome this gap, an optional internship/ in-plant training (called as IDEA) in lieu of thesis/ research work is recommended which will give the students an opportunity to have a real-time hands-on experience in the industry.

It is envisaged that the internship/ in-plant training would enhance the interactions between academic organizations and the relevant industry. It would not only enable the development of highly learned and skilled manpower to start their-own enterprises but also the industry would also be benefitted through this process. This pragmatic approach would definitely result in enhanced partnerships between academia and industry.

The main objectives of the programme:

1. To promote the linkages between academia and industry
2. To establish newer University – Cooperative R&D together with industry for knowledge creation, research and commercialization
3. Collaboration between Universities and industries through pilot projects
4. To develop methods for knowledge transfer, innovation and networking potential
5. To enhance skill, career development and employability

Following criteria for IDEA will be taken into consideration:

- At any point of time there will not be more than 50% of students who can opt under IDEA
- Major Advisor will be from Academia and Co-advisor (or Advisory Committee member) from industry
- Total credits (30) will be divided into 20 for internship/ in-plant training and 10 for writing the report followed by viva-voce similar to dissertation
- Work place will be industry; however, academic/ research support would be provided by the University or both. MoU may be developed accordingly
- The IPR, if any, would be as per the University policy

9. Teaching assistantship

- Teaching assistantship shall be encouraged. This will give the required experience to the students on how to conduct courses, practical classes, evaluation and other related academic matters. This is an important part of Ph.D. training all over the world and it is expected to address the shortage of faculty in many institutions/ universities.
- The fulltime doctoral students of the University with or without fellowship may be considered for award of Teaching Assistantships in their respective Departments. The Teaching Assistantship shall be offered only to those doctoral students who have successfully finished their course work. Any consideration for award of Teaching Assistantships must have the consent of the supervisor concerned.
- Teaching Assistantships shall be awarded on semester to semester basis on the recommendation of a screening/ selection committee to be constituted by the



ViceChancellor. All classes and assignments given to the Teaching Assistants, including tutorials, practicals and evaluation work shall be under the supervision of a faculty member who would have otherwise handled the course/ assignment.

- Each Ph.D. student may be allowed to take a maximum of 16 classes in a month to UG/ Masters students.
- No additional remuneration shall be paid to the students who are awarded ICAR JRF/ SRF. The amount of fellowship to be paid as remuneration to other students (who are receiving any other fellowship or without any fellowships) may be decided by the concerned universities as per the rules in force. However, the total amount of remuneration/ and fellowship shall not exceed the amount being paid as JRF/ SRF of ICAR.
- At the end of each term, Teaching Assistants shall be given a certificate by the concerned Head of the Department, countersigned by the School Dean, specifying the nature and load of assignments completed.

10. Registration of project personnel (SRF/ RA) for Ph.D.

- A provision may be made to enable the project personnel (SRF/ RA) to register for Ph.D. However, this can be done only if they are selected based on some selection process such as walk-in-interview. The prior approval of PI of the project is mandatory to consider the application of project personnel (SRF/ RA) for Ph.D. admission
- The candidates need to submit the declaration stating that the project work shall not be compromised because of Ph.D. programme. Further, in order to justify the project work and Ph.D. programme, the number of course credits should not be more than 8 in a semester for the project personnel (SRF/ RA) who intend to register for Ph.D.

11. Compliance with the National Education Policy-2020

- While implementing the course structure and contents recommended by the BSMA Committees, the Higher Education Institutions (HEIs) are required to comply with the provisions of National Education Policy-2020, especially the following aspects:
- Given the 21st century requirements, quality higher education must aim to develop good, thoughtful, well-rounded, and creative individuals. It must enable an individual to study one or more specialized areas of interest at a deep level, and also develop character, ethical and Constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and 21st century capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects. A quality higher education must enable personal accomplishment and enlightenment, constructive public engagement, and productive contribution to the society. It must prepare students for more meaningful and satisfying lives and work roles and enable economic independence (9.1.1. of NEP-2020).
- At the societal level, higher education must enable the development of an enlightened, socially conscious, knowledgeable, and skilled nation that can find and implement robust solutions to its own problems. Higher education must form the basis for knowledge creation and innovation thereby contributing to a growing national economy. The purpose of quality higher education is, therefore, more than the creation of greater opportunities for individual employment. It represents the key to more vibrant, socially engaged, cooperative communities and a happier,



cohesive, cultured, productive, innovative, progressive, and prosperous nation (9.1.3. of NEP-2020).

- Flexibility in curriculum and novel and engaging course options will be on offer to students, in addition to rigorous specialization in a subject or subjects. This will be encouraged by increased faculty and institutional autonomy in setting curricula. Pedagogy will have an increased emphasis on communication, discussion, debate, research, and opportunities for cross-disciplinary and interdisciplinary thinking (11.6 of NEP-2020).
- As part of a holistic education, students at all HEIs will be provided with opportunities for internships with local industry, businesses, artists, crafts persons, etc., as well as research internships with faculty and researchers at their own or other HEIs/ research institutions, so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability (11.8 of NEP-2020).
- HEIs will focus on research and innovation by setting up start-up incubation centres; technology development centres; centres in frontier areas of research; greater industry-academic linkages; and interdisciplinary research including humanities and social sciences research (11.12. of NEP-2020).
- Effective learning requires a comprehensive approach that involves appropriate curriculum, engaging pedagogy, continuous formative assessment, and adequate student support. The curriculum must be interesting and relevant, and updated regularly to align with the latest knowledge requirements and to meet specified learning outcomes. High-quality pedagogy is then necessary to successfully impart the curricular material to students; pedagogical practices determine the learning experiences that are provided to students, thus directly influencing learning outcomes. The assessment methods must be scientific, designed to continuously improve learning and test the application of knowledge. Last but not least, the development of capacities that promote student wellness such as fitness, good health, psycho-social well-being, and sound ethical grounding are also critical for high-quality learning (12.1. of NEP-2020).

Definitions of Academic Terms

Chairperson means a teacher of the major discipline proposed by the Head of Department through the Dean of the College and duly approved by the Director of Education/ Dean Post Graduate Studies (or as per the procedure laid down in the concerned University regulations) to act as the Chairperson of the Advisory Committee and also to guide the student on academic issues.

Course means a unit of instruction in a discipline carrying a specific number and credits to be covered in a semester as laid down in detail in the syllabus of a degree programme.

Credit means the unit of work load per week for a particular course in theory and/ or practical. One credit of theory means one class of one clock hour duration and one credit practical means one class of minimum two clock hours of laboratory work per week.

Credit load of a student refers to the total number of credits of all the courses he/ she registers during a particular semester.

Grade Point (GP) of a course is a measure of performance. It is obtained by dividing the per cent mark secured by a student in a particular course by 10, expressed and rounded off to second decimal place.

Credit Point (CP) refers to the Grade point multiplied by the number of credits of the course, expressed and rounded off to second decimal place.

Grade Point Average (GPA) means the total credit point earned by a student divided by total number of credits of all the courses registered in a semester, expressed and rounded off to second decimal place.

Cumulative Grade Point Average (CGPA) means the total credit points earned by a student divided by the total number of credits registered by the student until the end of a semester (all completed semesters), expressed and rounded off to second decimal place.

Overall Grade Point Average (OGPA) means the total credit points earned by a student in the entire degree programme divided by the total number of credits required for the P.G. degree, expressed and rounded off to second decimal place.

Restructured and Revised
Syllabi of Post-graduate Programmes
Vol. 3

Basic Veterinary Sciences

- Veterinary Anatomy
- Veterinary Biochemistry
- Veterinary Biotechnology
- Veterinary Extension Education
- Veterinary Physiology

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Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Basic Veterinary Sciences

– Veterinary Anatomy

Preamble

(Veterinary Anatomy)

To enhance the comprehension, the courses of Veterinary Anatomy have been redesigned facilitating learning of Regional Anatomy and to encourage hands on training to PG students. Major emphasis in re-designed courses has been clinical application of the basic knowledge of Anatomy and Histology. Wild life and Forensic Anatomy course and Clinical Anatomy course have been newly introduced at Masters level in view of the importance of wild life and Forensic applications and clinical approaches. Courses like Cross sectional Anatomy first of its kind in Veterinary Anatomy and Animal alternatives in Veterinary Anatomy which is important in view of ban on usage of animals for dissection have been introduced at doctorate level. Similarly some courses are reorganized.



Course Title with Credit Load

M.V.Sc. in Veterinary Anatomy

Course Code	Course Title	Credit Hours
ANA 601	Comparative osteology and arthrology	1+2
ANA 602	Comparative splanchnology	2+2
ANA 603	Myology, angiology, neurology and aesthesiology of Ox	2+2
ANA 604	Gross, histological and histochemical techniques	1+3
ANA 605	Clinical anatomy	0+1
ANA 606	General histology and ultrastructure	1+1
ANA 607	Systemic histology and ultrastructure	3+1
ANA 608	Developmental anatomy	2+1
ANA 609	Wild life and forensic anatomy	1+0
ANA 610	Master's seminar	1+0
ANA 611	Master's research	0+30



Course Contents

M.V.Sc. in Veterinary Anatomy

- I. Course Title** : Comparative Osteology and Arthrology
II. Course Code : ANA 601
III. Credit Hours : 1+2

IV. Aim of the course

To make a student well versed with the bones and joints of different domestic animals.

V. Theory

Unit I

Technical terms, structure, chemical composition and classification of bones.

Unit II

Bones of appendicular skeleton of ox as a type and their comparison with those of horse, sheep, goat, dog, pig and poultry.

Unit III

Bones of axial skeleton of ox as a type and their comparison with those of horse, sheep, goat, dog, pig and poultry.

Unit IV

Classification and detailed study of different joints of the body.

Unit V

Study the various indices for estimating race, sex and age of different animals. Basics of biomechanics of the locomotor system. Radiography of normal and developing bones.

VI. Practical

Demonstration of all bones and dissection of joints of buffalo/ Cattle. Radiographic study of bones and joints

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Technical terms, structure, chemical and physical composition and classification of bones	1
2.	Study on scapula and humerus of ox, horse, dog, pig, sheep, goat and poultry (including clavicle and coracoid).	1
3.	Study on radius and ulna of ox, horse, dog, pig, sheep, goat and poultry.	1
4.	Study on carpals of ox, horse, dog, pig, sheep, goat and poultry.	1
5.	Study on metacarpals and digits including sesamoids of ox, horse, dog, pig, sheep, goat and poultry.	1



S. No.	Topic	No. of Lectures/ Practicals
6.	Comparative study on os-coxae including pelvimetry and femur of ox, horse, dog, pig, sheep, goat and poultry.	1
7.	Comparative study on tibia and fibula of ox, horse, dog, pig, sheep, goat and poultry.	1
8.	Comparative study on tarsal and metatarsal of ox, horse, dog, pig, sheep, goat and poultry.	1
9.	Study on the ethmoid, occipital and sphenoid bone of ox, horse, dog, pig, sheep, goat and poultry.	1
10	Study on the frontal, parietal, interparietal and temporal bones of ox, horse, dog, pig, sheep, goat and poultry.	1
11	Study on the maxilla, premaxilla, palatine, pterygoid, nasal, lacrimal and malar bones of ox, horse, dog, pig, sheep, goat and poultry.	1
12	Study on vomer, hyoid and mandible bones of ox, horse, dog, pig, sheep, goat and poultry	1
13	Study on cervical, thoracic, lumbar, sacral and coccygeal vertebrae of ox, horse, dog, pig, sheep, goat and poultry	1
14	Study on ribs and sternum of ox, horse, dog, pig, sheep, goat and poultry.	1
15	Detailed study of different joints of the body	2
16	Biomechanics of the locomotor system	1
17	Radiographic anatomy	1
	Total	18
Practical		
1	Topographic terms.	1
2	Classification of bones	1
3-4	Comparative study on scapula and humerus	2
5-6	Comparative study on radius and ulna	2
7-8	Comparative study on carpals	2
9-10	Comparative study on metacarpals and digits	2
11	Comparative study on os-coxae and femur	1
12-13	Comparative study on tibia and fibula	2
14	Comparative study on tarsal and metatarsal	2
15-16	Comparative study on the ethmoid, occipital and sphenoid bone	3
17-18	Comparative study on the frontal, parietal, interparietal and temporal bones	2
19-20	Comparative study on the maxilla, premaxilla, palatine pterygoid, nasal, lacrimal and malar bones	2
21-22	Comparative study on vomer, hyoid and mandible bones	2
23-24	Comparative study on cervical and thoracic vertebrae	2
25-27	Comparative study on bones of lumbar, sacral and coccygeal vertebrae.	2
28-30	Comparative study on ribs and sternum	2
31-32	Classification and detailed study of different joints of the body.	2
33-34	Biomechanics of the locomotor system	2
35-36	Radiographic anatomy	2
	Total	36

I. Course Title : Comparative Splanchnology

II. Course Code : ANA 602

III. Credit Hours : 2+2

IV. Aim of the course

To give a detailed overview of different systems constituting splanchnology.



V. Theory

Unit I

Overview of different systems constituting descriptive anatomy of various organs of digestive system and associated glands of ox and their comparison with those of horse, sheep, goat, dog, pig and poultry. Study of formation of thoracic, abdominal and pelvic cavities; reflection of these cavities.

Unit II

Study of various organs/ structures and associated glands constituting the respiratory system of ox and their comparison with those of horse, sheep, goat, dog, pig and poultry.

Unit III

Detailed study of organs and associated glands comprising the urinary system of ox as a type and their comparison with those of horse, sheep, goat, dog, pig and poultry.

Unit IV

Complete study of various organs and associated glands of male and female genital systems.

Unit V

Surgical sites for various operations and clinically significant areas for performing auscultation, percussion and for carrying out surgical procedures such as laryngotomy, oesophagotomy, gastrotomy, rumenotomy, cystotomy, urethrotomy, caesarian section, exploratory laparotomy, mammectomy, thoracotomy, thoracocentesis, etc.

Unit VI

Study of various endocrine organs of ox and their comparison with horse, sheep, goat, dog, pig and poultry

VI. Practical

Demonstration of structure and placement of organs in body cavities of all the animals. Sonographic appearance of different organs.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction	1
2.	Study of topographic anatomy and reflection of thoracic, abdominal and pelvic cavities in ox, horse, dog, pig, sheep, goat and poultry	2
3.	Comparative anatomy of oral cavity in ox, horse, dog, sheep, goat and pig.	2
4.	Comparative anatomy of dentition in ox, horse, dog, sheep, goat and pig,	1
5.	Comparative anatomy of tongue in ox, horse, dog, sheep, goat and pig.	1
6.	Comparative anatomy of esophagus in different species	1
7.	Study of the salivary glands of various species	1
8.	Study of ruminant stomach along with omentum	2
9.	Study of monogastric stomach and omentum of various species	2
10.	Comparative anatomy of small intestines of various species	1
11.	Comparative anatomy of large intestines of various species	1



S. No.	Topic	No. of Lectures/ Practicals
12.	Study of liver and gall bladder of various species	1
13.	Study of spleen and pancreas of various species	1
14.	Study of digestive system of poultry	1
15-16.	Study of nasal cavity in ox, horse, dog, sheep, goat and pig	2
17.	Study of larynx of various species	1
18.	Study of trachea of various species	1
19.	Comparative anatomy of lungs of various species	2
20.	Study of digestive system of fowl	1
21.	Study of kidneys of various species	1
22.	Study of ureter and urinary bladder	1
23.	Study of urethra	1
24.	Study of male genital system and associated organs of various species	1
25.	Study of female genital system and associated organs of various species	2
26.	Study of male and female genital system of fowl	1
27.	Study of udder of different species of animals	1
28.	Study of body cavities	1
	Total	35
Practical		
1.	Introduction	1
2.	Study of topographic anatomy of thoracic, abdominal and pelvic cavities in different animals.	2
3.	Comparative anatomy of oral cavity in ox, horse, dog, sheep, goat and pig.	2
4.	Comparative anatomy of dentition in ox, horse, dog, sheep, goat and pig,	1
5.	Comparative anatomy of tongue in ox, horse, dog, sheep, goat and pig.	1
6.	Comparative anatomy of esophagus in different species	1
7.	Study of the salivary glands of various species.	1
8.	Study of ruminant stomach along with omentum	2
9.	Study of monogastric stomach and omentum of various species	2
10.	Comparative anatomy of small and large intestines and anus of various species	2
11.	Study of liver and gall bladder, spleen, pancreas of various species	2
12.	Study of larynx of various species	1
13.	Comparative anatomy of lungs of various species	2
14.	Study of body cavities	2
15-16.	Study of urinary system and associated organs of various species	2
17.	Study of male genital system and associated organs of various species	2
18.	Comparative study of accessory sex glands in different species	1
19.	Study of female genital system and associated organs of various species	2
20.	Study of endocrine organs of various species	2
21.	Study of udder of different species of animals	1
	Total	32

I. Course Title : Myology, Angiology, Neurology and Aesthesiology of Ox

II. Course Code : ANA 603

III. Credit Hours : 2 +2

IV. Aim of the course

To give a thorough knowledge about the muscles, course of blood vessels and



nerves of the body in addition to various organs of circulatory, nervous and sensory systems of ox as a type animal.

V. Theory

Unit I

Classification of muscle fibres. Origin, insertion and relations of muscles of different body parts.

Unit II

Topographic anatomy of the vascular system comprising of heart, arteries, veins and lymphatics.

Unit III

Study of various components of central nervous system, peripheral nervous system and autonomic nervous system.

Unit IV

Complete study of the gross anatomy of various sense organs.

Unit V

Study of different nerve blocks, intravenous sites and enucleation of eye ball.

VI. Practical

Dissection of heart, different vessels, brain, cranial nerves, brachial plexuses and lumbo-sacral plexus. Dissection of eye, ear, hoof and horn of buffalo/ cattle.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Myology and organization of various types of muscles	2
2.	Heart and pericardium	4
3.	Muscles and blood supply to the head and neck	3
4.	Muscles and blood supply to the forelimb	3
5.	Muscles of thorax and abdomen and thoracic aorta, abdominal aorta and its branches	2
6.	Muscles and blood supply to the hind limb	2
7.	Venous system	2
8.	Lymph glands and its afferent and efferent vessels	2
9.	Study of brain	2
10.	Study of cranial nerves	2
11.	Study of spinal cord and spinal nerves	2
12.	Brachial and lumbo-sacral plexus	2
14.	Structure of eye ball	2
15.	Structure of external, middle and internal ear of different species	2
16.	Study of hoof	2
17.	Study of horn	2
	Total	36
Practical		
1	Introduction to general myology	1
2	Structure of heart	2
3	Brachiocephalic trunk, course of aorta, coronary arteries and pulmonary trunk	1
4	Bicarotid trunk	1



S. No.	Topic	No. of Lectures/ Practicals
5	Blood supply to the forelimb	1
6	Thoracic aorta and its branches abdominal aorta	1
7	Abdominal aorta and its branches	1
8	Blood supply to the hind limb	1
9	Meninges	1
10	Dorsal and ventral aspect of brain and ventricles of brain, sagittal sections of brain of different species	1
11	Cranial nerves,	1
12	Spinal cord and spinal nerves	1
13	Brachial plexus	1
14	Lumbo-sacral plexus	1
15	Venous drainage and lymphatic system	1
16	Blood supply to the brain	2
17	Study of eye	1
18	Study of ear	1
19	Autonomic nervous system	1
20	Muscle of face, larynx, mastication, soft palate, tongue, pharynx and ear	4
21	Muscles of neck	2
22	Muscles of fore limb	2
23	Muscles of thorax	1
24	Muscles of, abdomen	1
25	Muscles of hip and thigh	2
26	Extensors and flexors of hind limb	1
27	Muscles of tail and penis	1
	Total	34

I. Course Title : Gross, Histological and Histochemical Techniques

II. Course Code : ANA 604

III. Credit Hours : 1+3

IV. Aim of the course

Hands-on training for preparation of gross anatomical specimens and processing of tissues to demonstrate structural components by different stains for research and teaching purposes.

V. Theory

Unit I

Preparation of tissues for microtomy and light microscopy using different fixatives.

Unit II

Different staining methods for routine light microscopy and special staining methods.

Unit III

Frozen sectioning techniques and staining methods for enzymes, carbohydrates, lipids, proteins, pigments, etc.

Unit IV

Silver staining techniques for nervous tissue.



Unit V

Preparation of tissue for electron microscopic studies

VI. Practical

Embalming fluids, embalming of animals, maceration and preparation of skeletons. Gross staining of brain sections. Demonstration of sites of ossifications. Preparation of transparent specimens, preparation of casts of various organs, blood vessels and ducts, etc. Study of different techniques for collection, fixation and processing of animal tissues; preparation of paraffin and frozen sections; handling and care of microtomes. Demonstration of staining of carbohydrates, lipids, proteins, nucleic acids and enzymes.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	Embalming fluid and its preparation	1
2	Embalming techniques, formalin and modified gravity feed embalming technique.	1
3	Maceration and preparation of skeletons; taxidermy, burial method, chemical method(sodium hydroxide method) gross staining of brain specimens different species; Tompsett 1955, Mulligam 1931 for gray matter, Waldman and Michaels (1954) for white matter, Hewitt method	1
4	Demonstration of sites of ossifications alizarin red technique	1
5	Preparation of transparent specimens of various organs, plastination	1
5	Preparation of transparent specimens of various organs, plastination	1
7	Chemical composition of a living cell	1
8	Fixation of tissue samples with different fixatives and post fixation of tissue samples	1
9	Embedding, block preparation and paraffin sectioning.	1
10	Natural and synthetic dyes	1
11	Metachromasia and supravital staining	1
12	Routine hematoxylin and eosin staining	1
13	Special staining for connective, muscular and nervous tissue.	1
14	Staining for carbohydrates and proteins and lipids.	1
15	Special stain for demonstration of nucleic acids	1
16	Special staining for cytoplasmic granules and pigments and minerals	1
17	Differential staining for cell types	1
18	Demonstration of silver staining techniques	1
	Total	18
Practical		
1	Embalming fluid and its preparation	2
2	Embalming techniques, formalin and modified gravity feed embalming technique.	2
3	Maceration and preparation of skeletons; taxidermy, burial method, chemical method(sodium hydroxide method) gross staining of brain specimens different species; Tompsett 1955, Mulligam 1931 for gray matter, Waldman and Michaels (1954) for white matter, Hewitt method	2
4	Demonstration of sites of ossifications alizarin red technique	2
5	Preparation of transparent specimens of various organs, plastination	2
6	Preparation of casts of various organs, vinyl acetate cast	2
7	Chemical composition of a living cell	2
8	Fixation of tissue samples with different fixatives	4



S. No.	Topic	No. of Lectures/ Practicals
9	Post fixation of tissue samples	2
10	Embedding, block preparation and paraffin sectioning.	4
11	Natural and synthetic dyes	2
12	Metachromasia and supravital staining	2
13	Routine hematoxylin and eosin staining	2
14	Special staining for connective: elastic, reticular and collagen fibres, muscular and nervous tissue.	4
15	Staining for carbohydrates: pas, amp and proteins.	2
16	Special stain for demonstration of nucleic acids, lipids and enzymes	2
17	Special staining for cytoplasmic granules	2
18	Special staining for pigments and minerals	2
19	Differential staining for cell types	2
20	Demonstration of silver staining techniques	2
	Total	48

I. Course Title : Clinical Anatomy

II. Course Code : ANA 605

III. Credit Hours : 0+1

IV. Aim of the course

To give exposure to different clinical conditions.

V. Practicals

Clinical examination of animal in health and disease, auscultation of different organs, different types of nerve blocks, surgical conditions of different body systems, radiographical techniques and post-mortem examination.

S. No.	Topic	No. of Lectures/ Practicals
Practical		
1.	Clinical examination of animal by palpation, percussion and auscultation	1
2.	Site to record temperature, pulse, palpable lymph nodes, collection of blood and pregnancy diagnosis in domestic animals	1
3.	Area of auscultation for lungs and heart, passing of probang	1
4.	Preferable site for injections in domestic animals (intradermal, subcutaneous, intramuscular, intravenous, intracardiac, intratracheal, subconjunctival, intra-articular, epidural)	1
5.	Nerve blocks of head region (frontal, infraorbital, mandibulo-alveolar, mental, retrobulbar, Peterson, auriculopalpebral and cornual) for different surgical conditions (extraction of tooth, trephining of frontal and maxillary sinuses, extirpation of eye ball, amputation of horn, haematoma)	2
6.	Surgical conditions of respiratory system (catheterization of guttural pouch, ventriculectomy in horse, tracheotomy, thoracocentesis)	1
7.	Paravertebral nerve block, paracentesis, rumenocentesis. Surgical conditions of digestive system (passing of stomach tube, ligation of parotid duct, oesophagotomy, abdominocentesis, rumenotomy, laparotomy/ celiotomy, gastrotomy, splenectomy, enterotomy, extirpation of anal sacs in dog)	2



S. No.	Topic	No. of Lectures/ Practicals
8.	Surgical conditions of urinary system (urethrotomy, puncturing of urinary bladder, catheterization of urinary bladder, cystotomy)	1
9.	Surgical conditions of genital system (hysterotomy/ caesarean section, ovario-hysterectomy (spaying), castration, vasectomy, caponing in fowl)	1
10.	Nerve blocks of fore limb (radial, median, ulnar, volar digital nerves) for surgical affections	1
11.	Nerve blocks of hind limb (tibial, peroneal, saphenous, plantar digital nerves) for surgical affections including patellar desmotomy	1
12.	Nerve blocks (pudic, cranial epidural, caudal epidural) for surgical affections including docking	1
13.	Radiographical techniques, contrast radiography	1
14.	Radiographic visualization of organs of thoracic and abdominal cavity	1
15.	Radiographic visualization of organs of pelvic cavity	1
16.	Post-mortem examination and collection of material for teaching and research	1
	Total	16

I. Course Title : General Histology and Ultrastructure

II. Course Code : ANA 606

III. Credit Hours : 1+1

IV. Aim of the course

To understand basic principles of light microscopy and light and ultrastructure of four basic tissues.

V. Theory

Unit I

Light and ultrastructural details of animal cell.

Unit II

Light and ultrastructural details of epithelial tissue.

Unit III

Light and ultrastructural details of muscular tissue.

Unit IV

Light and ultrastructural details of connective tissue.

Unit V

Light and ultrastructural details of nervous tissue.

VI. Practical

Demonstration of different components of cells and intercellular substances of the above referred tissues by special staining through the use of light, phase contrast, dark field, fluorescent and electron microscopes.



S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to animal cell and Study of plasma membrane	1
2.	Study of nucleus and nuclear membrane and Study of mitochondria and endoplasmic reticulum	1
3.	Study of Golgi apparatus, centriole, lysosomes, microtubules, microfilaments, etc.	1
4.	Cell division and Cell wall modifications and junctional complexes	1
5.	Light and ultrastructural study of different types of epithelial tissue and glands	2
6.	Light and ultrastructural study of different types of muscular tissue	1
7.	Introduction to different types of connective tissue and Detailed study of connective tissue fibres; collagen, reticular and elastic	1
8.	Study of different cell types of connective tissue, constituents of ground substance	1
9.	Study of different types of connective tissues	1
10.	Light and ultrastructural details of different cartilages; hyaline, elastic and fibrous cartilage	1
11.	Light and ultrastructural details of bone	1
12.	Structural details of blood and its different constituents	2
13.	Light and ultrastructural study of neurons and neuroglial cells of CNS and PNS, nerves, ganglion, etc.	2
	Total	16
Practical		
1.	Study on electron micrographs of an animal cell to distinguish different organelles	1
2.	Study of electron micrographs of plasma membrane, nucleus and nuclear membrane	2
3.	Study of electron micrographs of mitochondria, Golgi apparatus and endoplasmic reticulum	1
4.	Study of different types of epithelial tissues by light microscope	1
5.	Study of different types of epithelial tissues and glands by electron micrographs	1
6.	Study of different types of Muscle tissues by light microscope	1
7.	Study of different types of Muscle tissues by electron micrographs	1
8.	Study of different types of connective tissue fibres and cells	1
9.	Study of different types of connective tissues	3
10.	Study of different types of cartilages	1
11.	Study of Bone; ground bone and decalcified bone	1
12.	Study of different constituents of blood	1
13.	Light and ultrastructural study of nervous tissue	2
	Total	17

I. Course Title : Systemic Histology and Ultrastructure

II. Course Code : ANA 607

III. Credit Hours : 3+1

IV. Aim of the course

To understand and identify arrangement of four basic tissues in organs of different body systems



V. Theory

Unit I

Light and ultrastructure of different organs of digestive system of ruminants with differential features among domestic animals.

Unit II

Light and ultrastructure of different organs of respiratory, lymphoid and cardiovascular systems.

Unit III

Light and ultrastructure of different organs of urino-genital systems.

Unit IV

Light and ultrastructure of different sense organs and nervous system.

Unit V

Light and ultrastructure of different organs of endocrine system

VI. Practical

Study of histological structure of organs of digestive, respiratory, urinary, genital and cardiovascular systems of buffalo, horse and dog/ cat.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	General organization of the wall of tubular organs	1
2.	Light microscopic and ultra structural study of tongue, lip and cheek	2
3.	Light microscopic and ultra structural study of salivary gland	2
4.	Light microscopic and ultra structural study of pharynx and oesophagus	2
5.	Light microscopic and ultra structural study of rumen, reticulum and omasum	2
6.	Light microscopic and ultra structural study of abomasum	2
7.	Light microscopic and ultra structural study of small intestine	2
8.	Light microscopic and ultra structural study of large intestine	2
9.	Light microscopic and ultra structural study of liver	2
10.	Light microscopic and ultra structural study of pancreas and gall bladder	2
11.	Light microscopic and ultra structural study of nasal cavity	1
12.	Light microscopic and ultra structural study of larynx and trachea	2
13.	Light microscopic and ultra structural study of lungs	2
14.	Light microscopic and ultra structural study of cardiovascular system including heart	2
15.	Light microscopic and ultra structural study of lymphoid organs	2
16.	Light microscopic and ultra structural study of ovary	2
17.	Light microscopic and ultra structural study of oviduct and uterus	2
18.	Light microscopic and ultra structural study of cervix, vagina and mammary glands	2
19.	Light microscopic and ultra structural study of testes	2
20.	Light microscopic and ultra structural study of epididymis and vas deferens	1
21.	Light microscopic and ultra structural study of urethra and accessory sex glands and penis	2



S. No.	Topic	No. of Lectures/ Practicals
22.	Light microscopic and ultra structural study of kidney	2
23.	Light microscopic and ultra structural study of ureter, urinary bladder and urethra	1
24.	Light microscopic and ultra structural study of endocrine glands; thyroid, pituitary, adrenal gland, parathyroid, pineal gland	2
25.	Light and ultrastructural details of Spinal cord, cerebrum and cerebellum	1
26.	Light microscopic and ultra structural study of integument	1
27.	Light microscopic and ultra structural study of eye	2
28.	Light microscopic and ultra structural study of ear	2
	Total	50

Practical

1.	Light microscopic and ultra structural study of lip and cheek, tongue and salivary glands	1
2.	Light microscopic and ultra structural study of pharynx and oesophagus	1
3.	Light microscopic and ultra structural study of rumen, reticulum, Omasum and abomasum	1
4.	Light microscopic and ultra structural study of small intestine	1
5.	Light microscopic and ultra structural study of large intestine	1
6.	Light microscopic and ultra structural study of liver, pancreas and gall bladder	1
7.	Light microscopic and ultra structural study of larynx and trachea	1
8.	Light microscopic and ultra structural study of lungs	1
9.	Light microscopic and ultra structural study of cardiovascular system including heart	1
10.	Light microscopic and ultra structural study of lymphoid organs	1
11.	Light microscopic and ultra structural study of ovary and oviduct	1
12.	Light microscopic and ultra structural study of uterus, cervix, vagina and mammary glands	1
13.	Light microscopic and ultra structural study of male reproductive system	1
14.	Light microscopic and ultra structural study of kidney, ureter, urinary bladder and Urethra	1
15.	Light microscopic and ultra structural study of endocrine glands; thyroid, pituitary, adrenal gland, parathyroid, pineal gland	1
16.	Light and ultrastructural study of Spinal cord, cerebrum and cerebellum	1
17.	Light microscopic and ultra structural study of sense organs	1
	Total	17

I. Course Title : Developmental Anatomy

II. Course Code : ANA 608

III. Credit Hours : 2+1

IV. Aim of the course

To understand the developmental processes of different body systems at various stages of pregnancy.

V. Theory**Unit I**

Gametogenesis, Classification of eggs, fertilization, cleavage and gastrulation



Unit II

Development of foetal membranes and placenta in domestic animals.

Unit III

Histogenesis of nervous system, sense organs, lymphoid organs, endocrine organs and cardiovascular system

Unit IV

Embryonic development of digestive, respiratory, uro-genital and musculoskeletal system.

VI. Practical

Study of serial sections of the chick and pig embryos at different stages of development.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to Embryology, history of embryology, term used in embryology Gametogenesis; Spermatogenesis	2
2.	Oogenesis; classification of eggs, structure of mammalian and avian eggs	2
3.	Fertilization, Cleavage Implantation Placentation	2
4.	Blastulation Gastrulation, formation of extra embryonic membranes	2
5.	Formation of extra embryonic membranes	2
6.	Organogenesis and histogenesis of nervous system,	2
7.	Development of sense organs	2
8.	Development of endocrine organs	2
9.	Cardiovascular system including fetal circulation.	2
10.	Embryonic development of gastro-intestinal tract	2
11.	Development of liver, pancreas and gall bladder	2
12.	Development of Respiratory system	2
13.	Development of urinary system	2
14.	Male reproductive system	2
15.	Female reproductive system	2
16.	Musculoskeletal system	2
	Total	32
Practical		
1.	Study of sperm and ova	1
2.	Cleavage, Blastulation and Gastrulation	1
3.	Study of whole mount sections of chick embryo and serial sections of chick embryo	1
4.	Organogenesis, Development of nervous system	1
5.	Organogenesis, Development of digestive system	2
6.	Organogenesis. Development of respiratory system	2
7.	Organogenesis, Development of cardiovascular system	2
8.	Organogenesis, Development of endocrine system	1
9.	Organogenesis, Development of urinary system	2
10.	Organogenesis, Development of male and female reproductive system	2
11.	Determination of age of different species of embryo	1
	Total	16



- I. Course Title** : **Wild Life and Forensic Anatomy**
II. Course Code : **ANA 609**
III. Credit Hours : **1+0**

IV. Aim of the course

To give exposure to different body systems of wild animals of local region for the forensic purpose.

V. Theory

Unit I

Importance of anatomy of wild animals in veterinary anatomy.

Unit II

Anatomy of different body systems of wild animals.

Unit III

Anatomy of different body systems of wild birds.

Unit IV

Application of wild life anatomy in forensic veterinary medicine

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction, scope and importance of anatomy of wild animals	1
2.	Origin, evolution and classification of wild mammals and birds	1
3.	Morphological adaptations of wild mammals and birds	1
4.	Radiography and ultrasonography as a tool to study wild life anatomy	1
5.	Anatomy of skeletal system of Elephants with special emphasis on dentition and ageing and sexual dimorphism	1
6.	Anatomy of digestive, respiratory, reproductive and urinary systems of elephants	1
7.	Anatomy of skeletal system of wild carnivores including lion, tiger, leopard, cheetah, wolf and fox.	1
8.	Anatomy of digestive, respiratory, reproductive and urinary systems of wild carnivores	1
9.	Anatomy of skeletal, digestive, respiratory, reproductive and urinary systems of wild ruminants	1
10.	Anatomy of skeletal, digestive, respiratory, reproductive and urinary systems of wild primates	1
11.	Anatomy of skeletal system of Cervidae family	1
12.	Anatomy of digestive, respiratory, reproductive and urinary systems of Cervidae family	1
13.	Anatomy of cardio-vascular system of wild animals	1
14.	Anatomy of nervous system of wild animals	1
15.	Anatomy of sense organs of wild animals	1
16.	Anatomy of wild birds	1
17.	Application of wild life anatomy in forensic veterinary medicine	1
18.	Clinical anatomy of captive wild animals	1
	Total	18



Course Title with Credit Load Ph.D. in Veterinary Anatomy

Course Code	Course Title	Credit Hours
RPE 700	Research and Publication Ethics*	1+1
ANA 701	Myology, angiology, neurology and aesthesiology of equine, canine and porcine	2+1
ANA 702	Principles and applications of biomechanics	1+0
ANA 703	Avian anatomy	1+1
ANA 704	Neuroanatomy	2+1
ANA 705	Comparative endocrine anatomy	1+1
ANA 706	Theory and applications of electronmicroscopy	1+1
ANA 707	Histoenzymology and immunocytochemistry	2+1
ANA 708	Applied embryology and teratology	1+1
ANA 709	Functional veterinary anatomy	1+0
ANA 710	Gross anatomy of laboratory animals	1+1
ANA 711	Cross sectional anatomy of ox	0+1
ANA 712	Animal alternatives in veterinary anatomy	1+1
ANA 713	Special problem	0+2
ANA 714	Doctoral seminar- I	1+0
ANA 715	Doctoral seminar- II	1+0
ANA 716	Doctoral research	0+75

*Compulsory Major course for Doctorate programme. The other 10 credits can be registered from remaining 700 Series courses listed above. Suggested list of specified Minor subjects (Departments).

Major Subject	Supporting subjects (Departments)*
Veterinary Anatomy	Biochemistry, Physiology, Veterinary Pathology, Veterinary Gynaecology and Obstetrics, Veterinary Surgery and Radiology, Biotechnology.

*The Minor courses may be taken from any number of disciplines/ departments listed against major discipline limiting to credits prescribed as decided by the Chairman of Advisory Committee of the student.

Minor courses may also be taken from the disciplines/ departments other than those listed above on the recommendations of advisory committee, if essentially required as per the research problem with the concurrence of Head of the Department and Concerned Authorities.



Course Contents

Ph.D. in Veterinary Anatomy

- I. Course Title** : Myology, Angiology, Neurology And Aesthesiology Of Equine, Canine And Porcine
- II. Course Code** : ANA 701
- III. Credit Hours** : 2+1

IV. Aim of the course

To teach students about anatomy of muscles, blood vessels, nervous tissue and sense organs in equine, canine and porcine.

V. Theory

Unit I

Comparative study of mycology of horse, dog and pig.

Unit II

Comparative study of angiology of horse, dog and pig.

Unit III

Comparative study of neurology of horse, dog and pig.

Unit IV

Comparative study of aesthesiology of horse, dog and pig.

VI. Practical

Dissection of different body regions with respect to muscles, blood vessels and nerves; and see the topographic positioning of different organs in different body cavities in equine, canine and porcine.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Comparative study of muscles of head and neck of horse, dog and pig	2
2.	Comparative study of muscles of forelimb: shoulder and arm	1
3.	Comparative study of extensor and flexors of forelimb	1
5.	Comparative study of muscles of abdomen	1
7.	Comparative study of muscles of pelvic region, hind limb and tail	2
8.	Comparative study of topography and structure of heart, blood supply to heart	2
9.	Study of arterial supply to head and neck	2
10.	Comparative study of blood supply to the forelimb	1
11.	Study of the collateral and terminal branches of aorta	2
12.	Comparative study of blood supply to the hind limb	2
13.	Comparative study of venous system	1
14.	Study the lymphatic system	1
15.	Comparative study of brain and spinal cord	2
16.	Study of cranial nerves	2



S. No.	Topic	No. of Lectures/ Practicals
17.	Study of brachial plexus and its branches	1
18.	Study of cervical, thoracic and lumbar nerves	1
19.	Comparative study of lumbo-sacral plexus	2
20.	Comparative study of eye	1
21.	Comparative study of ear	1
22.	Comparative study of hoof	1
23.	Comparative study of gustatory and olfactory organs	1
	Total	32
Practical		
1.	Comparative study of muscles of head and neck of horse, dog and pig	1
2.	Comparative study of muscles of forelimb: shoulder, arm extensors and flexors	1
3.	Comparative study of muscles of abdomen	1
4.	Comparative study of muscles of pelvic region, hind limb and tail	1
5.	Comparative study of topography and structure of heart, blood supply to heart	1
6.	Study of arterial supply to head and neck	1
7.	Comparative study of blood supply to the forelimb	1
8.	Study of the collateral and terminal branches of aorta	1
9.	Comparative study of blood supply to the hind limb	1
10.	Comparative study of venous and lymphatic system	1
11.	Comparative study of brain and spinal cord	1
12.	Study of cranial nerves	1
13.	Study of brachial plexus and its branches	1
14.	Study of cervical, thoracic and lumbar nerves	1
15.	Comparative study of lumbo-sacral plexus	1
16.	Comparative study of eye and ear	1
17.	Comparative study of hoof	1
18.	Comparative study of gustatory and olfactory organs	1
	Total	18

I. Course Title : Principles and Applications of Biomechanics

II. Course Code : ANA 702

III. Credit Hours : 1+0

IV. Aim of the course

To sensitize the student about the importance of biomechanics.

V. Theory

Unit I

Biomechanics, its definition and scope with reference to anatomy and physiology of domestic animals and musculo-skeletal dynamics.

Unit II

Locomotion and clinical applications. Biomechanics of cortical and trabecular bones.

Unit III

Biomechanics of fracture fixation. Instrumentation and techniques in locomotion and their applications in lameness.



S. No.	Topic	No. of Lectures
Theory		
1.	Definition of Biomechanics and its classification.	1
2.	Scope Biomechanics of with reference to anatomy and physiology of domestic animals	1
3.	Musculo-skeletal dynamics	2
4.	Locomotion and its type in domestic animals	2
5.	Instrumentation and techniques in locomotion and their applications in lameness.	2
6.	Biomechanics of microscopic structures	1
7.	Polariscope, its principle and application	2
8.	Biomechanics of cortical and trabecular bones.	1
9.	Biomechanics of articular cartilages	2
10.	Biomechanics of mammalian body; bow and string theory	2
11.	Biomechanics of fracture fixation	1
12.	Biomechanics of heart	1
	Total	18

I. Course Title : Avian Anatomy

II. Course Code : ANA 703

III. Credit Hours : 1+1

IV. Aim of the course

To give detailed overview of poultry anatomy.

V. Theory

Unit I

The study of the gross features of different body systems of domestic fowl.

Unit II

The study of microscopic features of different body systems of domestic fowl.

VI. Practical

Dissection and demonstration of various body systems of fowl and different domestic birds. Microscopic examination of slides of various organ systems of fowl.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	The study of gross features of axial and appendicular skeleton of domestic fowl	1
2	Study of various joints of axial and appendicular skeleton of domestic fowl	2
3	Gross and microscopic study of muscular system of domestic fowl	1
4	Gross and microscopic study of digestive system of domestic fowl.	2
5	Gross and microscopic study of respiratory organs of domestic fowl.	1
6	Gross and microscopic study of urinary organs of domestic fowl.	1
7	Gross and microscopic study of reproductive system of domestic fowl.	1
8	Study of the blood of domestic fowl.	2
9	Gross and microscopic study of circulatory system of domestic fowl.	1
10	Gross and microscopic study of nervous system of domestic fowl.	1



S. No.	Topic	No. of Lectures/ Practicals
11	Gross and microscopic study of eye and its appendages of domestic fowl.	1
12	Gross and microscopic study of ear of domestic fowl.	1
13	Gross and microscopic study of skin and its appendages of domestic fowl.	1
14	Gross and microscopic study of lymphoid organ of domestic fowl.	1
15	Gross and microscopic study of endocrine system of domestic fowl.	1
	Total	18
Practical		
1	The study of gross features of axial and appendicular skeleton of domestic fowl and turkey	1
2	Study of various joints of axial and appendicular skeleton of domestic fowl	2
3	Gross and microscopic study of muscular system of domestic fowl	1
4	Gross and microscopic study of digestive system of domestic fowl.	2
5	Gross and microscopic study of respiratory organs of domestic fowl.	1
6	Gross and microscopic study of urinary organs of domestic fowl.	1
7	Gross and microscopic study of reproductive system of domestic fowl.	1
8	Study of the blood of domestic fowl.	2
9	Gross and microscopic study of circulatory system of domestic fowl.	1
10	Gross and microscopic study of nervous system of domestic fowl.	1
11	Gross and microscopic study of eye and its appendages of domestic fowl.	1
12	Gross and microscopic study of ear of domestic fowl.	1
13	Gross and microscopic study of skin and its appendages of domestic fowl.	1
14	Gross and microscopic study of lymphoid organ of domestic fowl.	1
15	Gross and microscopic study of endocrine system of domestic fowl.	1
	Total	18

I. Course Title : Neuroanatomy

II. Course Code : ANA 704

III. Credit Hours : 2+1

IV. Aim of the course

To provide in-depth knowledge of nervous system.

V. Theory

Unit I

The gross and microscopic anatomy of the brain and spinal cord.

Unit II

Study of various cranial and spinal nerves along with their associated nuclei and ganglia.

Unit III

Motor and sensory pathways, different ascending and descending tracts of brain and spinal cord and autonomic nervous system.

VI. Practical

Gross dissection and microscopic examination of the brain and spinal cord; demonstration of the nerves, nerve plexuses, ganglia of cranial importance, study of the serial sections of the brain and spinal cord in domestic animals.



S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	The gross and microscopic study of anatomy of brain, limbic system, reticular formation, lemniscal system, pyramidal system, extrapyramidal system	5
2.	Study of cranial nerves along with their associated nuclei and ganglia	5
3.	The gross and microscopic study of spinal cord including tracts and pathways	4
4.	Study of spinal nerves along with their associated nuclei and ganglia	4
5.	Hypothalamo-hypophysial system	4
6.	Brachial plexus	3
7.	Lumbo-sacral plexus	3
8.	Study of autonomic nervous system	5
	Total	33
Practical		
1.	The gross and microscopic study of anatomy of brain, limbic system, reticular formation, lemniscal system, pyramidal system, extrapyramidal system	2
2.	Study of cranial nerves along with their associated nuclei and ganglia	2
3.	The gross and microscopic study of Spinal cord including tracts and pathways	2
4.	Study of spinal nerves along with their associated nuclei and ganglia	2
5.	Hypothalamo-hypophysial system	2
6.	Brachial plexus	2
7.	Lumbo-sacral plexus	2
8.	Nerve blocks	2
9.	Study of autonomic nervous system	2
	Total	18

I. Course Title : Comparative Endocrine Anatomy

II. Course Code : ANA 705

III. Credit Hours : 1+1

IV. Aim of the course

To project the importance and details of endocrine glands.

V. Theory

Unit I

Advanced gross and microscopic anatomy of the pituitary gland.

Unit II

Advanced gross and microscopic anatomy of the thyroid, parathyroid and thymus.

Unit III

Advanced gross and microscopic anatomy of the adrenal gland, islets of Langerhans, corpus luteum, Leydig cells, pineal body and other tissues associated with endocrine secretions

VI. Practical

Demonstration of the topographic anatomy in the embalmed specimens and microscopic examination of the endocrine glands of ruminants.



S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction and general characteristics of endocrine gland	2
2.	Gross, microscopic and ultra structural study of Pituitary gland	1
3.	Gross, microscopic and ultra structural study of thyroid gland	1
4.	Gross, microscopic and ultra structural study of parathyroid gland	2
5.	Gross, microscopic and ultra structural study of thymus	2
6.	Gross, microscopic and ultra structural study of adrenal gland	1
7.	Gross, microscopic and ultra structural study of hypothalamus and Pineal	1
8.	Microscopic and ultra structural study of islets of Langerhans	2
9.	Gross, microscopic and ultra structural study of endocrine glands of male reproductive system	1
10.	Gross, microscopic and ultra structural study of endocrine glands of female reproductive system including corpus luteum	2
11.	Study of paraganglia, diffused endocrine system cells, endocrine cells of heart and kidney	2
12.	Advances in gross and microscopic anatomy of endocrine glands of gastro-intestinal tract	1
	Total	18
Practical		
1.	Introduction and general characteristics of endocrine gland	1
2.	Gross, microscopic and ultra structural study of Pituitary gland	2
3.	Gross, microscopic and ultra structural study of thyroid gland	1
4.	Gross, microscopic and ultra structural study of parathyroid gland	1
5.	Gross, microscopic and ultra structural study of thymus	1
6.	Gross, microscopic and ultra structural study of adrenal gland	1
7.	Gross, microscopic and ultra structural study of hypothalamus and Pineal	2
8.	Microscopic and ultra structural study of islets of Langerhans	1
9.	Gross, microscopic and ultra structural study of endocrine glands of male reproductive system	2
10.	Gross, microscopic and ultra structural study of endocrine glands of female reproductive system including corpus luteum	2
11.	Study of paraganglia, diffused endocrine system cells, endocrine cells of heart and kidney	2
12.	Advances in gross and microscopic anatomy of endocrine glands of gastro-intestinal tract	2
	Total	18

I. Course Title : Theory and Applications of Electron Microscope

II. Course Code : ANA 706

III. Credit Hours : 1+1

IV. Aim of the course

To give an overview of the electron microscope.

V. Theory

Unit I

Introduction and principles of electron microscopy.

Unit II

Methods for transmission electron microscopy.

**Unit III**

Methods for scanning electron microscopy.

VI. Practical

Preparation of blocks and demonstration of various techniques used for carrying out TEM and SEM.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction of the electron microscope	1
2.	Principles of transmission electron microscopy	1
4.	Collection and fixation of samples for electron microscopy, various fixatives used in electron microscopy	2
5.	Principles of scanning electron microscopy and processing of samples for transmission electron microscopy	1
6.	Processing of samples for scanning electron microscopy	1
9.	Ultramicrotomy (semithin and ultra thin sections)	1
10.	Coating of grids with supportive films	1
11.	Staining of semi thin and ultra thin sections	1
12.	Negative staining	1
13.	Applications of scanning and transmission electron microscopy	1
14.	Cryo-electron microscopy	1
15.	Immuno electron microscopy	1
16.	Strategies in immunolabelling	1
17.	Applications in nano science	1
	Total	19
Practical		
1.	Collection of tissue samples for em	1
2.	Fixation of samples for electron microscopy	1
3.	Processing of samples for scanning electron microscopy	2
4.	Processing of samples for transmission electron microscopy	2
5.	Ultramicrotomy (semithin and ultra thin sections)	2
6.	Coating of grids with supportive films	2
7.	Staining of semi thin and ultra thin sections	1
8.	Negative staining	1
9.	Cryo-electron microscopy	2
10.	Immunolabelling	2
11.	Atomic force microscope	1
	Total	17

I. Course Title : Histoenzymology and Immunocytochemistry

II. Course Code : ANA 707

III. Credit Hours : 2+1

IV. Aim of the course

To give a student hands-on practice for various advanced histoenzymic and histochemical techniques.

V. Theory**Unit I**

Classification of enzymes – Principles of enzymes histochemistry methods.



Unit II

Substrates –combination–coupling azo-dye methods –capture reagents.

Unit III

Localization of enzymes and controls in enzyme histochemistry.

Unit IV

Fluorescence microscopy in enzyme histochemistry. Principles and techniques of immunohistochemistry.

VI. Practical

Preparation of fixatives and buffers used in histochemistry. Methods of preparations and microscopical examination of routine and special preparations showing different cell organelles and inclusions. Methods for tryptophan-SS, SH groups; Glycogen-glycoproteins; Mucopolysaccharides and lipids. Methods and identification of alkaline and acid phosphatases-succinic dehydrogenase, cytochrome-oxidase, choline-esterase, catecholamines by fluorescence microscopy. Immunohistochemistry-principles and techniques.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Classification of enzymes	3
2.	Principles of enzyme histochemistry methods	3
3.	Substrate and coenzymes	2
4.	Different methods of enzyme study	3
5.	Hydrolytic enzyme histochemistry	2
6.	Alkaline and acid phosphatase	2
7.	Oxidases and peroxidases	2
8.	Diaphorases and dehydrogenases	2
9.	Peptidases	2
10.	Fluorescence microscopy	2
11.	Principles of immunohistochemistry	3
12.	Techniques in immunohistochemistry	3
13.	Study of part different parts of cryotome and their functions	3
	Total	32
Practical		
1.	Preparation of fixatives and buffers	3
2.	Demonstration of alkaline and acid phosphatase	2
3.	Demonstration of succinic dehydrogenase	2
4.	Demonstration of cytochrome oxidase	2
5.	Localization of diaphorases and choline esterase	2
6.	Fluorescence microscopy	2
7.	Principles and techniques in immunohistochemistry	3
	Total	16

I. Course Title : Applied Embryology and Teratology

II. Course Code : ANA 708

III. Credit Hours : 1+1

IV. Aim of the course

To apprise the students about the current trends in developmental processes.



V. Theory

Unit I

Principles of experimental embryology and teratology.

Unit II

Factors affecting the developmental mechanisms of embryo.

Unit III

Use of organizers implants, chemical and hormonal preparations in the developmental models and available literature on teratogenic experimentation.

VI. Practical

Collection and study of various teratological specimens from domestic animals. Class discussions on experimental models and available literature on teratogenic experimentation. To apprise the students about the current trends in developmental processes.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to embryology and teratology.	1
2.	Principles of experimental embryology and teratology.	2
3.	Factors affecting the developmental mechanisms of embryo.	2
4.	Developmental anomalies of cardiovascular system	2
5.	Immunodeficiency and inherited defects in natural immunity	1
6.	Developmental anomalies of brain and spinal cord	2
7.	Developmental anomalies of skeletal system	1
8.	Developmental anomalies of digestive system	2
9.	Developmental anomalies of urinary system	1
10.	Developmental anomalies of male and female reproductive system	1
11.	Congenital malformations of face and oral cavity	1
12.	Congenital and inherited defects of skin	1
13.	Genetic, chromosomal and environmental factors adversely affecting prenatal development	1
	Total	18
Practical		
1.	Discussion on principles and factors affecting developmental embryology and teratology in the available literature.	2
2.	Study on different teratological models/ specimens of cardiovascular system	2
3.	Immunodeficiency and inherited defects in natural immunity	1
4.	Study on different teratological models/ specimens of brain and spinal cord	2
5.	Study on different teratological models/ specimens of skeletal system	1
6.	Study on different teratological models/ specimens of digestive system	2
7.	Study on different teratological models/ specimens of urinary system	1
8.	Study on different teratological models/ specimens of male and female reproductive system	2
9.	Congenital malformations of face and oral cavity	1
10.	Congenital and inherited defects of skin	1
11.	Study on mutations and chromosomal abnormalities	1
12.	Study of teratogenic agents	1
13.	Assessing the aetiology of different congenital diseases	1
	Total	18



- I. Course Title : Functional Veterinary Anatomy**
II. Course Code : ANA 709
III. Credit Hours : 1+0

IV. Aim of the course

To make the student understand the functional anatomy of various organs/ systems in relation to structure.

V. Theory

Unit I

The relationship of structure to form and function.

Unit II

The relationship of structure for adaptation and behaviour.

Unit III

Relationship of structure in relation to clinical conditions/ applications.

S. No.	Topic	No. of Lectures
Theory		
1.	Introduction to functional anatomy	1
2.	Tissue organization and function	1
3.	Functional anatomy of digestive system: mouth cavity, tongue, salivary gland, esophagus and stomach including mastication, regurgitation	2
4.	Functional anatomy of digestive system: small intestine, large intestine, liver, gall bladder and pancreas	2
5.	Study of functional anatomy of respiratory system	1
6.	Functional anatomy of urinary system	1
7.	Functional anatomy of reproductive system	1
8.	Functional anatomy of mammary gland	1
9.	Functional anatomy of cardiovascular system	1
10.	Functional anatomy of central nervous system	1
11.	Functional anatomy of peripheral and autonomic nervous system	1
12.	Functional anatomy of special senses (vision, hearing)	1
13.	Functional anatomy of skeleton system including synovial fluid	1
14.	Functional anatomy of muscular system	1
15.	Functional anatomy of endocrine system	1
16.	Functional anatomy of integumentary system	1
	Total	18

- I. Course Title : Gross Anatomy of Laboratory Animals**
II. Course Code : ANA 710
III. Credit Hours : 1+1

IV. Aim of the course

To give an overview of different body systems of laboratory animals.

V. Theory

Unit I

Study of different organs of digestive system of different laboratory animals.

**Unit II**

Detailed study of urinary, male and female reproductive systems of different laboratory animals.

Unit III

Complete study of respiratory system of different laboratory animals.

Unit IV

Study of organs of circulation and nervous system of different laboratory animals.

Unit V

Descriptive anatomy of endocrine glands of different laboratory animals.

VI. Practical

Demonstration of placement and relations of different organs in the body cavities of different laboratory animals.

S. No. Topic	No. of Lectures/ Practicals
Theory	
1. An overview of skeleton of rabbit, guinea pig, mice and rat	1
2. Digestive system of rabbit and guinea pig	1
3. Digestive system of mice and rat	1
4. Respiratory system of rabbit and guinea pig	1
5. Respiratory system of mice and rat	1
6. Urinary system of rabbit and guinea pig	1
7. Urinary system of mice and rat	1
8. Male reproductive system of rabbit and guinea pig	1
9. Male reproductive system of mice and rat	1
10. Female reproductive system of rabbit and guinea pig	1
11. Female reproductive system of mice and rat	1
12. Endocrine glands of rabbit and guinea pig	1
13. Endocrine glands of mice and rat	1
14. Circulatory system of rabbit and guinea pig	1
15. Circulatory system of mice and rat	1
16. Nervous system of rabbit and guinea pig	1
17. Nervous system of rat and mice	1
18. Lymphoid organs of laboratory animals	1
Total	18
Practical	
1. Study of skeleton of rabbit, guinea pig, mice and rat	1
2. Study of digestive system of rabbit and guinea pig	1
3. Study of digestive system of mice and rat	1
4. Study of respiratory system of rabbit and guinea pig	1
5. Study of respiratory system of mice and rat	1
6. Study of urinary system of rabbit and guinea pig	1
7. Study of urinary system of mice and rat	1
8. Study of male reproductive system of rabbit and guinea pig	1
9. Study of male reproductive system of mice and rat	1
10. Female reproductive system of rabbit and guinea pig	1
11. Study of female reproductive system of mice and rat	1
12. Study of endocrine glands of rabbit and guinea pig	1
13. Study of endocrine glands of mice and rat	1



S. No.	Topic	No. of Lectures/ Practicals
14.	Study of circulatory system of rabbit, guinea pig, rat and mice	1
15.	Study of circulatory system of mice and rat	1
16.	Study of nervous system of rabbit and guinea pig	1
17.	Study of nervous system of rat and mice	1
18.	Lymphoid organs of laboratory animals	1
	Total	18

I. Course Title : Cross Sectional Anatomy of Ox

II. Course Code : ANA 711

III. Credit Hours : 0+1

IV. Aim of the course

To study Gross cross sectional profiles of various parts in ox

V. Practical

Demonstration and topographic anatomy of various structures and organs at different levels of cross sections of the body. Correlation of different structures in different cross sections.

S. No.	Topic	No. of Practical
Practical		
1.	Cross sectional profile of head at the level of 4 th incisor and first cheek tooth	1
2.	Cross sectional profile of head at the level of third cheek tooth and 6 th cheek tooth	1
3.	Cross sectional profile of head at the level of orbit and external acoustic meatus	1
4.	Cross sectional profile of the neck at the level of upper third and middle third.	1
5.	Cross sectional profile of the neck at the level of lower third	1
6.	Cross sectional profile of the thoracic inlet.	1
7.	Cross sectional profile of the thorax at the level of 3 rd rib	1
8.	Cross sectional profile of the thorax at the level of 6 th rib and 12 th rib	1
9.	Cross sectional profile of the abdomen at the level of 2 nd lumbar and 5 th lumbar	1
10.	Cross sectional profile of the mid pelvis and tail.	1
11.	Cross sectional profile at the middle and lower level of the shoulder and middle level of the arm.	1
12.	Cross sectional profile at the proximal level of forearm, lower level of the forearm and mid level of metacarpus.	1
13.	Cross sectional profile at the mid level of the first phalanges and mid level of second phalanges	1
14.	Cross sectional profile at the upper and middle and lower levels of the thigh	1
15.	Cross sectional profile at the lower levels of the thigh	1
16.	Cross sectional profile at the upper and middle levels of the leg.	1
17.	Cross sectional profile at the lower level of the leg and mid level of metatarsus	1
	Total	17



- I. Course Title : Animal Alternatives in Veterinary Anatomy**
II. Course Code : ANA 712
III. Credit Hours : 1+1

IV. Aim of the course

Alternatives of animals in veterinary anatomy teaching to avoid usage of Animals.

V. Theory**Unit I**

Introduction and ethical issues, scope, advantages and disadvantages of alternatives.

Unit II

Plastination, 2D and 3D Models.

Unit III

Taxidermy, computer simulations.

Unit IV

Maannequins, interactive multimedia.

Unit V

Museum specimen preparation.

VI. Practical

Techniques of Plastination, 2D and 3D Models, Taxidermy, computer simulations
 Maannequins, interactive multimedia.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to animal alternatives	1
2.	Ethical issues on alternatives used	1
3.	Necessity of animal alternatives- advantages and disadvantages of alternatives	1
4.	Scope for animal alternatives	1
5.	Plastination, basic principles	1
6.	Methodology involved in plastination	1
7.	Types of plastination- advantages, disadvantages of plastination	1
8.	Three-D, Two-D models as alternatives in veterinary anatomy: advantages/ disadvantages of models used	1
9.	Drawings, Charts, Power points as self explanatory alternatives in Veterinary anatomy-An overview	1
10.	Taxidermy in veterinary anatomy-methodology involved-limitations	1
11.	Computer simulation-screen based simulations	1
12.	Virtual lab.-E-learning as alternatives	1
13.	Interactive digital tool-multimedia and Videos as effective audio visual tools- benefits and weakness of digital alternatives	1
14.	Mannequins as alternatives in veterinary anatomy, advantages and disadvantages -scope for mannequins in veterinary anatomy	1
15.	Museum specimen preparation	1
16.	Procedures involved in museum preservation- advantages and disadvantages involved in museum specimens	1
	Total	16



S. No.	Topic	No. of Lectures/ Practicals
Practical		
1	Methodology involved in plastination and preparation of plastinated specimens	3
2	Three-D, Two-D Models as alternatives in veterinary anatomy	2
3	Methodology involved taxidermy -preparation of specimens	2
4	Computer Simulation-screen based simulations	2
5	Virtual lab -E-learning as alternatives	2
6	Interactive digital tool-multimedia and Videos	1
7	Mannequins as alternatives in veterinary anatomy	2
8	Museum specimen preparation	2
	Total	16

I. Course Title : Special Problem

II. Course Code : ANA 713

III. Credit Hours : 0+2

IV. Aim of the course

To provide expertise in handling practical research problem(s).

V. Practical

S. No.	Topic	No. of Practical
1.	Short research problem(s) involving contemporary issues and research techniques.	32

VI. Recommended list of Books

Gross Anatomy

- Dyce KM, Sack WO and Wensing CJG. 1996. *Text Book of Veterinary Anatomy*. W.B. Saunders Co.
- Konig HE and Liebich HG. 2004. *Veterinary Anatomy of Domestic Animals: Textbook and Colour Atlas*. 1stedn., Stuttgart, Schattauer Co., Germany.
- Nickel R, Schumer A, Seiferle E, Freewin J and Wills KH. 1986. *The Locomotor System of Domestic Mammals*. Verlag Paul Parey.
- Schummer A, Nickel R and Sack WO. 1979. *The Viscera of the Domestic Mammals*. Verlag Paul Parey.
- Seiferle E. 1975. *Nervous System, Sensory Organs, Endocrine Glands of Domestic Mammals*. Verlag Paul Parey.
- Sisson S and Grossman JD. 1975. *The Anatomy of the Domestic Animals*. Vols. I, II. W.B. Saunders Co.

Histology

- Banks WJ. 1993. *Applied Veterinary Histology*. Mosby Year Book, USA.
- Dellmann HD. 1993. *Textbook of Histology*. Lea and Febiger, USA.
- DiFiore MS, Mancini R and Derbertis EDP. 2006. *New Atlas of Histology*. Williams and Wilkins, Lippincott, USA.
- Eurell JA and Frappier BL. 2006. *Dellmann's Textbook of Veterinary Histology*. 6thedn., Blackwell Publishing, Ames, Iowa, USA.
- Greep RO. 1977. *Histology*. McGraw-Hill Book Co., New York, USA.



- Ham AW and Cormack DH. 1979. *Histology*. J.B. Lippincott, Philadelphia, USA.
- Stinson AW and Calhoun ML. 1993. *Text book of Veterinary Histology*. 4th edn., Lea and Febiger, Philadelphia, USA.

Embryology

- Arey LB 1965. *Developmental Anatomy*. W.B. Saunders.
- Freeman WH and Brace Girdle B. 1967. *Atlas of Embryology*. Heilemann Edu. Books Ltd.
- Langman J. 1976. *Medical Embryology*. William and Wilkin, Lippincott, USA.
- Latshaw WK. 1984. *Veterinary Developmental Anatomy; A Clinically Oriented Approach*. B.C. Decker Inc., Philadelphia, USA.
- Patten BM. 1985. *Foundation of Embryology*. Tata McGraw-Hill Book Co., USA.
- Patten BM. 2014. *Foundation of Embryology*. 6th edn., Tata McGraw-Hill Education, India.
- Tuchmann-Duplessis, MH David G, and Haegel P. 1972. *Illustrated Human Embryology*. Vol. I, II. Embryogenesis. Springer Verlag, USA.

Anatomical Techniques

- Durry RAB and Wallington EA. 1967. *Carleton's Histological Techniques*. Oxford University Press, London.
- Luna LG 1968. *Manual of Histologic Staining Methods of the Armed Forces Institute of Pathology*. McGraw-Hill Book Co., USA.
- Pearse AGE. 1968. *Histochemistry-Theoretical and Applied*. 3rd edn., Vol. I, Churchill Livingstone, London.
- Tompsett DH and Wakeley SC. 1956. *Anatomical Techniques*. E. and W. Living Stone, London.
- Bancroft JD and Stevens A. 1977. *Theory and Practice of Histological Techniques*. Churchill Livingstone.
- Thomson SW and Hunt RD. 1968. *Selected Histochemical and Histopathological Methods*. Charles C. Thomas Publication, Springfield, Illinois, USA.

List of Journals

- *Acta Anatomica*
- *American Journal of Anatomy*
- *Anatomia Histologia and Embryologia*
- *Anatomical Record*
- *Anatomy and Embryology*
- *Indian Journal of Veterinary Anatomy*
- *Journal of Anatomy*

e-Resources

- <http://www.interscience.wiley.com/journal/117927935/group/home/home>. (American Journal of Anatomy)
- <http://www.ovid.com/site/catalog/Journal/1057.jsp> (Journal of Anatomy)
- <http://www.interscience.wiley.com/jpages/0003-276X/>(Anatomical Record)
- <http://www.blackwellpublishing.com/submit.asp> (Anatomia Histologia and Embryologia)

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Basic Veterinary Sciences

– Veterinary Biochemistry

Preamble

(Veterinary Biochemistry)

At Masters level in Veterinary Biochemistry new courses, Biophysical Chemistry, Analytical Techniques and Instrumentation in Biochemistry, Intermediary Metabolism and Regulation, Molecular Biochemistry, Biochemistry of Ruminants and Wild Animals and Introduction to Bioinformatics and Computational Biology are introduced. Similarly at Doctorate level new courses, Applied Molecular Biochemistry and Systems Biology, Diagnostic Techniques in Clinical Biochemistry, Bioinformatic Tools in Biochemistry, Environmental and Toxicological Biochemistry, Biochemistry of Diseases and Disorders and Immuno-Biochemistry are introduced keeping latest trends and requirements in mind.



Course Title with Credit Load

M.V.Sc. in Veterinary Biochemistry

Course Code	Course Title	Credit Hours
BCT 601	Biophysical Chemistry	2 + 0
BCT 602	Biochemistry of Biomolecules	2 + 0
BCT 603	Enzymology	2 + 1
BCT 604	Analytical Techniques and Instrumentation in Biochemistry	1 + 1
BCT 605	Clinical Biochemistry of Animals	2 + 1
BCT 606	Intermediary Metabolism and Regulation	3 + 0
BCT 607	Molecular Biochemistry	2 + 1
BCT 608	Nutritional and Industrial Biochemistry	2 + 0
BCT 609	Endocrinology and Reproductive Biochemistry	2 + 0
BCT 610	Biochemistry of Ruminants and Wild Animals	1 + 1
BCT 611	Introduction to Bioinformatics and Computational Biology	1 + 1
BCT 612	Master's Seminar	1 + 0
BCT 613	Master's Research	0 + 30

Basic Veterinary Sciences: Veterinary Biochemistry



Suggested list of specified Minor subjects (Departments)

Major Subject	Minor subjects (Departments)*
Veterinary Biochemistry	Physiology, Medicine, Animal Nutrition, Animal Genetics and Breeding, Biotechnology, Livestock Production Management, Pharmacology and Toxicology, Microbiology, Parasitology, Pathology, Gynaecology.

*The Minor courses may be taken from any number of disciplines/ departments listed against major discipline limiting to credits prescribed as decided by the Chairman of Advisory Committee of the student. Minor courses may also be taken from the disciplines/ departments other than those listed above on the recommendations of advisory committee, if essentially required as per the research problem with the concurrence of Head of the Department and Concerned Authorities.



Course Contents

M.V.Sc. in Veterinary Biochemistry

- I. Course Title** : Biophysical Chemistry
II. Course Code : BCT 601
III. Credit Hours : 2 + 0

IV. Aim of the course

Teaching of principles of physical chemistry as applicable to veterinary sciences.

V. Theory

Unit I

Physical properties of water-the medium of life, Acids and bases, ionic strength and activity, Henderson-Hasselbach equation, pH, indicators and buffers, Colloids and their properties, Mechanism of osmosis, osmotic pressure, Donnan membrane equilibrium, Viscosity, surface tension, surface forces, Adsorption and light scattering, Membrane filtration, dialysis, diffusion coefficient and partial specific volume.

Unit II

Laws of thermodynamics, Concepts of enthalpy, free energy and entropy in biochemical reactions. High energy compounds, Redox potential and free energy changes, Bioenergetics and biological oxidation, Components of mitochondrial electron transport chain. Formation of ATP and ATP cycle. Energy transformation in living cells.

Unit III

Basic Methods in Biophysical Chemistry: Basic Optical Principles, Optical Properties of Biomolecules, Optical spectroscopy, Basic Fluorescence Techniques, Chiroptical and Scattering Methods; Conventional and Confocal Fluorescence Microscopy, Basics of Super-Resolution Fluorescence Microscopy, Fluorescence spectroscopy, Patch Clamping.

VI. Suggested Reading

- David L Nelson and Cox Michael M. 2008. *Lehninger's Principles of Biochemistry*. 5th Ed. Freeman.
- James P Allen. 2008. *Biophysical Chemistry*. 1st Ed. Wiley-Blackwell Publication.
- Peter Jomo Walla. 2014. *Modern Biophysical Chemistry: Detection and Analysis of Biomolecules*. 2nd Ed. Wiley-VCH Publication.

Course Outline

S. No.	Topic	No. of Lectures
Theory		
1.	Physical properties of water-the medium of life, Acids and bases, ionic strength and activity	2
2.	Henderson-Hasselbach equation, pH, indicators and buffers	2



S. No.	Topic	No. of Lectures
3.	Colloids and their properties, Mechanism of osmosis, osmotic pressure, Donnan membrane equilibrium, Viscosity, surface tension, surface forces, Adsorption and light scattering	3
4.	Membrane filtration, dialysis, diffusion coefficient and partial specific volume.	2
5.	Laws of thermodynamics, Concepts of enthalpy, free energy and entropy in biochemical reactions, High energy compounds, Redox potential and free energy changes	3
6.	Bioenergetics and biological oxidation, Components of mitochondrial electron transport chain. Formation of ATP and ATP cycle. Energy transformation in living cells	4
7.	Basic Methods in Biophysical Chemistry: Basic Optical Principles, Optical Properties of Biomolecules, Optical spectroscopy	4
8.	Basic Fluorescence Techniques	2
9.	Chiroptical and Scattering Methods	2
10.	Conventional and Confocal Fluorescence Microscopy	3
11.	Basics of Super-Resolution Fluorescence Microscopy	2
12.	Fluorescence spectroscopy.	2
13.	Patch Clamping	1
	Total	32

I. Course Title : Biochemistry of Biomolecules

II. Course Code : BCT 602

III. Credit Hours : 2 + 0

IV. Aim of the course

Teaching molecular basis of structure and functional aspects of carbohydrates, lipids, amino acids and nucleic acids.

V. Theory

Unit I

Carbohydrates: Structure and biological significance of important monosaccharides: Ribose, Glucose, Fructose, Galactose, Mannose and Amino Sugars; Chemical reactions of monosaccharides; Isomerism of carbohydrates; Structure and biological significance of Disaccharides (Maltose, Isomaltose, Lactose, Sucrose and Cellobiose); Structure and biological significance of polysaccharides (Starch, Dextrins, Dextrans, Glycogen, Cellulose, Inulin, Chitin), and Mucopolysaccharides including Blood group substances and Bacterial cell wall polysaccharides. Glycoconjugates in cell surface, extra cellular matrix, sugar code functions, peptidoglycan-specific antibiotics; Basic principles of separation, purification and characterization of carbohydrates; Methods of structural analysis of carbohydrates.

Unit II

Lipids: Definition, Classification, Properties and Biological significance of simple, compound and derived lipids; Fat indices; Structure and functions of prostaglandins, steroids, steroid hormones and fat soluble vitamins. Basic principles of extraction and analysis of lipids; Lipid bilayers, lipid motility, integral membrane proteins, lipid linked proteins, peripheral membrane proteins, fluid mosaic model, membrane

skeleton, lipid asymmetry, cardiac glycosides, abnormalities in cell membrane fluidity, signaling biomolecules.

Unit III

Proteins: Amino acids - Structure and classification. Physical and chemical properties of amino acids - amphoteric nature, acid-base property, optical activity and peptide bond formation; Structure and geometry of peptide bond. Chemical synthesis of polypeptide and Oligopeptides of biological significance; Classification of proteins; Structure – primary, secondary, tertiary and quaternary; Physico-chemical, acid-base and colloidal properties of proteins; Biological significance of proteins; Denaturation, extraction and purification criteria for proteins.

Unit IV

Nucleic acids: Chemistry of purines, pyrimidines, nucleosides and nucleotides. Biological significance of nucleosides and nucleotides. Structures and functions of Watson-crick model of deoxyribonucleic acid (DNA) and a typical ribonucleic acid (RNA). Different types of DNA, acid-base properties, sedimentation behaviour, hyperchromic effect, melting of DNA, Chemical and enzymatic hydrolysis of nucleic acids. Base sequence analysis of DNA, Nucleic acid- protein interaction - histone and non-histone proteins.

VI. Suggested reading

- David L Nelson and Cox Michael M. 2017. *Lehninger's Principles of Biochemistry*. 7th Ed. Freeman.
- Voet D, Voet JG and Pratt CW. 2016. *Fundamentals of Biochemistry of Life at the Molecular Level*. 5th Ed. John Wiley and Sons.
- Berg JM, Tymoczko JL, Stryer L and Clarke ND 2015. *Biochemistry*. 8th Ed. WH Freeman and Co.
- Zubay GL. 1998. *Biochemistry*. 4th Ed. WCB London.

Course Outline

S. No.	Topic	No. of Lectures
Theory		
1	Carbohydrates: Structure and Biological Significance of Important Monosaccharides: Ribose, Glucose, Fructose, Galactose, Mannose and Amino Sugars;	1
2	Chemical reactions of monosaccharides; Isomerism of carbohydrates; Structure and Biological Significance of Disaccharides (Maltose, Isomaltose, Lactose, Sucrose and Cellobiose);	1
3	Structure and Biological Significance of Polysaccharides (Starch, Dextrins, Dextrans, Glycogen, Cellulose, Inulin, Chitin), and Mucopolysaccharides including Blood group substances and Bacterial Cell Wall polysaccharides;	1
4	Glycoconjugates in cell surface, extra cellular matrix, sugar code functions, peptidoglycan-specific antibiotics;	2
5	Basic principles of separation, purification and characterization of carbohydrates;	1
6	Methods of Structural analysis of carbohydrates.	1
7	Definition, Classification, Properties and Biological Significance of simple, compound and derived lipids;	1
8	Fat indices; Structure and functions of prostaglandins, steroids, steroid hormones and fat soluble vitamins;	2



S. No.	Topic	No. of Lectures
9	Basic principles of extraction and analysis of lipids;	1
10	Lipid bilayers, lipid motility, integral membrane proteins, lipid linked proteins, peripheral membrane proteins;	2
11	Fluid mosaic model, membrane skeleton, lipid asymmetry, cardiac glycosides, abnormalities in cell membrane fluidity, signaling biomolecules.	3
12	Amino acids – Structure and classification.	1
13	Physical and chemical properties of amino acids – amphoteric nature, acid-base property, optical activity and peptide bond formation.	1
14	Structure and geometry of peptide bond; Chemical synthesis of polypeptide; Oligopeptides of biological significance;	2
15	Classification of proteins; Structure – primary, secondary, tertiary and quaternary; Physico-chemical, acid-base and colloidal properties of proteins;	2
16	Biological significance of proteins; Denaturation, extraction and purification criteria for proteins.	1
17	Chemistry of purines, pyrimidines, nucleosides and nucleotides;	1
18	Biological significance of nucleosides and nucleotides;	1
19	Structures and functions of Watson-crick model of deoxyribonucleic acid (DNA) and a typical ribonucleic acid (RNA).	1
20	Different types of DNA, acid-base properties, sedimentation behaviour;	2
21	Hyperchromic effect, melting of DNA; Chemical and enzymatic hydrolysis of nucleic acids;	2
22	Base sequence analysis of DNA, Nucleic acid- protein interaction – histone and non-histone proteins.	2
	Total	32

I. Course Title : Enzymology

II. Course Code : BCT 603

III. Credit Hours : 2 + 1

IV. Aim of the course

To give thorough knowledge of molecular basis of enzyme action in relation to diagnostic importance.

V. Theory

Unit I

Introduction and historical perspective, Enzyme nomenclature and classification, enzyme compartmentalization in cell organelles, measurement of enzyme activity. ribozymes, isozymes, abzymes, restriction endonucleases.

Unit II

Enzyme structure, enzyme specificity, active site, active site mapping, mechanism of enzyme catalysis. cofactors, coenzymes- their structure and role.

Unit III

Enzyme kinetics, enzyme inhibition and activation, multienzyme complexes, allosteric enzymes and their kinetics, regulation of enzyme activity. qualitative description of “concerted” and “sequential” models for allosteric enzymes. Half site

reactivity, Flip-flop mechanism, positive and negative co-operativity. Monod Koshland Model.

Concept of ES complex, active site, specificity derivation of Michaelis-Menten equation for uni- substrate reactions. Different plots for the determination of K_m and V_{max} and their physiological significances. Importance of K_{cat}/K_m . Kinetics of zero and first order reactions. Significance and evaluation of energy of activation.

Unit IV

Isolation, purification and characterization of enzymes, Applications of enzymes in chemical and feed industry, enzyme immobilization, biosensors, clinical and diagnostic applications of enzymes.

VI. Practical

- Enzyme assay by taking any model enzyme like alpha-amylase or alkaline phosphatase.
- Isolation, purification and characterization of any model enzyme like B-galactosidase or acid phosphatase.
- Study of the effect of enzyme and substrate concentrations and determination of K_m and V_{max} .
- Determination of pH and temperature optima of alkaline phosphatase.
- To study the effect of various inhibitors of enzymatic activity.
- Determination of the pH and temperature stability of alkaline phosphatase.
- Assay of Diagnostic enzymes from Clinical samples.
- Application of enzymes in ELISA and Western Blotting

VII. Suggested Reading

- Bergmeyer HU. 1983. *Methods of Enzymatic Analysis*. Vol. II. Verlag Chemie, Academic Press.
- Dixon M, Webb EC, Thorne CJR and Tipton KF. 1979. *Enzymes*. 3rd Ed. Longman.
- Maragoni AG. 2003. *Enzyme Kinetics - A Modern Approach*. John Wiley.
- Palmer T. 2001. *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry*. 5th Ed. Horwood Publ.
- Price NC and Stevens L. 2003. *Fundamentals of Enzymology*. Oxford Univ. Press.
- Wilson K and Walker J. (Eds.). 2000. *Principles and Techniques of Practical Biochemistry*. 5th Ed. Cambridge Univ. Press.
- David L Nelson and Cox Michael M. 2008. *Lehninger's Principles of Biochemistry*. 5th Ed. Freeman.
- Kaneko JJ, Harvey JH and Bruss ML. 2008. *Clinical Biochemistry of Domestic Animals*. 6th Ed. Academic Press.

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	Introduction and historical perspective, Enzyme nomenclature and classification	2
2	Enzyme compartmentalization in cell organelles	1
3	Ribozymes, isozymes, abzymes, restriction endonucleases.	2
4	Enzyme structure	1
5	Enzyme specificity, active site, active site mapping,	2
6	Mechanism of enzyme catalysis.	2



S. No.	Topic	No. of Lectures/ Practicals
7	Cofactors, coenzymes- their structure and role.	2
8	Enzyme kinetics	1
9	Enzyme inhibition and activation	2
10	Multienzyme complexes, allosteric enzymes and their kinetics, regulation of enzyme activity.	2
11	Qualitative description of “concerted” and “sequential” models for allosteric enzymes. Half site reactivity, Flip-flop mechanism, positive and negative co-operativity. Monod Koshland Model.	3
12	Concept of ES complex, active site, specificity derivation of Michaelis-Menten equation for uni- substrate reactions.	2
13	Different plots for the determination of Km and Vmax and their physiological significances. Importance of Kcat/ Km.	2
14	Kinetics of zero and first order reactions. Significance and evaluation of energy of activation.	2
15	Isolation, purification and characterization of enzymes	2
16	Applications of enzymes in chemical and feed industry	2
17	Enzyme immobilization, biosensors, clinical and diagnostic applications of enzymes.	2
	Total	32
Practical		
1	Enzyme assay by taking any model enzyme like alpha-amylase or alkaline phosphatase.	1
2	Isolation, purification and characterization of any model enzyme like β -galactosidase or acid phosphatase.	3
3	Study of the effect of enzyme and substrate concentrations and determination of Km and Vmax.	2
4	Determination of pH and temperature optima of alkaline phosphatase.	2
5	To study the effect of various inhibitors of enzymatic activity.	2
6	Determination of the pH and temperature stability of alkaline phosphatase.	2
7	Assay of Diagnostic enzymes from Clinical samples.	1
8	Application of enzymes in ELISA and Western Blotting.	3
	Total	16

I. Course Title : Analytical Techniques and Instrumentation in Biochemistry

II. Course Code : BCT 604

III. Credit Hours : 1 + 1

IV. Aim of the course

To make students well versed with certain basic methodologies used in biochemistry to carry out independent research.

V. Theory

Unit I

Solutions and Buffers: Units of expression of concentration of solutions - Preparation of solutions - Preparation of Buffers - Henderson-Hasselbalch equation in the

preparation of buffers. Spectroscopy: Theory and applications of Colorimetry and Spectrophotometry; Major components of the following instruments and their functions: UV-Visible Spectrophotometer, Spectrofluorometer, Flame photometer, Atomic absorption spectrophotometer, Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES).

Unit II

Chromatographic Techniques: Basic principle and applications of Paper, Column and Thin layer chromatography including HPTLC; Factors affecting chromatographic resolution; Methods of preparation of biological samples for chromatographic analysis and common methods for qualitative and quantitative chromatography of amino acids, lipids and sugars including elution and densitometry. Molecular Sieving and its application in Biochemistry – General properties of dextran, acrylamide, agar and other media used for gel filtration. Principles and applications of chromatographic techniques, viz., ion-exchange, gel-filtration, affinity, hydrophobic interaction chromatography, metal chelate chromatography, planar chromatography, lateral flow immunochromatographic assays, Introduction to GLC and HPLC (Normal and Reverse Phase).

Unit III

Theory and applications of Electrophoresis: Factors affecting migration of charged particles – Moving boundary, paper and gel electrophoresis - Electrophoresis of amino acids, proteins and nucleic acids – Use of SDS PAGE in molecular weight determination. Isoelectric focusing and Isotachophoresis - Densitometry procedures and quantitative assays. Introduction to 2-D gel electrophoresis; Immuno-electrophoresis and other techniques like ELISA, RIA and Immuno-blotting.

Unit IV

Theory and applications of Centrifugation: Basic principle of sedimentation – Types, care and safety aspects of Centrifuges – Preparative centrifugation and Analytical centrifugation - Introduction to Ultracentrifugation - Fractionation of sub-cellular components - Density Gradient centrifugation – Determination of relative molecular mass.

N.B.: GLC and HPLC at length are to be discussed under BCT 705 (Ph.D. course); here only introduction.

VI. Practical

- Preparation of solutions and buffers; Solving problems using Henderson–Hasselbalch equation, pH, pKa and buffer concentration, normality; Verification of Beer's – Lambert's law; Estimation of glucose and total cholesterol in serum; Determination of absorption maxima and molar extinction coefficient of p-Nitrophenol from its absorption spectrum; Estimation of proteins using biuret, foiln-cioalteau methods and UV spectrophotometry; Estimation of enzyme activity by spectrophotometry (Kinetic mode).
- Separation of Lipids/ amino acids using paper chromatography and TLC; Fractionation of proteins by ammonium sulphate precipitation and desalting by dialysis; Separation of proteins using Ion-exchange chromatography, affinity chromatography and gel-filtration chromatography; Demonstration of separation of fatty acid methyl esters using GLC.



- Electrophoretic analysis of albumin using non-denaturing and denaturing conditions – Detection of molecular weight of protein by SDS-PAGE - Characterization of immunoglobulins by PAGE - Demonstration of sub-cellular fractionation by centrifugation.

VII. Suggested Reading

- David L Nelson and Cox Michael M. 2017. *Lehninger's Principles of Biochemistry*. 7th Ed. Freeman.
- Wilson K and Walker J. (Eds.). 2010. *Principles and Techniques of Biochemistry and Molecular Biology*. 7th Ed. Cambridge Univ. Press.
- Willard *et al.* 1988. *Instrumental Methods of Analysis*. 7th Ed. Wadsworth Pub Co.
- Garrity S. 1999. *Experimental Biochemistry*. 3rd Ed. Academic Press.
- Gowenlock AH. 2002. *Varley's Practical Clinical Biochemistry*. 6th Ed. CBS.
- Holme DJ and Hazel P. 1998. *Analytical Biochemistry*. 3rd Ed. Longman.
- George W. Latimer, Jr. 2016. *Official Methods of Analysis of AOAC International*, 20th Ed. AOAC International.
- Carl A. Burtis, Edward R. Ashwood and David E. Burns, 2014. *Tietz Textbook of clinical Biochemistry and Molecular Diagnostics*. 5th Edition. Elsevier

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	Concentration of Solutions and units of expression, preparation of solutions and buffers, Henderson-Hasselbalch equation and its significance in preparation of buffers	1
2	Introduction to Spectroscopy and Principle of Colorimetry and Spectrophotometry, basic components, principle and applications of UV-Visible Spectrophotometer, Reflectance Spectrophotometer and Spectro-fluorometer	1
3	Basic components, principle and applications of Flame photometer and Atomic Absorption Spectrophotometer	1
4	Basic components, principle and applications of Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES)	1
5	Introduction to Chromatography – Principle, types and applications; Theory, components and applications of Paper Chromatography, TLC and HPTLC	1
6	Theory, components and applications of Column Chromatography, factors affecting chromatographic resolution and methods of preparation of biological samples for chromatographic analysis	1
7	Methods for qualitative and quantitative chromatography of amino acids, lipids and sugars including elution and densitometry	1
8	Molecular sieving and its application in biochemistry, general properties of dextran, acrylamide, agar and other media used for gel filtration	1
9	Principles and applications of ion-exchange, gel-filtration, hydrophobic interaction, planar chromatography and lateral flow immuno-chromatographic assays	1
10	Introduction to GLC and HPLC (Normal and Reversed Phase)	1
11	Introduction to Electrophoresis - Principle, types and applications, factors affecting migration of charged particles	1
12	Principle and applications of Moving boundary, paper and gel electrophoresis, Common methods for electrophoresis of amino acids,	1



S. No.	Topic	No. of Lectures/ Practicals
	proteins and nucleic acids with the components of electrophoretic apparatus	1
13	Use of SDS-PAGE in molecular weight determination, Isoelectric focusing, Isotachopheresis, densitometry procedures and quantitative assays applied to electrophoresis, introduction to Immuno-electrophoresis and 2-D gel electrophoresis	1
14	ELISA, RIA and Immuno-blotting	1
15	Basic principle of sedimentation – Types, care and safety aspects of Centrifuges – Preparative and Analytical; introduction to Ultracentrifugation and Fractionation of sub-cellular components	1
16	Density Gradient centrifugation and Determination of relative molecular mass	1
	Total	16
Practical		
1	Preparation of solutions and buffers – dil. Acids, bases, phosphate buffer, etc.	1
2	Problem solving based on Henderson-Hasselbalch equation	1
3	Verification of Beer-Lambert's Law	1
4	Estimation of glucose and total cholesterol in serum	1
5	Determination of absorption maxima and molar extinction coefficient of p-Nitrophenol from its absorption spectrum	1
6	Estimation of proteins using biuret, foiln-ciocalteau methods and UV spectrophotometry	1
7	Estimation of enzyme activity by spectrophotometry - kinetic mode	1
8	Separation of amino acids by TLC/ paper chromatography	1
9	Separation of proteins by Affinity chromatography	1
10	Separation of proteins by Ion-exchange chromatography	1
11	Separation of proteins by Gel filtration chromatography	1
12	Demonstration of GLC for separation of fatty acids	1
13	Electrophoretic analysis of albumin using non-denaturing and denaturing conditions	1
14	Detection of molecular weight of protein by SDS-PAGE	1
15	Salt fractionation, dialysis and PAGE of immunoglobulins	1
16	Demonstration of sub-cellular fractionation by Ultra Centrifugation	1
	Total	16

I. Course Title : Clinical Biochemistry of Animals

II. Course Code : BCT 605

III. Credit Hours : 2 + 1

IV. Aim of the course

To give a detailed overview of role of biomolecules in health and diseases and aid in diagnosis and prognosis of diseases in animals and poultry.

V. Theory

Unit I

Quality control and automation in clinical biochemistry. Disturbance in water, electrolytes and acid-base balance - electrolyte abnormalities - respiratory acidosis



and alkalosis - metabolic acidosis and alkalosis – compensation – biochemical tests for diagnosis.

Unit II

Disorders of Carbohydrate metabolism: Diabetes mellitus, hyperinsulemia, galactosemia, hypoglycaemia, Glycogen storage disease and glycated proteins. Carbohydrate and protein balance for optimum rumen microflora. Ruminant ketosis – Ketosis associated with fasting, diabetes, pregnancy, lactation and post-exercise.

Unit III

Disorders of Lipid metabolism: Hypercholesterolemia, atherosclerosis, hyperlipidemia in canine, feline, equine – pathophysiology of ketonemia. Disorders of proteins, amino acids and nucleic acids metabolism: Normal and abnormal plasma proteins – Dysproteinemia – acute phase proteins – inborn errors of amino acid metabolism– Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch-Nyhan syndrome, sickle cell anemia, Histidinemia – defect in collagen biosynthesis. Abnormalities in Nitrogen Metabolism – Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance. Composition and diagnostic significance of cerebrospinal fluid and amniotic fluid. Doping in horses.

Unit IV

Liver function tests - indications and limitations - classification of tests – Biochemical tests for liver function - serum enzyme activities to assess liver function - Hepatic encephalopathy – Hepatic photosensitivity – Ascites. Renal function: Direct and indirect test for glomerular filtration – tests for tubular function – test for kidney damage Gastrointestinal function: Disturbances in gastrointestinal function – disturbance in rumen function.

Unit V

Clinical enzymology - functional and non-functional plasma enzymes - plasma enzymes of diagnostic importance - ALP, CK, LDH, AST, ALT, OCT - Iso-enzymes and their diagnostic importance. Oxidative Stress: Biochemical basis of disease progression and diagnostic enzymes. Biochemical markers of cardiac diseases: Hypertension, myocardial infarction and heart failure. Respiratory distress syndrome, COPD, Ischemia, shock.

Unit VI

Disorders of mineral metabolism: Hypercalcaemia, hypocalcaemia, normocalcaemia, hypophosphataemia, hyperphosphataemia. Biochemistry of tumours and various types of tumour markers for the diagnosis of prostate cancer, ovarian cancer, mammary tumour, lymphoma, bladder cancer and pancreatic cancer.

Unit VII

Biochemical basis and diagnosis of prevalent diseases and metabolic disorders in wild animals, and poultry.

VI. Practical

Urine analysis - Physical and chemical tests for normal and pathological constituents of urine. Quality Control-Precision, Accuracy, Sensitivity and Specificity; Estimation of Blood glucose - Serum biochemical parameters – Total protein, A/G ratio, Cholesterol, urea, uric acid, bilirubin, creatinine – Serum enzymes – ALP, ACP,

AST and ALT – Electrophoresis of plasma proteins - Separation of Iso-enzymes. Estimation of Ca, Mg, P, K, Na in serum samples. Estimation of Vit C, D and E.

VII. Suggested Reading

- David L Nelson and Cox Michael M. 2007. *Lehninger's Principles of Biochemistry*. 4th Ed. Freeman.
- Kaneko JJ, Harvey JH, Bruss ML. 2008. *Clinical Biochemistry of Domestic Animals*. 6th Ed. Academic Press.
- Racek J and Rajdl D. 2016. *Clinical Biochemistry*. 1st Ed. Karolinum Press.
- Voet D, Voet JG and Pratt CW. 2006. *Fundamentals of Biochemistry of Life at the Molecular Level*. 2nd Ed. John Wiley and Sons.

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	Quality control and automation in clinical biochemistry	1
2	Disturbance in water, electrolytes and acid-base balance - electrolyte abnormalities	1
3	Respiratory acidosis and alkalosis: compensation and biochemical tests for diagnosis.	1
4	Metabolic acidosis and alkalosis: compensation and biochemical tests for diagnosis.	1
5	Diabetes mellitus, classification and diagnosis	1
6	Hyperinsulemia, galactosemia, hypoglycaemia of baby pigs	1
7	Glycogen storage disease and glycated proteins	1
8	Carbohydrate balance in ruminants.	1
9	Biochemical alterations in body fluids of ruminants in hypoglycaemia	1
10	Ruminant ketosis – Ketosis associated with fasting, diabetes, pregnancy, lactation and post-exercise	1
11	Disorders of Lipid metabolism: Hypercholesterolemia, atherosclerosis, hyperlipidemia in canines, felines and equines	1
12	Pathophysiology of ketonemia.	1
13	Disorders of proteins, amino acids and nucleic acids metabolism: Normal and abnormal plasma proteins – Dysproteinemias, acute phase proteins	1
14	Inborn errors of amino acid metabolism– Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch-Nyhan syndrome, sickle cell anemia, Histidinemia – defect in collagen biosynthesis	1
15	Abnormalities in Nitrogen Metabolism – Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance	1
16	Composition and diagnostic significance of cerebrospinal fluid and amniotic fluid	1
17	Doping in horses	1
18	Liver function tests - indications and limitations	1
19	Classification of tests – Biochemical tests for liver function - serum enzyme activities to asses liver function	1
20	Hepatic encephalopathy – Hepatic photosensitivity – Ascites	1
21	Renal function: Direct and indirect test for glomerular filtration – tests for tubular function – test for kidney damage	1



S. No.	Topic	No. of Lectures/ Practicals
22	Gastrointestinal function: Disturbances in gastrointestinal function – disturbance in rumen function	1
23	Clinical enzymology - functional and non-functional plasma enzymes	1
24	Plasma enzymes of diagnostic importance - ALP, CK, LDH, AST, ALT, OCT - Iso-enzymes and their diagnostic importance	1
25	Oxidative Stress: Biochemical basis of disease progression and diagnostic enzymes	1
26	Biochemical markers of cardiac diseases: Hypertension, myocardial infarction and heart failure.	1
27	Respiratory distress syndrome, COPD, Ischemia, shock	1
28	Disorders of mineral metabolism: Hypercalcaemia, hypocalcaemia, normocalcaemia, hypophosphataemia, hyperphosphataemia.	1
29	Biochemistry of tumours and various types of tumour markers	1
30	Role of tumour markers for the diagnosis of prostate cancer, ovarian cancer, mammary tumour, lymphoma, bladder cancer and pancreatic cancer	3
31	Biochemical basis and diagnosis of prevalent diseases and metabolic disorders in wild animals	1
32	Biochemical basis and diagnosis of prevalent diseases and metabolic disorders in poultry	1
	Total	34

Practical

1.	Urine analysis - volume, colour, acidity, pH, specific gravity - normal urinary constituents - pathological constituents and sediments	2
2.	Quality Control - Precision, Accuracy, Sensitivity and Specificity	1
3.	Estimation of Blood glucose	1
4.	Estimation of Total protein and A/G ratio	1
5.	Estimation of Cholesterol from serum	1
6.	Estimation of urea from serum	1
7.	Estimation of uric acid from serum	1
8.	Estimation of bilirubin from serum	1
9.	Estimation of creatinine from serum	1
10.	Estimation of serum enzymes: ALP, ACP, AST, ALT	1
11.	Electrophoresis of plasma proteins	1
12.	Separation of Isoenzymes	1
13.	Estimation of Ca, Mg, P, K, Na in serum samples	1
14.	Estimation of Vit C	1
15.	Estimation of Vit D and Vit E	1
16.	Estimation of total antioxidant activity	1
	Total	17

I. Course Title : Intermediary Metabolism and Regulation

II. Course Code : BCT 606

III. Credit Hours : 3 + 0

IV. Aim of the course

To teach regulatory mechanisms concerned with the metabolism of carbohydrates, lipids, amino acids, proteins and nucleotides in health and diseases and to give exposure in inter-relationship of cellular metabolism of various macromolecules.

V. Theory

Unit I

Carbohydrate metabolism and regulation - Major pathways - Glycolysis - Reactions, functions and its control - Metabolism of other sugars - Fructose, Galactose, Mannose and Lactose - Pyruvate dehydrogenase and reactions of Citric acid cycle - Anaplerotic reactions - Energetics of glucose oxidations. Alternate pathways of glucose metabolism - HMP pathway and its importance - Glucuronic acid cycle - Gluconeogenesis - Substrates - pathway and control of amino sugar - Glycogen metabolism - Glycogenolysis and Glycogenesis reactions - Metabolic disorders - Glycogen storage diseases (GSD).

Unit II

Lipid metabolism and regulation - Lipid transport and storage - Plasma lipoproteins - Role of liver and adipose tissue in fat metabolism - Role of brown adipose tissue in thermogenesis - Catabolism of triacylglycerols – Beta oxidation of fatty acids – Ketogenesis and utilization of ketone bodies - Biosynthesis of fatty acids, triacylglycerols, phospholipids and cholesterol – Production of Bile acids - Metabolism of Eicosanoids - Lipid storage diseases.

Unit III

Amino acids metabolism - Protein turnover and regulation - amino acid pools and absorption of amino acids - catabolism of amino acids - Deamination, transamination. Ammonia carriers; Excretion of nitrogen - urea cycle. Catabolism of carbon skeletons of amino acids. Conversion of amino acids to specialized products – Heme Biosynthesis - Physiologically active amines. Biosynthesis of non-essential amino acids. Metabolic disorders.

Unit IV

Catabolism and regulation of purine and pyrimidine nucleotides/ deoxynucleotides - Biosynthesis and regulation of purine and pyrimidine nucleotides - Biosynthesis of nucleotide coenzymes and regulation - Inhibitors of purine and pyrimidine metabolism and role in cancer therapy – Metabolic disorders.

Unit V

Structural and functional relationships of specialized tissues and organs; Organ specialization in fuel metabolism: Brain, muscle, adipose tissue, liver, kidney; Inter organ metabolic pathways, hormonal control of fuel metabolism. Tracing metabolic fates, perturbing the system. Metabolic interrelationships in obesity, diabetes, cancer, aerobic and anaerobic exercise in horses, pregnancy, lactation and stress injury.

VI. Suggested Reading

- Berg JM, Tymoczko JL, Stryer L and Clarke ND 2015. *Biochemistry*. 8th Ed. WH Freeman and Co.
- David L Nelson and Cox Michael M. 2017. *Lehninger's Principles of Biochemistry*. 7th Ed. Freeman.
- Kaneko JJ, Harvey JH and Bruss ML. 2008. *Clinical Biochemistry of Domestic Animals*. 6th Ed. Academic Press.
- Metzler DE. *Biochemistry*. John Wiley.
- Swenson MJ and Reece WO. 2015. *Dukes' Physiology of Domestic Animals*. 13th Ed. Panima.
- Voet D, Voet JG and Pratt CW. 2016. *Fundamentals of Biochemistry of Life at the Molecular Level*. 5th Ed. John Wiley and Sons.
- Zubay GL. 1998. *Biochemistry*. 4th Ed. WCB London.



Course Outline

S. No.	Topics	No. of Lectures
Theory		
1.	Glycolysis - Reactions, functions and its control	1
2.	Metabolism and regulation of other sugars – Fructose and Galactose	1
3.	Metabolism and regulation of other sugars - Mannose and Lactose	1
4.	Pyruvate dehydrogenase Complex, Reactions of Citric acid cycle and its regulation	1
5.	Anaplerotic reactions - Energetics of Glucose oxidations; Introduction to Alternate pathways of Glucose metabolism.	1
6.	Reactions of HMP pathway and its regulation	1
7.	Glucuronic acid cycle and its regulation	1
8.	Gluconeogenesis with its regulation – Substrates - Pyruvate and Lactate	1
9.	Gluconeogenesis with its regulation – Substrates - Glucogenic amino acids, Glycerol and Propionate	1
10.	Glycogen metabolism – Reactions and regulation of Glycogenolysis.	1
11.	Glycogen metabolism - Reactions and regulation of Glycogenesis.	1
12.	Metabolic disorders – Glycogen Storage Diseases (GSD)	1
13.	Lipid transport and storage – Metabolism of Plasma Lipoproteins	1
14.	Role of liver and adipose tissue in fat metabolism	1
15.	Role of brown adipose tissue in thermogenesis	1
16.	Catabolism of Triacylglycerols and its regulation	1
17.	Beta oxidation of Fatty acids and its regulation	1
18.	Ketogenesis and utilization of ketone bodies	1
19.	Biosynthesis of Fatty acids and its regulation	1
20.	Biosynthesis of Triacylglycerols and Phospholipids and their regulation	1
21.	Biosynthesis of Cholesterol and its regulation – Production of Bile acids	1
22.	Metabolism of Eicosanoids	1
23.	Lipid Storage Diseases	1
24.	Introduction to protein turnover and amino acid pools – Meister cycle	1
25.	Catabolism of amino acids - Deamination, transamination reactions and Ammonia carriers/ transport	1
26.	Excretion of nitrogen - Urea cycle and its regulation	1
27.	Catabolism of carbon skeletons of amino acids and its regulation	2
28.	Conversion of amino acids to specialized products - Heme Biosynthesis	1
29.	Conversion of amino acids to specialized products - Physiologically active amines	1
30.	Biosynthesis of non-essential amino acids and its regulation	1
31.	Metabolic disorders – phenylketonuria, methyl malonic aciduria, alkaptonuria, maple syrup urine disease, parkinson's disease, homocystinuria, hartnup's disease.	1
32.	Catabolism and regulation of Purine nucleotides	1
33.	Catabolism and regulation of Pyrimidine nucleotides	1
34.	Biosynthesis and regulation of Purine nucleotides	1
35.	Biosynthesis and regulation of Pyrimidine nucleotides	1
36.	Biosynthesis of nucleotide coenzymes and regulation	1
37.	Inhibitors of purine and pyrimidine metabolism – Role in Cancer therapy	1
38.	Metabolic disorders-hyperuricemia and gout.	1
39.	Structural and functional relationships of specialized tissues and organs, viz., Brain, muscle, adipose tissue, liver and kidney	2
40.	Organ specialization in fuel metabolism of brain, muscle, adipose tissue, liver and kidney	2



S. No.	Topics	No. of Lectures
41.	Inter-organ metabolic pathways	1
42.	Hormonal control of fuel metabolism	1
43.	Tracing metabolic fates - perturbing the system.	1
44.	Metabolic interrelationships in obesity, diabetes, cancer, aerobic and anaerobic exercise in horses, pregnancy, lactation and stress injury	2
	Total	48

I. Course Title : Molecular Biochemistry

II. Course Code : BCT 607

III. Credit Hours : 2 + 1

IV. Aim of the course

To provide knowledge regarding genes, their functions, expression, regulation and transfer in heterologous systems.

V. Theory

Unit I

Historical development of molecular biology, nucleic acids as genetic material, chemistry and structure of DNA and RNA, Genome organization in prokaryotes and eukaryotes, repetitive and non-repetitive DNA, satellite DNA; chromatin structure and function.

Unit II

DNA replication mechanisms in prokaryotes and Eukaryotes, DNA polymerases, Topoisomerases, DNA ligase, Reverse transcriptase, Transcription mechanisms in Prokaryotes and Eukaryotes, RNA polymerases, RNA editing, post transcriptional RNA processing. Recombination mechanisms, DNA repair mechanisms, Telomeres, Telomerase, Role of Telomeres in Cancer.

Unit III

Ribosomes - structure and function, organization of ribosomal proteins, genetic code, aminoacyl tRNA synthases, Inhibitors of replication, transcription and translation; Translation mechanisms in Eukaryotes and Prokaryotes and Post-translational modification; Nucleases and restriction enzymes, regulation of gene expression in prokaryotes and eukaryotes.

Unit IV

DNA sequencing techniques, Recombinant DNA technology, Plasmid biology, Cloning Vectors, Expression vectors, selection of recombinants, Heterologous protein expression systems, Recombinant protein purification, Polymerase Chain Reaction and its variants; Site Directed Mutagenesis, *In-vitro* transcription, Gene Silencing. Transgenic Animals, Introduction to Systems Biology.

VI. Practical

Isolation and purification of DNA - Plasmid isolation- Isolation and purification of RNA – Determination of concentration of DNA and RNA by spectrophotometry - Determination of T_m of DNA by Spectrophotometry - Restriction Digestion of DNA, Agarose gel electrophoresis - RAPD analysis of DNA - cDNA synthesis using PCR



VII. Suggested Reading

- Jocelyn E Krebs *et al.* 2017. *Lewin's Genes XII*. Jones and Bartlett Publishers Inc.
- Watson JD *et al.* 2017. *Molecular Biology of the Gene*. 7th Ed. Pearson Education.
- Eberhard. O. Voit. 2017. *A First Course in Systems Biology*, 2nd Edition. Garland Science Publishers.
- *Genome Editing and Engineering: From TALENs, ZFNs and CRISPRs to Molecular Surgery*, Ed. Krishnarao Appasani, Cambridge University Press, 2018
- *Molecular Cell Biology*, 8th Ed, Lodish *et al.* WH Freeman and Co., 2016
- *Molecular Biology of the Cell*, 6th Ed. Bruce Alberts *et al.*, WW Norton and Company, 2014
- *Transgenic Animal Technology: A laboratory handbook*, 3rd Edition, Ed. Carl. A. Pinkert, Academic Press, 2014.
- *Molecular Biology*, 4th Ed, Robert F. Weaver, McGraw Hill Higher Education, 2007.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Historical Development of Molecular Biology	1
2.	Nucleic acids as genetic material, Chemistry and Structure of DNA and RNA	1
3.	Genome organization in prokaryotes and eukaryotes	1
4.	Repetitive and non-repetitive DNA, Satellite DNA	1
5.	Chromatin structure and function	1
6.	DNA replication mechanisms in prokaryotes and Eukaryotes, DNA polymerases, DNA ligase	1
7.	Topoisomerases	1
8.	Transcription mechanisms in Prokaryotes and Eukaryotes, RNA Pol.	1
9.	RNA editing	1
10.	Post-transcriptional RNA processing	1
11.	Recombination mechanisms	1
12.	DNA repair mechanisms	1
13.	Reverse transcriptase	1
14.	Telomeres, Telomerase, Role of Telomeres in Cancer	1
15.	Translation mechanisms in Eukaryotes and Prokaryotes	1
16.	Post - translational modification	1
17.	Ribosomes - structure and function, organization of ribosomal proteins,	1
18.	Genetic code	1
19.	Aminoacyl tRNA synthases	1
20.	Inhibitors of replication, transcription and translation	1
21.	Regulation of gene expression in prokaryotes and eukaryotes	1
22.	Recombinant DNA technology - Introduction	1
23.	Plasmid biology, Cloning Vectors, selection of recombinants	1
24.	Nucleases and restriction enzymes	1
25.	Polymerase Chain Reaction and its variants	1
26.	Expression vectors	1
27.	Heterologous protein expression systems	1
28.	Recombinant protein purification	1
29.	Site Directed Mutagenesis, <i>In-vitro</i> transcription,	1
30.	Gene Silencing	1
31.	Transgenic Animals	1
32.	Introduction to Systems Biology	1
	Total	32



S. No.	Topic	No. of Lectures/ Practicals
Practical		
1.	Isolation and purification of DNA	2
2.	Plasmid isolation	2
3.	Isolation and purification of RNA	2
4.	Determination of concentration of DNA and RNA by spectrophotometry	1
5.	Determination of TM of DNA by Spectrophotometry	1
6.	Polymerase chain reaction	2
7.	Restriction Digestion of DNA	2
8.	Agarose gel electrophoresis	1
9.	RAPD analysis of DNA	2
10.	cDNA synthesis using PCR	2
	Total	17

I. Course Title : Nutritional and Industrial Biochemistry

II. Course Code : BCT 608

III. Credit Hours : 2 + 0

IV. Aim of the course

To give exposure about biochemical principle as applicable to nutrition in animals and industry.

V. Theory

Unit I

Introduction - Nutrients and their importance in ruminants, non-ruminants and poultry - Energy value of various nutrients their importance and calorimetry - Nutrient absorption and biochemical changes involved - Introduction to BMR, SDA, PER and Biological value for protein - Requirements of different nutrients in animals - Role of nutrients in growth and production of animals – Bio-availability of nutrients in different food sources.

Unit II

Metabolic role of Nutrients - Overview of metabolism of different nutrients and regulation of nutrient absorption and utilization - Alterations that occur in nutritional requirements during diseases and biochemical reactions due to Toxic factors in feed - Biochemical role of Macro and micro minerals in animal production - Vitamins and their role as co enzymes in metabolism – Nutrient deficiencies and metabolic disorders in animals - Biochemical alterations occurring due to phyto-toxins in ruminants - Biochemical importance of different feed additives - Agonists and antagonists of minerals and vitamins - Nutrient control of gene expression - Clinical issues of micro mineral metabolism - Nutrients (minerals) that resist digestion process in animals - Energy releasing and hematopoietic water soluble vitamins.

Unit III

Industrial biochemistry - applications of biological molecules for medical, industrial, environmental, agricultural or analytical purposes - Generation of gene-mediated industrial/ medical products - Introduction and application of fermentation



technology for ethanol and biogas production - conversion of sunlight into biomass (bioreactors and biophotolysis) - Significance of pharmaceuticals products of animal origin (sex hormones- oestrogens, progesterone; corticosteroids) - Significance of pharmaceuticals of plant origin (alkaloids, atropine, morphine, cocaine, ergot alkaloids, flavonoids, xanthenes and terpenoids) - Physical, chemical and biological treatment of waste water, bioremediation of contaminated soils.

VI. Suggested Reading

- *Nutritional Biochemistry*, 2nd Edition, Tom Brody, Elsevier pub.2009
- *Text book of Biochemistry with clinical correlations*. 6th edition, Thomas M Devlin, Wileys-liss. Press.
- *A textbook of industrial microbiology* 2nd edition, Crueger W and Crueger A. 2000, Panima Publishing Corp.
- *Principle of fermentation technology*, 1997, Stanbury PF, Ethitaker H, Hall S, Aditya Books (P) Ltd.
- *Bioprocess Engineering: Basic Concepts*. Shuler M and Kargi F. Second Edition. Pearson Education. 2002
- *Nutritional Biochemistry of the vitamins*, by David a Bender, 2nd Edition, Cambridge University Press.

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Nutrients and their importance in ruminants.	1
2.	Nutrients and their importance in Non ruminants and poultry	1
3.	Energy value of various nutrients their importance and calorimetry.	1
4.	Nutrient absorption and biochemical changes involved.	1
5.	Introduction to BMR, SDA, PER and Biological value for protein.	1
6.	Requirements of different nutrients in animals	1
7.	Role of nutrients in growth and production of animals	1
8.	Bio-availability of nutrients in different food sources	1
9.	An overview of metabolism of different nutrients.	1
10.	An overview of regulation of nutrient absorption and utilization.	1
11.	Alterations that occur in nutritional requirements during diseases.	1
12.	Alterations in biochemical reactions due to Toxic factors in feed.	1
13.	Biochemical role of Macro minerals in animal production	1
14.	Biochemical role of Micro minerals in animal production.	1
15.	Vitamins and their role as co enzymes in metabolism	1
16.	Deficiencies of nutrients that cause metabolic disorders in animals	1
17.	Biochemical alterations occurring due to phyto toxins in ruminants	1
18.	Biochemical importance of different feed additives	1
19.	Agonists and antagonists of minerals.	1
20.	Agonists and antagonists of vitamins.	1
21.	Nutrient control of gene expression	1
22.	Clinical issues of micro mineral metabolism.	1
23.	Nutrients (minerals) that resist digestion process in animals.	1
24.	Energy releasing and hematopoietic water soluble vitamins.	1
25.	Industrial biochemistry- applications of biological molecules for medical, industrial, environmental, agricultural or analytical purposes.	1
26.	Generation of gene-mediated industrial/ medical products.	1
27.	Introduction and application of fermentation technology for ethanol and biogas production.	1



S. No.	Topic	No. of Lectures/ Practicals
28.	Introduction to industrial microorganisms and products, growth and product formation in biocatalysis.	1
29.	Conversion of sunlight into biomass (bioreactors and bio-photolysis)	1
30.	Significance of pharmaceuticals products of animal origin, sex hormones, oestrogens, progesterone, corticosteroids.	1
31.	Significance of pharmaceuticals of plant origin, Alkaloids, atropine, morphine, cocaine, ergot alkaloids, flavonoids, xanthenes and terpenoids;	1
32.	Physical, chemical and biological treatment of waste water, bioremediation of contaminated soils.	1
	Total	32

I. Course Title : Endocrinology and Reproductive Biochemistry

II. Course Code : BCT 609

III. Credit Hours : 2 + 0

IV. Aim of the course

To impart knowledge on the role of hormones in signalling and their biochemical role in reproduction of animals.

V. Theory

Unit I

Endocrinology - Classification, secretion, transport and regulation of hormones - Mechanism of hormone action and intracellular signalling after receptor activation - Releasing factors from hypothalamus and their effects on pituitary gland and metabolism - Synthesis, secretion, regulation, metabolic functions and physio-pathology of Hormones from Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal and Pineal Glands.

Unit II

Endocrinology of Gonads and Reproductive Biochemistry - Female hormonal system - Synthesis, secretion, regulation, functions, and physio-pathology of ovarian hormones and male sex hormones - Prostaglandins: chemistry, functions and clinical importance - Endocrine aspects of reproduction status in domestic animals - Endocrine aspects of reproduction in poultry - Hormones involved in the development of ductal and lobule-alveolar system of mammary gland - Endocrine control of biosynthesis of milk.

VI. Suggested Reading

- *Dukes' Physiology of Domestic Animals*, 13th edition/ editor, William O Reece, Wiley Blackwell.
- Guyton and Hall *Textbook of Medical Physiology*, 13th edition/ editor, John E Hall, Elsevier.
- *Applied Animal Endocrinology*, E. James Squires, CABI
- *Endocrinology: An Integrated Approach*, by SS Nussey, SA Whitehead, 1st edition, CRC Press.
- *Biochemistry of Lactation*, TB Mepham, Elsevier



Course Outline

S. No.	Topics	No. of Lectures
Theory		
1.	Classification, secretion, transport and regulation of hormones.	2
2.	Mechanism of hormone action and intracellular signalling after receptor activation.	2
3.	Releasing factors from hypothalamus and their effects on pituitary gland and metabolism.	2
4.	Hormones from Pituitary, secretion, regulation, metabolic functions and physio-pathology.	2
5.	Synthesis, secretion, regulation, metabolic functions and physio-pathology of Thyroid hormones.	1
6.	Parathyroid gland, its hormone and effect on calcium and phosphate concentrations in the extracellular fluid	2
7.	Endocrine Pancreas: Hormone synthesis, secretion, regulation, metabolic functions and physio-pathology.	2
8.	Endocrine Adrenal: Hormone synthesis, secretion, regulation, metabolic functions and physio-pathology.	2
9.	The Pineal Gland and Melatonin secretion, regulation and function.	1
10.	Female hormonal system - Effect on ovaries - Synthesis, secretion, regulation, functions, and physio-pathology of ovarian hormones.	2
11.	Synthesis, secretion, regulation, metabolic functions and physio-pathology of male sex hormones.	2
12.	Prostaglandins: Chemistry, Functions and Clinical Importance	2
13.	Hormones concerned with animal production.	2
14.	Endocrine aspects in reproduction status in domestic animals	2
15.	Hormones concerned with poultry production.	2
16.	Endocrine aspects of reproduction in poultry	2
17.	Hormones involved in development of Ductal and Lobule-Alveolar System of mammary gland - Endocrine control of milk secretion and its biosynthesis	2
	Total	32

I. Course Title : Biochemistry of Ruminants and Wild Animals

II. Course Code : BCT 610

III. Credit Hours : 1 + 1

IV. Aim of the course

To acquaint the students about comparative metabolism in ruminant species and the common metabolic disorders in ruminants; to impart a basic knowledge about biochemistry of wild animals.

V. Theory

Unit I

Biochemistry of Ruminants - An overview of metabolism of carbohydrates, proteins and lipids in ruminants - Metabolism of nutrients by rumen microflora - Blood biochemistry of ruminants - Disorders associated with carbohydrates, proteins and lipid metabolism in ruminants - Liver and Kidney function tests - Diseases associated with major and trace elements in ruminants.

Unit II

Biochemistry of Wild Animals - Blood biochemistry and blood typing of wild animals - Fluid balance and electrolyte maintenance in wild animals - Biomarkers for assessment of diseases in wild animals - Diabetes mellitus in primates - Neurological diseases in cheetah

VI. Suggested reading

- Dvorak AM and Harris W. 1991. *Blood Cell Biochemistry*. 2nd Ed. Plenum.
- *Clinical Biochemistry of Domestic Animals*, 6th Edition/ Editors: Jiro Kaneko John Harvey Michael Bruss, Elsevier.
- *Lipid Metabolism in Ruminant Animals*, 1st Edition/ Editors: William W Christie, Elsevier.
- *Digestive Physiology and Metabolism in Ruminants*, Editors: Ruckebusch Y, Thivend.
- *Energy Nutrition in Ruminants*, Editors: Orskov ER.
- *Zoo and Wild Animal Medicine (Current Therapy 3)* by Murray E Fowler, 5th edition.
- *Textbook of Veterinary Biochemistry*, by RS Dhanotiya, JAYPEE.

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Comparative metabolism of carbohydrates, proteins and lipids in ruminants	2
2.	Metabolism of nutrients by rumen microflora	1
3.	Blood biochemistry of ruminants	1
4.	Disorders associated with carbohydrate, protein and lipid metabolism	2
5.	Liver dysfunction and tests	1
6.	Kidney dysfunction and tests	1
7.	Diseases associated with major and trace elements	2
8.	Blood biochemistry and blood typing of wild animals	1
9.	Fluid balance and electrolyte maintenance in wild animals	2
10.	Biomarkers for assessment of diseases in wild animals	1
11.	Diabetes in primates	1
12.	Neurological diseases in cheetah	1
	Total	16
Practical		
1.	Methods of examining fluids and tissue in wild animals	1
2.	Pancreatic function test	1
3.	Estimation of Serum amylase	1
4.	Estimation of Serum Bilirubin	1
5.	Estimation of serum Inorganic Phosphate	1
6.	Estimation of serum Calcium	1
7.	Estimation of serum Magnesium	1
8.	Estimation of Vitamin A	1
9.	Estimation of serum LDH	1
10.	Estimation of rumen volatile fatty acid	1
11.	Estimation of rumen lactic acid	1
12.	Estimation of Cellulolytic activity	1
13.	Estimation of milk ketone bodies (acetone) by microdiffusion method	1
14.	Estimation of milk lactose	1
	Total	14



- I. Course Title** : **Introduction to Bioinformatics and Computational Biology**
- II. Course Code** : **BCT 611**
- III. Credit Hours** : **1 + 1**

IV. Aim of the course

To impart an introductory knowledge of Bioinformatics and Computational biology to postgraduate students studying any discipline of veterinary/ agricultural science.

V. Theory

Unit I

Introduction to bioinformatics, scope and applications of bioinformatics; biological databases: primary, secondary and structural; basic concept of Protein and Gene Information Resources-PIR, SWISS-PROT, PDB, GenBank, DDBJ; Basic concept of computational biology, applications in different subfield of biology, software tools.

Unit II

Basic concept of sequence search algorithm and alignment tools: BLAST and FASTA; DNA and protein sequence analysis, local and global alignment; Algorithms: Dot Matrix method, dynamic programming methods; Pairwise and multiple sequence alignment and its application; Tools of Multiple sequence alignment: ClustalW.

Unit III

Basic concept of Phylogeny study; cDNA libraries and EST, EST analysis; database search engines: introduction and application; Commercial databases and software packages, GPL software for Bioinformatics.

Unit IV

Computer aided drug design: basic principles, docking; QSAR, 2DQSAR, 3DQSAR, their basic concept and applications, machine learning tools for QSAR.

VI. Practical

- Basic computing: Introduction to LINUX and Windows
- Nucleotide information resource: EMBL, GenBank, DDBJ
- Protein information resource: SwissProt, TrEMBL, Uniprot
- Structure databases: PDB, MMDB
- Search Engines: Entrez, ARSA, SRS
- Usage of NCBI resources
- Retrieval of sequence/ structure from databases
- Database searching
- Visualization of structures of DNA and Proteins using Rasmol
- Sequence similarity search using BLAST
- Multiple sequence alignment
- Primer designing

VII. Suggested Reading

- *Introduction to Bioinformatics* 2003. Attwood TK and Parry-Smith DJ, Pearson Education.
- *Essential bioinformatics* 2006. Xin Xiong. Cambridge University Press.
- *Bioinformatics: Concepts, Skills and Applications* 2004. Rastogi SC, Mendiratta N and Rastogi P. CBS.
- *Principles of Genome Analysis and Genomics* 2003. SB Primrose and RM Twyman, Blackwell Publishing.



- *Molecular Analysis and Genome Discovery* 2004. Ralph Rapley and Stuart Harbron (Eds.), John Wiley and Sons.
- *Bioinformatics* 2001. Andreas D Baxevanis and BF Francis Ouellette (Eds.)
- *Wiley Interscience Proteins and Proteomics* 2003. Richard J. Simpson, Cold Spring Harbor Laboratory.

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to bioinformatics - Scope and applications of bioinformatics	1
2.	Introduction to biological databases: primary, secondary and structural databases	1
3.	Basic concept of Protein and Gene Information Resources-PIR, SWISS-PROT, PDB, GenBank, DDBJ	1
4.	Basic concept of computational biology, applications in different subfields of biology	1
5.	Basic concept of sequence search algorithm and alignment tools: BLAST and FASTA; DNA and protein sequence analysis, local and global alignment	1
6.	Dot Matrix method, dynamic programming methods	1
7.	Pairwise and multiple sequence alignment and its application	1
8.	Tools of Multiple sequence alignment: ClustalW	1
9.	Basic concept of Phylogeny study	1
10.	cDNA libraries and EST, EST analysis	1
11.	Database search engines-introduction and application	1
12.	Commercial databases and software packages, GPL software for Bioinformatics	1
13.	Computer aided drug design-basic principles	1
14.	Introduction of Molecular docking and QSAR	1
15.	2DQSAR, 3DQSAR, their basic concept and applications	1
16.	Machine learning tools for QSAR	1
	Total	16
Practical		
1.	Basic concept of computer hardware and software, computer operating systems: Linux and windows	2
2.	Nucleotide information resource: EMBL, GenBank, DDBJ	1
3.	Protein information resource: SwissProt, TrEMBL, Uniprot	1
4.	Structure databases: PDB, MMDB	1
5.	Basic concept of molecular search Engines: Entrez, ARSA, SRS	1
6.	Usage of NCBI resources	2
7.	Retrieval of sequence/ structure from databases	1
8.	Database searching	1
9.	Visualization of structures of DNA and Proteins using Rasmol	1
10.	Sequence similarity search using BLAST	1
11.	Multiple sequence alignment tools: ClustalW, Bioedit, etc.	2
12.	Phylogeny study using different software tools	1
13.	Primer designing using different software tools	1
	Total	16



Course Title with Credit Load

Ph.D. in Veterinary Biochemistry

Course Code	Course Title	Credit Hours
RPE700*	Research and Publications Ethics	1 + 1
BCT 701	Applied Molecular Biochemistry and Systems Biology	2 + 1
BCT 702	Membrane Biochemistry	2 + 0
BCT 703	Recent trends in Enzymology	2 + 1
BCT 704	Diagnostic Techniques in Clinical Biochemistry	0 + 2
BCT 705	Recent Trends in Biochemical Techniques and Instrumentation	2 + 1
BCT 706	Developmental Biochemistry	2 + 0
BCT 707	Bioinformatics Tools in Biochemistry	1 + 1
BCT 708	Environmental and Toxicological Biochemistry	2 + 0
BCT 709	Biochemistry of Diseases and Disorders	2 + 0
BCT 710	Immuno-Biochemistry	2 + 0
BCT 711	Special Problem	0 + 2
BCT 712	Doctoral Seminar-I	1 + 0
BCT 713	Doctoral Seminar-II	1 + 0
BCT 714	Doctoral Research	0+75

*compulsory Major course for Doctorate programme. The other 10 credits can be registered from remaining 700 Series courses listed above



Course Contents

Ph.D. in Veterinary Biochemistry

- I. Course Title** : Applied Molecular Biochemistry and Systems Biology
II. Course Code : BCT 701
III. Credit Hours : 2 + 1
IV. Pre-requisite

Should have studied BCT-607: Molecular Biochemistry (2+1) or other equivalent courses with similar syllabi/ content at Master's level.

V. Aim of the course

To impart latest information on the molecular biochemistry of isolation, transfer and expression of genes and biochemical approaches employed in gene therapy and computational approaches to biology/ synthetic biology.

VI. Theory

Unit I

Organization of prokaryotic genome, nuclear and organelle genes, concept of genome mapping and Organization, Molecular evolution, Prokaryotic and Eukaryotic gene regulation, RNA editing.

Unit II

Comparative genomics, functional genomics, transcriptomics and transcriptional network, Application of genomics, Livestock genomics, Buffalo Genome Initiative, Dog genome projects, Role of genomics in Wild life conservation and Reconstruction of species, Bioethics and biosafety guidelines and IPR in recombinant DNA research.

Unit III

Transgenics, Gene Knock – out technology, Site specific nucleases, Zinc – Fingers, TALENS and CRISPR – Cas 9, Applications of Gene knock out, Development of Knock - out Animal models, Gene silencing, Antisense oligos, Ribozymes, RNAi, 3'UTR and miRNA, Applications of gene silencing, Site directed mutagenesis, gene targeting and gene therapy.

Unit IV

Nucleic acid sequencing: Various methods of sequencing including automated sequencing and Microarrays, Whole Genome Sequencing, epigenetic regulation, Protein sequencing, Peptide synthesis, Peptide arrays, protein engineering, Directed evolution of proteins.

Unit V

Mathematical modelling, Static Network models, Mathematics of Biological systems, Parameter estimation, Gene systems, Gene regulation models, Protein systems, Metabolic systems, Signalling systems, Population systems, Physiological modelling, Systems biology in Medicine and Drug development, Basic design of biological systems, Introduction to nutrigenomics and pharmacogenomics, Applications in Veterinary Science.



VII. Practical

DNA methylation protocols, Genome Editing protocols, *in-vitro* Site Directed Mutagenesis, Gene silencing protocols, Next Generation sequencing platforms, Quantitative PCR, SAGE, Massively Parallel Signature Sequencing (MPSS), Oligonucleotide synthesis and quality control, Cap Analysis of Gene Expression (CAGE)/ deep CAGE, Chip-Chip assay Proteomics - 2D-PAGE, MSMS, MALDI-TOF, and Protein-protein interaction (Hybrid assay, DNA-Protein interaction and gene regulation (EMSA and Chip assay), DNA Microarrays, Protein sequencing protocols.

VIII. Suggested Reading

- *Molecular Biology of the Gene*, 7th Ed. JD Watson *et al.*, Pearson Education, 2017
- *Lewin's Genes XII*, Jocelyn E Krebs *et al.*, Jones and Bartlett Publishers Inc., 2017
- *A First Course in Systems Biology*, 2nd Edition, Eberhard. OVoit, Garland Science publishers 2017
- *Directed Enzyme Evolution: Advances and Applications*, Ed. Miguel Alcalde, Springer International Publishing, 2017
- *Genome Editing in Animals: Methods and Protocols*, Ed. Izuho Hatada, Springer Protocols, 2017
- *Genome Editing and Engineering: From TALENs, ZFNs and CRISPRs to Molecular Surgery*, Ed. Krishnarao Appasani, Cambridge University Press, 2018
- *Molecular Cell Biology*, 8th Ed, Lodish *et al.*, WH Freeman and Co., 2016
- *Nutrigenomics*, Eds. Carsten Carlberg, Stine Marie Ulven and Ferdinand Molnar, Springer Intl. Pub, 2016
- *CRISPR: Methods and Protocols*, Eds. Magnus Lundgren, Emmanuelle Charpentier, Peter C Fineran, Humana Press, 2015
- *Genome Analysis: Current Procedures and Applications*, Ed Maria S Poptsova, Caister Academic Press, 2014
- *Transgenic Animal Technology: A laboratory handbook*, 3rd Edition, Ed. Carl A Pinkert, Academic Press, 2014
- *Molecular Biology of the Cell*, 6th Ed. Bruce Alberts *et al*, WW Norton and Company, 2014
- *Bovine Genomics*, Ed. James E Womack, Wiley Blackwell, 2012
- *The Genetics of the Dog*, Eds. Elaine A Ostrander and Anatoly Ruvinsky, CABI press, 2012
- *An Introduction to Systems Biology*. Ed. Sangdun Choi, Humana Press, 2010
- *Genome Mapping and Genomics in Domestic Animals*, Eds. Noelle E Cockett, Chittaranjan Kole, Springer Verlag, 2009.
- *Gene Knockout protocols*, Eds. Ralf Kuhn, Wolfgang Wurst, 2009, Springer
- *Molecular Biology*, 4th Ed, Robert F. Weaver, McGraw Hill Higher Education, 2007
- *Comparative Genomics*, Ed. Nicholas H Bergman, Humana press, 2007
- *Molecular Biology and Genomics*, Cornel Mulhardt, Academic Press, 2007
- *The Dog and Its Genome*, Eds. Elaine A. Ostrander, Urs Giger, Kerstin Lindblad-Toh, CSHL press, 2006
- *Life: An Introduction to Complex Systems Biology*, Springer, 2006
- *An Introduction to Systems Biology: Design principles of Biological circuits*, Uri Alon, 2006, Chapman and Hall/ CRC
- *Directed molecular Evolution of Proteins: or How to improve Enzymes for Biocatalysis*, Eds. Susanne Brakmann, Kai Johnsson, Wiley VCH Verlag GmbH, 2003
- *Directed Evolution Library Creation*, Eds. Frances H Arnold, George Georgiou, Humana Press, 2003.
- Selected articles from journals.

**Course Outline**

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Organization of prokaryotic genome	1
2.	Nuclear and organelle genes.	1
3.	Concept of genome mapping and Organization	1
4.	Molecular evolution	1
5.	Prokaryotic and Eukaryotic gene regulation	1
6.	RNA editing	1
7.	Comparative genomics	1
8.	Functional genomics	1
9.	Transcriptomics and transcriptional network	1
10.	Application of genomics, Livestock genomics, Buffalo Genome Initiative, Dog genome projects, Role of genomics in Wild life conservation and Reconstruction of species	1
11.	Bioethics and biosafety guidelines and IPR in recombinant DNA research	1
12.	Transgenics, Gene Knock-out technology.	1
13.	Site specific nucleases, Zinc-Fingers, TALENS and CRISPR – Cas 9,	1
14.	Applications of Gene knock out, Development of Knock-out Animal models	1
15.	Gene silencing, Applications of gene silencing	1
16.	Antisense oligos, Ribozymes	1
17.	RNAi, 3'UTR and miRNA, Site directed mutagenesis	1
18.	gene targeting and gene therapy	1
19.	Nucleic acid sequencing: Various methods of sequencing including automated sequencing and Microarrays	1
20.	Whole Genome Sequencing, epigenetic regulation	1
21.	Protein sequencing, Peptide synthesis	1
22.	Peptide arrays	1
23.	Protein engineering	1
24.	Directed evolution of proteins	1
25.	Mathematical modelling, Static Network models	1
26.	Mathematics of Biological systems, Parameter estimation	1
27.	Gene systems, Gene regulation models	1
28.	Protein systems, Metabolic systems	1
29.	Signalling systems, Population systems	1
30.	Physiological modelling	1
31.	Systems biology in Medicine and Drug development	1
32.	Basic design of biological systems	1
33.	Introduction to Nutrigenomics - Applications in Veterinary Science	1
34.	Pharmacogenomics - Applications in Veterinary Science	1
	Total	34
Practical		
1.	DNA methylation protocols	2
2.	Genome Editing protocols, <i>In-vitro</i> Site Directed Mutagenesis	2
3.	Gene silencing protocols	2
4.	Next Generation sequencing platforms	1
5.	Quantitative PCR, SAGE, Massively Parallel Signature Sequencing (MPSS)	1
6.	Oligonucleotide synthesis and quality control	2
7.	Cap Analysis of Gene Expression (CAGE)/ deep CAGE	2
8.	Chip-Chip assay Proteomics	1



S. No.	Topic	No. of Lectures/ Practicals
9.	2D-PAGE, MSMS, MALDI-TOF	2
10.	Protein-protein interaction (Hybrid assay, DNA-Protein interaction and gene regulation (EMSA and Chip assay), DNA Microarrays, Protein sequencing protocols	2
	Total	17

I. Course Title : Membrane Biochemistry

II. Course Code : BCT 702

III. Credit Hours : 2 + 0

IV. Pre-requisite

Should have studied BCT -602: Biochemistry of Biomolecules (3+0) or other equivalent courses with similar syllabi/ content at Master's level.

V. Aim of the course

To teach structure and functions of biomembranes, structure-function relationships, membrane biogenesis.

VI. Theory

Unit I

Concept of biomembranes and their classification based on cellular organelles; physico-chemical properties of different biological and artificial membranes, Membrane biogenesis and differentiation, Trafficking of Membrane Components - lipids, carbohydrates and proteins, cell surface receptors and antigen.

Unit II

Distribution and organization of membrane components-lipids; proteins- intrinsic and extrinsic: their arrangement; carbohydrates in membranes and their function. Cell membrane structure and the Fluid-mosaic model. Restoration and maintenance of cell membrane integrity and permeability. Methods for analysis of plasma membrane integrity. Separation of different membrane components.

Unit III

Molecular basis of biochemical behaviours of membranes, Various membrane movements; transport across membrane-Active transport, passive transport, diffusion, osmosis, exocytosis and endocytosis, Fick's law of diffusion and its physiological importance, energy transduction.

Unit IV

Role of membrane in cellular metabolism, cell recognition and cell -to -cell interaction; signal transduction, Molecular mechanisms, ion translocating antibiotics, valinomycin, gramicidin, ouabain, group translocation, ionophores, electrical gradient, energy coupling mechanism, recent trends and tools in membrane research.

VII. Suggested Reading

- Alberts B, Johnson A, Lewis J, Raff M, Roberts HK and Walter P. *Molecular Biology of the Cell. Garland Science*, Taylor and Fransis Group.
- Cooper GM and Hausam RE. 2015. *The Cell: A Molecular Approach*. Oxford University Press. ISBN: 9781605352909



- Lodish H, Berk A, Zipursky SA, Matsudaira P, Baltimore D and Darnel J. 1999. *Molecular Cell Biology*. WH Freeman.
- Nelson DL and Cox MM. 2000. *Lehninger Principles of Biochemistry*. 3rd Ed. Replika Press Pvt. Ltd., New Delhi for Worth Publ., New York.
- Selected articles from journals.

Course Outline

S. No.	Topics	No. of Lectures
Theory		
1.	Concepts of bio membranes and their classification based on cellular organelles	2
2.	Physico-chemical properties of different biological and artificial membranes	1
3.	Membrane biogenesis and differentiation	2
4.	Trafficking of Membrane Components - lipids, carbohydrates and proteins	2
5.	Cell surface receptors and antigen	1
6.	Distribution and organization of membrane components-lipids; proteins, intrinsic and extrinsic: their arrangement	2
7.	Cell membrane structure and the Fluid-mosaic model	1
8.	Restoration and maintenance of cell membrane integrity and permeability	1
9.	Methods for analysis of plasma membrane integrity.	2
10.	Separation of different membrane components.	1
11.	Molecular basis of biochemical behaviours of membranes	2
12.	Various membrane movements	1
13.	Transport across membrane-Active transport, passive transport, diffusion, osmosis, exocytosis and endocytosis	2
14.	Fick's law of diffusion and its physiological importance	1
15.	Energy transduction	1
16.	Role of membrane in cellular metabolism	1
17.	Role of membrane in cell recognition	1
18.	Cell to cell interaction	2
19.	Signal transduction	2
20.	Molecular mechanisms, ion translocating antibiotics, valinomycin, gramicidin, ouabain, group translocation, ionophores, electrical gradient, energy coupling mechanism.	2
21.	Recent trends and tools in membrane research	3
	Total	33

I. Course Title : Recent Trends in Enzymology

II. Course Code : BCT 703

III. Credit Hours : 2 + 1

IV. Pre-requisite

Should have studied BCT-603: Enzymology (2+1) or other equivalent courses with similar syllabi/ content at Master's level.

V. Aim of the course

To teach current developments in actions of enzymes and their applications.



VI. Theory

Unit I

Enzyme: Structure, mechanism, and Regulation. Three dimensional structure of enzyme, flexibility and conformational mobility of enzymes, enzyme families, dehydrogenase and dinucleotide fold, Multienzyme complexes, features and mapping of active site of enzymes, methods of examining enzyme-substrate complexes, reaction mechanism of lysozyme, chymotrypsin, carboxypeptidase A and ribonuclease A. Regulation of enzyme activity by zymogen activation, covalent modification and feed back inhibition. Allosteric enzyme with special reference to aspartate trans carbomylase. Concerted and sequential models of allosteric enzymes.

Unit II

Enzyme catalysis: general acid-base, covalent electrostatic and metal ion catalysis, orbital steering, principles of kinetic equivalence and kinetic isotopic effects, transition state theory-application and significance of enzyme catalysis. Hammond postulate

Enzyme kinetics and inhibition: factors influencing enzyme reaction velocity, steady-state kinetic of enzyme catalyzed reaction, significance of Michaelis-Menten parameters, Extension and modification of the Michaelis-Menten mechanism. K_{cat}/K_m and kinetic perfection in enzyme catalysis, kinetics of multi-substrate system-random, sequential, ordered, Theorell-chance and the ping-pong mechanisms. Competitive, non-competitive enzyme inhibition, suicide substrates and anti-metabolites.

Unit III

Recent developments: Industrial application of Enzymes, Enzyme immobilization methods and application. Restriction endonucleases, enzyme engineering, use of site-directed mutagenesis for detection of enzyme mechanisms, Abzymes and ribozymes, Enzyme linkerage. Biosensors.

Unit IV

Diagnostic enzymology: Assay of enzymes in clinical cases, Enzymes in Pathogenesis, Enzyme histochemistry and cytochemistry, Application of microscopy in enzymology, Enzyme immuno diagnostics, Cholinesterase, lipase, amylase, GGT, GPx, arginase, AST, ALT and SDH in diagnosis of diseases of animals. Therapeutic Enzymes.

VII. Practical

- Estimation of Antioxidant Enzymes (Superoxide dismutase, Glutathione Peroxidase, Catalase, Glutathione S-transferase) from tissue samples.
- Isolation, purification and characterization of enzymes from biological samples.
- Application of enzymes in competitive bioassays (ELISA, RIA)
- Determination of Enzyme activity in Native Gel Electrophoresis.
- Estimation of Diagnostic enzymes from Clinical samples.
- Application of Restriction enzymes in cloning experiments.

VIII. Suggested Reading

- David L Nelson and Cox Michael M. 2008. *Lehninger's Principles of Biochemistry*. 5th Ed. Freeman.
- Kaneko JJ, Harvey JH and Bruss ML. 2008. *Clinical Biochemistry of Domestic Animals*. 6th Ed. Academic Press.
- Maragoni AG. 2003. *Enzyme Kinetics - A Modern Approach*. John Wiley.



- Palmer T. 2001. *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry*. 5th Ed. Horwood Publ.
- Price NC and Stevens L. 2003. *Fundamentals of Enzymology*. Oxford Univ. Press.
- Voet D, Voet JG and Pratt CW. 2006. *Fundamentals of Biochemistry of Life at the Molecular Level*. 2nd Ed. John Wiley and Sons.
- Wilson K and Walker J. (Eds.). 2000. *Principles and Techniques of Practical Biochemistry*. 5th Ed. Cambridge Univ. Press.
- Selected articles from standard journals.

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Enzyme: Structure, mechanism, and regulation.	3
2.	Three dimensional structure of enzyme, flexibility and conformational mobility of enzymes	2
3.	enzyme families, dehydrogenase and dinucleotide fold, Multienzyme complexes	1
4.	Features and mapping of active site of enzymes, methods of examining enzyme-substrate complexes	2
5.	reaction mechanism of lysozyme, chymotrypsin, carboxypeptidase A and ribonuclease A.	1
6.	Regulation of enzyme activity by zymogen activation, covalent modification and feedback inhibition.	1
7.	Allosteric enzyme with special reference to aspartate trans carbomylase. Concerted and sequential models of allosteric enzymes.	2
8.	Enzyme catalysis: general acid-base, covalent electrostatic and metal ion catalysis, orbital steering	2
9.	Principles of kinetic equivalence and kinetic isotopic effects, transition state theory-application and significance of enzyme catalysis. Hammond postulate	2
10.	Enzyme kinetics and inhibition: factors influencing enzyme reaction velocity, steady-state kinetic of enzyme catalyzed reaction, significance of Michacelis-Menten parameters	2
11.	Extension and modification of the Michacelis-Menten mechanism. Kcat/ Km and kinetic perfection in enzyme catalysis	2
12.	Kinetics of multi-substrate system-random, sequential, ordered Theorell-chance and the ping-pong mechanisms.	2
13.	Competitive, non-competitive enzyme inhibition, suicide substrates and anti-metabolites.	1
14.	Recent developments: Industrial application of Enzymes	1
15.	Enzyme immobilization methods and application.	1
16.	Restriction endonucleases	1
17.	Enzyme engineering, use of site-directed mutagenesis for detection of enzyme mechanisms	1
18.	Abzymes and ribozymes, Enzyme linking. Biosensors.	1
19.	Diagnostic enzymology: Assay of enzymes in clinical cases	1
20.	Enzymes in Pathogenesis, Enzyme histochemistry and cytochemistry	1
21.	Application of microscopy in enzymology	1
22.	Enzyme immuno diagnostics, Cholinesterase, lipase, amylase, GGT, GPx, arginase, AST, ALT and SDH in diagnosis of diseases of animals. Therapeutic Enzymes.	2
	Total	33



S. No.	Topic	No. of Lectures/ Practicals
Practical		
1.	Estimation of Antioxidant Enzymes (Superoxide dismutase, Glutathione Peroxidase, Catalase, Glutathione S-transferase) from tissue samples	3
2.	Isolation, purification and characterization of enzymes from biological samples.	4
3.	Application of enzymes in competitive bioassays (ELISA, RIA)	2
4.	Determination of Enzyme activity in Native Gel Electrophoresis.	2
5.	Estimation of Diagnostic enzymes from Clinical samples.	2
6.	Application of Restriction enzymes in cloning experiments.	3
	Total	16

I. Course Title : Diagnostic Techniques in Clinical Biochemistry

II. Course Code : BCT 704

III. Credit Hours : 0 + 2

IV. Pre-requisite

Should have studied BCT-605: Clinical Biochemistry of Animals (2+1) or other equivalent courses with similar syllabi/ content at Master's level.

V. Aim of the course

To give exposure about biochemical changes in diseases of animals and current developments of diagnostic techniques in clinical biochemistry.

VI. Theory

Unit I

Scope of diagnostic techniques in disease diagnosis. Fractionation of cell organelles. Molecular basis of cell injury and diseases; Molecular basis of autoimmunity, immunodeficiency, Immunochemical techniques: Immunochemical protein analysis: immunoelectrophoresis, immunofixation and immunoassays. Oncogenesis and tumour markers.

Unit II

Comparative ruminant metabolism, metabolism of various nutrients by micro flora. Postruminal digestion of dietary and microbial biomolecules. Metabolic disorders of rumen and recent development in disorders of ruminants associated with protein, carbohydrate, fat (LDL, HDL, VLDL, apoproteins, etc. and triglycerides), mineral and electrolyte metabolism.

Unit III

Photometric methods: spectrophotometry (UV, visible) atomic reflectometry, turbidimetry, nephelometry, spectrofluorometry, atomic emission, etc. Spectrometric methods: AAS, mass spectrometry, nuclear magnetic resonance (NMR), infra-red (IR) spectroscopy.

Unit IV

Functional tests: Nucleic acid extraction, DNA finger printing, micro and mini satellites, PCR, RT-PCR, RFLP, Fluorescent In-situ hybridization (FISH), genome

mapping, DNA microarrays, biomolecular prospecting and molecular designing in clinical biochemistry.

Unit V

Tests for cardiovascular diseases: Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin. Myocardial infarction and shock; enzyme patterns and marker proteins.

Unit VI

Diagnostic use of serum enzyme assays and radioactive isotopes. LFT, KFT and tests for drugs of abuse.

Unit VII

Case Based Learning and selected articles from journals pertaining to disease diagnosis.

VII. Suggested Reading

- Bishop ML, Fody EP and Schoeff LE. 2004. *Clinical Chemistry: Principles, Procedures, Correlations* 5th edition, Lippincott Williams and Wilkins Press
- Nelson DL and Cox MM. 2007. *Lehninger's Principles of Biochemistry*. 4th Ed. Freeman.
- Kaneko JJ, Harvey JH and Bruss ML. 2008. *Clinical Biochemistry of Domestic Animals*. 6th Ed. Academic Press.
- Voet D, Voet JG and Pratt CW. 2006. *Fundamentals of Biochemistry of Life at the Molecular Level*. 2nd Ed. John Wiley and Sons.
- Racek J and Rajdl D. 2016. *Clinical Biochemistry*. 1st Ed. Karolinum Press.

Course Outline

Sl. No.	Topics	No. of Practical
Practical		
1.	Scope of diagnostic techniques in disease diagnosis. Fractionation of cell organelles	2
2.	Molecular basis of cell injury and diseases	1
3.	Molecular basis of autoimmunity, immunodeficiency, Immunochemical techniques -Immunochemical protein analysis-immunoelectrophoresis, immunofixation and immunoassays	3
4.	Oncogenesis and tumour markers	2
5.	Comparative ruminant metabolism, metabolism of various nutrients by micro flora	1
6.	Postruminal digestion of dietary and microbial biomolecules.	1
7.	Metabolic disorders of rumen and recent development in disorders of ruminants associated with protein	1
8.	Metabolic disorders of rumen and recent development in disorders of ruminants associated with carbohydrates	2
9.	Metabolic disorders of rumen and recent development in disorders of ruminants associated with fat, mineral and electrolyte metabolism.	2
10.	Photometric methods: spectrophotometry (UV, visible) atomic reflectometry, turbidimetry, nephelometry, spectrofluorimetry, atomic emission, etc.	1
11.	Spectrometric methods: AAS, mass spectrometry, nuclear magnetic resonance (NMR), infra-red (IR) spectroscopy.	1



S. No.	Topics	No. of Practical
12.	Functional tests: Nucleic acid extraction, DNA finger printing, micro and mini satellites	1
13.	PCR, RT-PCR, RFLP, Fluorescent In-situ hybridization (FISH)	1
14.	Genome mapping, DNA microarrays	1
15.	Biomolecular prospecting and molecular designing in clinical biochemistry	1
16.	Tests for cardiovascular diseases: Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin	2
17.	Myocardial infarction and shock; enzyme patterns and marker proteins.	1
18.	Diagnostic use of serum enzyme assays	1
19.	Radioactive isotopes in radiodiagnosis	1
20.	Liver function tests (LFT)	1
21.	Liver function tests (KFT)	1
22.	Tests for drugs of abuse	1
23.	Case Based Learning and selected articles from journals pertaining to disease diagnosis	1
	Total	30

I. Course Title : Recent Trends In Biochemical Techniques And Instrumentation

II. Course Code : BCT 705

III. Credit Hours : 2 + 1

IV. Pre-requisite

Should have studied VBC-604: Analytical Techniques and Instrumentation in Biochemistry (2+1) or other equivalent courses with similar syllabi/ content at Master's level.

V. Aim of the course

To expose students about current developments in techniques used in animal biochemistry.

VI. Theory

Basic components of the Instrument, principle and applications of the following analytical techniques:

Unit I

Separation, purification and quantification of biomolecules:

Gas Chromatography (GC) and High performance liquid chromatography (HPLC) - Types of pumping systems and their essential features; Column packing; Normal and modified stationary phases; Detection systems;

Blotting techniques (Western), 2-D gel electrophoresis – IPG-DALT, IEF-SDS PAGE

Unit II

Structural elucidation of biomolecules and quantification:

NMR spectrometry, X-ray crystallography, ESR Spectroscopy, CD Spectroscopy and Mass Spectrometry (LC/ MS, GC/ MS, MALDI-TOF, SELDI-TOF).

Microscopy – Electron microscopy – SEM/ TEM/ STEM; Atomic force microscopy (AFM) or scanning force microscopy (SFM); Scanning Tunnelling Microscope (STM).

Unit III

Other Analytical techniques: Radiotracer techniques: Radiotracers in study of biological processes.

Tissue Culture: Setting up a cell culture laboratory; Principles of aseptic handling; Cell line derivation; Cell freezing and quantitation; Contamination control; Cell freezing and thawing; Cell culture media constituents and their functions; Designing serum-free medium. Techniques for short-term and long-term culture of organs. Any other current technique with relevance to biochemistry.

VII. Practical

Demonstration of feasible techniques available at the department/ institute/ other institutes.

VIII. Suggested Reading

- Burtis CA, Ashwood ER and Burns DE. 2014. *Tietz Textbook of clinical Biochemistry and Molecular Diagnostics*. 5th Edition. Elsevier
- Nelson DL and Cox MM. 2017. *Lehninger's Principles of Biochemistry*. 7th Ed. Freeman.
- Garrity S. 1999. *Experimental Biochemistry*. 3rd Ed. Academic Press.
- Gowenlock AH. 2002. *Varley's Practical Clinical Biochemistry*. 6th Ed. CBS.
- George W Latimer Jr. 2016. *Official Methods of Analysis of AOAC International*, 20th Ed. AOAC International.
- Holme DJ and Hazel P. 1998. *Analytical Biochemistry*. 3rd Ed. Longman.
- Wilson K and Walker J. (Eds.). 2010. *Principles and Techniques of Biochemistry and Molecular Biology*. 7th Ed. Cambridge Univ. Press.
- Willard *et al.* 1988. *Instrumental Methods of Analysis*. 7th Ed. Wadsworth Pub Co.
- Selected articles from standard journals.

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Gas Chromatography (GC) - Types of pumping systems and their essential features; S Column packing; Normal and modified stationary phases; Detection systems	4
2.	High performance liquid chromatography (HPLC) - Types of pumping systems and their essential features; Column packing; Normal and modified stationary phases; Detection systems	4
3.	Western blotting of proteins	1
4.	2-D gel electrophoresis of proteins – IPG-DALT, IEF-SDS PAGE	1
5.	NMR spectrometry	2
6.	X-ray crystallography	2
7.	ESR Spectroscopy	2
8.	CD Spectroscopy	2
9.	Mass Spectrometry (LC/ MS, GC/ MS, MALDI-TOF, SELDI-TOF)	3
10.	Electron microscopy – SEM/ TEM/ STEM	3
11.	Atomic force microscopy (AFM)	1
12.	Scanning Tunneling Microscopy (STM)	1
13.	Radiotracers in study of biological processes	2
14.	Tissue Culture: Setting up a cell culture laboratory; Principles of aseptic handling; Cell line derivation; Cell freezing and quantitation; Contamination control; Cell freezing and thawing; Cell culture media	



S. No.	Topic	No. of Lectures/ Practicals
	constituents and their functions; Designing serum-free medium. Techniques for short-term and long-term culture of organs, etc.	3
15.	Any other current technique	1
	Total	32
Practical		
1.	Gas Chromatography (GC)	1
2.	High performance liquid chromatography (HPLC)	1
3.	Western blotting of proteins	1
4.	2-D gel electrophoresis of proteins	1
5.	NMR spectrometry	1
6.	X-ray crystallography	1
7.	ESR Spectroscopy	1
8.	CD Spectroscopy	1
9.	Mass Spectrometry (LC/ MS, GC/ MS, MALDI-TOF, SELDI-TOF).	1
10.	Electron microscopy – SEM/ TEM/ STEM	1
11.	Atomic force microscopy (AFM)	1
12.	Scanning Tunneling Microscopy (STM)	1
13.	Radiotracers	1
14-16.	Tissue Culture	3
	Total	16

I. Course Title : Developmental Biochemistry

II. Course Code : BCT 706

III. Credit Hours : 2 + 0

IV. Pre-requisite

Should have studied VBC-609: Endocrinology and Reproductive Biochemistry or other equivalent courses with similar syllabi/ content at Master's level.

V. Aim of the course

To understand the developmental processes in embryogenesis and its gene expression.

VI. Theory

Unit I

Biochemistry of fertilization - Sperm-egg structure - Acrosome reaction and capacitation, Sperm-egg interaction –receptors involved; sperm entry into egg; zygote formation. Formation of multicellular and multi-layered embryo: factors affecting cleavage of zygote; Types of cleavage; blastula formation; gastrulation; neurulation; somite formation and cell migration; factors affecting cell migration; cell-cell interactions and their expression; involvement of extracellular matrix during development(cell movement and regulation of shape); growth factors and their role; organogenesis-biochemistry and molecular biology. Application of “OMICS” techniques in developmental biology.

Unit II

Development and differentiation: Genes involved in the development of Drosophilla and C. elegans and their regulation. Expression of genes during differentiation of

anterior and posterior and dorsal and ventral halves, head; thorax and abdomen. Pattern formation and positional information: Inductive interaction in the development of epithelia and body parts.

VII. Suggested Reading

- Scott F Gilbert. 2010. *Developmental Biology*, 9th edition. Sunderland (MA): Sinauer Associates.
- Scott Freeman 2014. *Biological Science*, 5th edition. Publisher: Benjamin-Cummings Publishing Co.
- Selected articles from standard journals.

Course Outline

S. No.	Title	No. of Lectures
Theory		
1.	Biochemistry of fertilization.	1
2.	Sperm-egg structure. Acrosome reaction and capacitation	3
3.	Sperm-egg interaction –receptors involved; sperm entry into egg; zygote formation.	3
4.	Formation of multicellular and multi-layered embryo: factors affecting cleavage of zygote; Types of cleavage	3
5.	Blastula formation; gastrulation; neurulation; somite formation and cell migration; factors affecting cell migration; cell-cell interactions and their expression; involvement of extracellular matrix during development(cell movement and regulation of shape); growth factors and their role;	5
6.	Organogenesis-biochemistry and molecular biology.	3
7.	Application of “OMICS” techniques in developmental biology.	3
8.	Development and differentiation: Genes involved in the development of <i>Drosophilla</i> and <i>C. elegans</i> and their regulation	4
9.	Expression of genes during differentiation of anterior and posterior and dorsal and ventral halves, head; thorax and abdomen.	4
10.	Pattern formation and positional information: Inductive interaction in the development of epithelia and body parts.	3
	Total	32

I. Course Title : Bioinformatics Tools in Biochemistry

II. Course Code : BCT 707

III. Credit Hours : 1 + 1

IV. Pre-requisite

Should have studied VBC-611: Introduction to Bioinformatics and Computational Biology or other equivalent courses with similar syllabi/ content at Master’s level.

V. Aim of the course

To impart knowledge of Bioinformatics applicable to biochemistry

VI. Theory

Unit I

Biological databases, nucleic acid and protein sequence databases; Pair wise sequence alignment; global and local alignments, matrices, gap penalties; Multiple sequence



alignment and phylogenetic analysis-methods and programs

Unit II

Genome sequencing using next generation sequencing (NGS) technologies, sequence assembly and comparison, human genome, livestock, bacterial and viral genomes, Computational gene discovery; Gene and promoter prediction; Microarray technology: basic concept and application

Unit III

Protein structure- secondary and tertiary structure prediction; Homology and ab-initio based tertiary structure prediction; Structure validation tools, Ramachandran Map; protein motifs and domain prediction; RNA folding and secondary structure predictions

Unit IV

Metabolomics: concepts and principles; Nutrigenomics: bioinformatics in nutrition and health; Pharmacogenomics: introduction, applications, current and future perspectives

VII. Practical

- Practical application of NCBI resources
- Web based tools: ExPasy, SwissProt, EBI
- Perform local alignment using different BLAST variants
- Multiple sequence alignment using ClustalW, T Coffee
- Analysis packages-commercial databases and packages, GPL software for Bioinformatics
- Database searching
- Phylogenetic analysis by PHYLIP and MEGA tools
- Protein structure visualization tools: RASMOL, SWISSPDB viewer,
- Homology modelling and structure validation of protein structures
- Tools for protein secondary and tertiary structure prediction- SANJIVNI, BHAGIRATH, SWISS Model, MODELLER, ROSETTA, I-TASSER, etc.
- Biomolecule chemical structure creation and modification using ChemSketch

VIII. Suggested Reading

- *Essential bioinformatics* 2006. Xin Xiong. Cambridge University Press
- *Discovering Genomics, Proteomics and Bioinformatics* 2007. A. Malcolm Campbell and Laurie J Heyer. Benjamin Cummings.
- *Proteins: Structures and Molecular Properties* 1993. Creighton TE. W.H. Freeman.
- *Bioinformatics: Sequence and Genome Analysis* 2001. Mount DW. Cold Spring Harbor.
- *Introduction to Computational Molecular Biology* 1997. Setubal Joao and Meidanis Joao. PWS Publishing Company.
- *Bioinformatics: Concepts, Skills and Applications* 2004. Rastogi SC, Mendiratta N and Rastogi P. CBS.
- *Principles of Genome Analysis and Genomics* 2003. SB. Primrose and R.M. Twyman, Blackwell Publishing.
- *Molecular Analysis and Genome Discovery* 2004. Ralph Rapley and Stuart Harbron (Eds.), John Wiley and Sons.
- *Bioinformatics* 2001. Andreas D. Baxeavanis and B. F. Francis Ouellette (Eds.).
- Online Resources available on Internet and Selected articles from standard journals.



Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Biological databases: nucleic acid and protein sequence databases	1
2.	Pair wise sequence alignment, global and local alignments, matrices, gap penalties	1
3.	Multiple sequence alignment: methods and programs	1
4.	Phylogenetic analysis: methods and applications	1
5.	Genome sequencing technologies-traditional and next generation sequencing (NGS)	1
6.	Assembly and comparison of genome: Human genome, livestock and bacterial genomes	1
7.	Computational gene discovery, Gene and promoter prediction	1
8.	Microarray technology: basic concept and application	1
9.	Protein structure- secondary and tertiary structure prediction	1
10.	Homology and ab-initio based tertiary structure prediction	1
11.	Protein structure validation tools, Ramachandran Map	1
12.	Protein motifs and domain prediction	1
13.	RNA folding and secondary structure predictions	1
14.	Metabolomics: concepts and principles	1
15.	Nutrigenomics: bioinformatics in nutrition and health	1
16.	Pharmacogenomics: introduction, applications, current and future perspectives	1
	Total	16
Practical		
1.	Practical application of NCBI resources	3
2.	Web based tools: Expasy, SwissProt, EBI	1
3.	Local alignment using different BLAST variants	2
4.	Multiple sequence alignment using ClustalW, T Coffee	1
5.	Commercial bioinformatics databases and packages, GPL software for Bioinformatics	2
6.	Database searching	1
7.	Phylogenetic analysis by PHYLIP and MEGA tools	1
8.	Protein structure visualization tools: RASMOL, SWISSPDB viewer, UCSF ChimeraX	1
9.	Homology modelling and structure validation of protein structures	1
10.	Practice on tools for protein secondary and tertiary structure prediction: SANJIVNI, BHAGIRATH, SWISS Model, MODELLER, ROSETTA, I-TASSER, etc.	2
11.	Biomolecule chemical structure creation and modification using ChemSketch	1
	Total	16

I. Course Title : Environmental and Toxicological Biochemistry

II. Course Code : BCT 708

III. Credit Hours : 2 + 0

IV. Aim of the course

To impart awareness on environmental pollutants and toxicants affecting livestock



and poultry; Clinical Biochemistry in Toxicology.

V. Theory

Unit I

Introduction to environmental pollutants and toxicants, their classification, sources and impact on animal health including poultry. Effect of various pollutants on animal and microbial metabolism; their detoxification mechanism in animals and birds, Biochemical basis of pollutant tolerance. Soil enzymes, their source and role in environment, methods for measurement of pollution, Pesticide residues and its effect on animal health. environmental chemo-dynamics. Heavy metals and metalloids, industrial chemicals and biotoxins on animal health and productivity.

Unit II

Water pollution, biochemical basis for measuring water pollution, chemical properties of water-physical, chemical and biological treatment process. Biochemical oxygen demand and water quality assessment. Biochemical aspects of water quality.

Unit III

Global environmental issues in the light of biochemistry, methanogenesis and role of ruminants, global warming, green house gases, acid rain and their effects on animal health and productivity.

Unit IV

Distribution and storage of toxicants in animal body, target organ toxicity, biotransformation and elimination of toxicants, methods for measurement of toxin level in animals.

Unit V

Clinical Biochemistry in Toxicology- Hepatotoxicity and biochemical changes due to hepatotoxicity, Nephrotoxicity and its effect, Effects of toxins on lungs, respiratory tract, endocrine system, nervous system, erythrocyte and haematopoietic system. Toxins affecting haemoglobin and oxidative metabolism.

VI. Suggested Reading

- Casarett, Louis J.; Doull, John. *Casarett and Doull's Toxicology: The Basic Science of Poisons* 8th ed.: New York: McGraw-Hill, 2013. ISBN:9780071769235
- Hayes AW, Kruger CL. *Hayes' principles and methods of toxicology* 6th ed. ISBN:9781842145364
- Kaneko JJ, Harvey JW and Bruss ML. *Clinical Biochemistry of Domestic Animals*, Academic press, ISBN 13:978-0-12-370491-7.
- Selected articles from journals.

Course Outline

S. No.	Topic	No. of Lectures
Theory		
1	Introduction to environmental pollutants and toxicants, their classification	2
2	Sources and impact of pollutants and toxicants on animal health including poultry	2
3	Effect of various pollutants on animal and microbial metabolism	2



S. No.	Topic	No. of Lectures
4	Detoxification mechanism in animals and birds	2
5	Biochemical basis of pollutant tolerance	1
6	Soil enzymes, their source and role in environment	1
7	Methods for measurement of pollution	1
8	Pesticide residues and its effect on animal health	1
9	Environmental chemo-dynamics	1
11	Heavy metals and metalloids, industrial chemicals and biotoxins on animal health and productivity.	2
12	Water pollution, biochemical basis for measuring water pollution	1
13	Chemical properties of water-physical, chemical and biological treatment process	1
14	Biochemical oxygen demand and water quality assessment	1
15	Biochemical aspects of water quality	1
16	Distribution and storage of toxicants in animal body	1
17	Target organ toxicity	1
18	Introduction to environmental pollutants and toxicology	1
19	Biotransformation and elimination of toxicants	2
20	Methods for measurement of toxin level in animals	1
21	Clinical Biochemistry in Toxicology	1
22	Hepatotoxicity and biochemical changes due to hepatotoxicity	1
23	Nephrotoxicity and its effect	1
24	Effects of toxins on lungs, respiratory tract, endocrine system, nervous system, erythrocyte and haematopoietic system	2
25	Toxins affecting haemoglobin and oxidative metabolism.	2
	Total	32

I. Course Title : Biochemistry of Diseases and Disorders

II. Course Code : BCT 709

III. Credit Hours : 2 + 0

IV. Pre-requisite

Should have studied BCT-605: Clinical Biochemistry of Animals (2+1) or other equivalent courses with similar syllabi/ content at Master's level.

V. Aim of the course

To update general biochemical concepts for an understanding of biological and chemical principles underlying health, disease and disorders of animals and poultry.

VI. Theory

Unit I

Scope of biochemistry and its applications in understanding the development of diseases and their control.

Biochemical basis of Immunological diseases: Equine immuno- deficiency, neutrophil function defects and its testing, Autoimmune Diseases, Primary Immune Deficiency Diseases, Secondary Immunodeficiency, Hypersensitivity Diseases.

Endocrine diseases arising from over or under production of hormones or from resistance to a particular hormone; Thyroid disorders; Pancreatic disorders; Cushings disease. Hemostatic diseases: Role of Vascular Endothelium, Platelets, Coagulation Proteins, Complexes, and Thrombin Activation; Fibrinolysis, Hereditary and Acquired disorders of hemostasis.



Unit II

Nutritional diseases arising from over or under-nutrition of fat and water soluble vitamins and minerals: Night blindness, pernicious anaemia, iron overload, metabolic disorders of iron metabolism, rickets, osteomalacia, milk fever, swayback, anaemia of Inflammatory disease.

Toxic diseases: Hepatotoxicity, Nephrotoxicity; Toxins affecting: Skeletal and Cardiac muscle; Lung and Respiratory tract; Gastrointestinal tract; Erythrocytes, Haematopoietic system, Hemoglobin and oxidative metabolism; Endocrine system, Nervous system and neuromuscular disorders.

Unit III

Neoplastic diseases: Biochemical changes in development of various neoplasms, Deranged glucose metabolism in cancerous tissue, oncogenesis.

Degenerative diseases: *Neurodegenerative diseases* – including amyotrophic lateral sclerosis, Parkinson's *disease*, Alzheimer's *disease*, and Huntington's *disease*. Molecular basis of cell injury and diseases by Free Radicals.

Unit IV

Biochemical basis of cardiomyopathies in dogs and birds, Prions disease (Scrapie), Bovine spongiform encephalopathy, Reticuloendotheliosis in poultry, Avian Influenza; Retinitis pigmentosa, retinal degeneration and Lysosomal storage diseases in animals.

Comparative medical genetics: Genome sequences, Disease Gene Mapping, Genetic diseases, Gene therapy

VII. Suggested Reading

- Charles A Janeway Jr, Paul Travers, Mark Walport and Mark J Shlomchik. 2001. *Immunobiology, The Immune System in Health and Disease*, 5th edition, New York.
- David L Nelson and Cox Michael M. 2017. *Lehninger's Principles of Biochemistry*. 7th Ed. Freeman.
- Kaneko JJ, Harvey JW and Bruss ML. *Clinical Biochemistry of Domestic Animals*, Academic press, ISBN 13:978-0-12-370491-7.
- Kenneth M Murphy and Casey Weaver 2016. *Janeway's Immunobiology*, 9th Edition ISBN: 978-0-815-34505-3.
- Thomas M. Devlin (Ed) 2011. *Textbook of Biochemistry with Clinical Correlations*, John Wiley and Sons.
- Voet D, Voet JG and Pratt CW. 2016. *Fundamentals of Biochemistry of Life at the Molecular Level*. 5th Ed. John Wiley and Sons.
- Selected articles from standard journals.

Course Outline

S. No.	Topic	No. of Lectures
Theory		
1.	Scope of biochemistry and its applications in understanding the development of diseases and their control	1
2.	Biochemical basis of Immunological diseases: Equine immunodeficiency, neutrophil function defects and its testing, Autoimmune Diseases, Primary Immune Deficiency Diseases, Secondary Immuno deficiency, Hypersensitivity Diseases	3
3.	Endocrine diseases arising from over or underproduction of hormones or from resistance to a particular hormone; Thyroid disorders; Pancreatic disorders; Cushings disease.	2



S. No.	Title	No. of Lectures
4.	Hemostatic diseases: Role of Vascular Endothelium, Platelets, Coagulation Proteins, Complexes, and Thrombin Activation; Fibrinolysis, Hereditary and Acquired disorders of hemostasis.	2
5.	Nutritional diseases arising from over or under-nutrition of fat and water soluble vitamins and minerals: Night blindness, pernicious anaemia, iron overload, metabolic disorders of iron metabolism, rickets, osteomalacia, milk fever, swayback, anaemia of Inflammatory disease.	4
6.	Toxic diseases: Hepatotoxicity, Nephrotoxicity; Toxins affecting: Skeletal and Cardiac muscle; Lung and Respiratory tract; Gastrointestinal tract; Erythrocytes, Haematopoietic system, Hemoglobin and oxidative metabolism; Endocrine system, Nervous system and neuromuscular disorders.	4
7.	Neoplastic diseases: Biochemical changes in development of various neoplasms, Deranged glucose metabolism in cancerous tissue, oncogenesis.	4
8.	Degenerative diseases: <i>Neurodegenerative diseases</i> – including amyotrophic lateral sclerosis, Parkinson's <i>disease</i> , Alzheimer's <i>disease</i> , and Huntington's <i>disease</i> ; Molecular basis of cell injury and diseases by Free Radicals.	4
9.	Biochemical basis of cardiomyopathies in dogs and birds, Prions disease (Scrapie), Bovine spongiform encephalopathy, Reticuloendotheliosis in poultry, Avian Influenza; Retinitis pigmentosa, retinal degeneration and Lysosomal storage diseases in animals.	5
10.	Comparative medical genetics: Genome sequences, Disease Gene Mapping, Genetic diseases, Gene therapy.	3
	Total	32

I. Course Title : Immuno-biochemistry

II. Course Code : BCT 710

III. Credit Hours : 2 + 0

IV. Aim of the course

To impart knowledge about fundamental principles and applications of immunology and immunochemical research techniques.

V. Theory

Unit I

History and scope of immunology, Cellular basis of immunity-adaptive and non-adaptive immunity, Memory, Specificity and Diversity, Self and non self discrimination, Immune system, Organs, tissues and cells, Cell mediated vs Humoral immunity, Immunoglobulins, Concept of antigen, Immunogen, Adjuvant, Hapten

Unit II

Classes of antibodies, Antibody diversity, Theories of generation of antibody diversity, Monoclonal antibodies, Polyclonal antibodies, Hybridoma, Recombinant antibodies, Single chain and single domain antibodies in immunodiagnostics and immunotherapy, Phage display library, complement system- classical and alternate.

Unit III

Cellular interactions in the immune response, affinity, avidity, B-cell and T-cell



response, major histocompatibility complex, cell mediated immune response, cytokines, Vaccine. Nanoparticles in vaccine development and delivery, Nanomedicine in immunodiagnostics and immunotherapy, Immunoregulation, immunological tolerance, hypersensitivity, innate resistance and specific immunity.

Unit IV

Current immunological techniques: Raising of antisera and antibody purification, Immunodiffusion, Immunoelectrophoresis, immunofluorescence, rocket electrophoresis, Immunological markers and fluorescence-activated cell sorting, Radioimmuno assay (RIA) and different types of ELISA, Immunohistochemistry, Immunoinformatics techniques.

VI. Suggested Reading

- Abbas AK and Lichtman AH. 2003. *Cellular and Molecular Immunology*. 5th Ed. WB Saunders.
- David J Dabbs. 2018. *Diagnostic Immunohistochemistry*. 5th Ed. Elsevier.
- Goldsby RA, Kindt TJ and Osborne BA. 2003. *Immunology*. 4th Ed. WH Freeman.
- Harlow and Lane D. (Eds.). 1988. *Antibodies: A Laboratory Manual*. Cold Spring Harbor Laboratory.
- *Immunochemistry*: Edited by CJ van Oss and MHV van Reganmortel. pp 1069. Marcel Dekker, New York. 1994. ISBN 0 8247 9123 1; TR O'Brien.
- Ivan Roitt (Eds.). 1997. *Essential Immunology* Publisher -Blackwell Scientific Publication, Oxford.
- Kuby J. 1996. *Immunology*. 3rd edition WH Freeman.
- Male D, Brostoff J, Roth DB and Roitt I. 2006. *Immunology*. 7th Ed. Elsevier.
- Manson MM. (Eds.). 1992. *Immunochemical Protocols: Methods in Molecular Biology* Vol. 10- Humana Press Totowa NJ.
- Mariusz Skwarczynski, Istvan Toth. 2017. *Micro and Nanotechnology in Vaccine Development*. 1st ed. Elsevier.
- Mathew Sebastian, Neethu Ninan AK. Haghi. 2012. *Nanomedicine and Drug Delivery*. 1st Ed. Apple Academic Press.
- Selected articles from standard journals.

Course Outline

S. No.	Title	No. of Lectures
Theory		
1.	History and scope of immunology, cellular basis of immunity- adaptive and non-adaptive immunity, memory, specificity and diversity, self and non self-discrimination,	2
2.	Immune system, organs, tissues and cells, cell mediated vs humoral immunity, immunoglobulins	3
3.	Concept of antigen, immunogen, adjuvant, haptens	1
4.	Classes of antibodies, Antibody diversity, theories of generation of antibody diversity,	3
5.	Monoclonal antibodies, polyclonal antibodies, Hybridoma, Recombinant antibodies, Single chain and single domain antibodies in immunodiagnostics and immunotherapy, Phage display library	4
6.	Complement system- classical and alternate.	2
7.	Cellular interactions in the immune response, affinity, avidity, B-cell and T-cell response, major histocompatibility complex, cell mediated immune response, cytokines.	4
8.	Vaccine Nanoparticles in vaccine development and delivery, Nanomedicine in immunodiagnostics and immunotherapy,	3



S. No.	Topics	No. of Lectures
9.	Immunoregulation, immunological tolerance, hypersensitivity, innate resistance and specific immunity.	2
10.	Current immunological techniques: Raising of antisera and antibody purification,	1
11.	Immunodiffusion, Immunelectrophoresis, immunofluorescence, rocket electrophoresis	2
12.	Immunological markers and fluorescence-activated cell sorting.	1
13.	Radioimmuno assay (RIA) and different types of ELISA.	2
14.	Immunohistochemistry.	1
15.	Immunoinformatics techniques.	1
	Total	32

I. Course Title : Special Problem

II. Course Code : BCT 711

III. Credit Hours : 0+2

IV. Aim of the course

To provide expertise in handling practical research problem(s).

V. Practical

Short research problem(s) involving contemporary issues and research techniques.

VI. List of Journals

- *Indian Journal of Chemical Technology*
- *Indian Journal of Biochemistry and Biophysics*
- *Indian Journal of Chemistry - Section B*
- *Indian Veterinary Journal*
- *Journal of Chemical Sciences*
- *Journal of Indian Chemical Society*
- *Meat Science - An International Journal*
- *The EMBO Journal*
- *Theriogenology*
- *Trends in Biochemical Sciences*

e-Resources

- www.niscair.res.in/ScienceCommunication (Indian Journal of Biochemistry)
- www.medind.nic.in/iaf/iafm.shtml (Indian Journal of Clinical Biochemistry)
- www.ijcb.co.in (Indian Journal of Clinical Biochemistry)
- www.mcponline.org (Molecular and Cellular Proteomics)
- www.elsevier.com/vj/proteomics (Proteomics Virtual Journal)
- www.elsevier.com (Journal of Proteomics)
- www.elsevier.com (Clinical Biochemistry)
- www.sciencedirect.com/science/journal (Science Direct – Clinical Biochemistry)
- www.jbc.org (Journal of Biological Chemistry)

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Basic Veterinary Sciences

– Veterinary Biotechnology

Preamble

Considering latest trends in Veterinary Biotechnology four new courses at Doctorate level, i.e. Recent Trends in Cell and Molecular Biology, Diagnostic Platform, Gene Manipulation and Genome Editing and Recent trends in Bioinformatics have been introduced and some courses are reorganized



Course Title with Credit Load

M.V.Sc. in Veterinary Biotechnology

Course Code	Course Title	Credit Hours
BTY 601	Basic and Applied Biotechnology	2+0
BTY 602	Fundamentals of Cell Biology	2+0
BTY 603	Molecular Biology and Genetic Engineering	2+0
BTY 604	Animal Cell Culture–Principles and Applications	2+1
BTY 605	Molecular Diagnostics	2+1
BTY 606	Immunology Applied to Biotechnology	2+1
BTY 607	Introduction to Bioinformatics	2+1
BTY 608	Animal Genomics	2+1
BTY 609	Techniques in Molecular Biology and Genetic Engineering	0+2
BTY 610	Reproductive Biotechnology	2+1
BTY 611	Masters Seminar	1+0
BTY 612	Masters Research	0+30



Course Contents

M.V.Sc. in Veterinary Biotechnology

- I. Course Title** : **Basic and Applied Biotechnology**
II. Course Code : **BTY 601**
III. Credit Hours : **2+0**

IV. Theory

Unit I

History and scope of Biotechnology, Application of Biotechnology in Agriculture, Veterinary Sciences, diagnostics and therapeutics, pharmaceutical industry, food industry, chemical industry and environment, plant tissue culture and its applications

Unit II

Biofermentation, Fermentation technology, aerobic and anaerobic fermentation, Different types of fermentations, Basic design and construction of fermenter, Media sterilization, Upstream and Downstream processing, Microbes and enzymes of industrial importance, Microbial growth kinetics, Immobilized enzymes and cells and immobilization process.

Unit III

Vaccines and their immune response, Types of vaccines: Conventional and new generation vaccine, Subunit vaccine, recombinant vaccines, Vectored vaccines, DNA vaccine, edible vaccine, DIVA strategy and reverse vaccinology

Unit IV

Biodiversity, genetic diversity, molecular taxonomy, species and population biodiversity, quantifying biodiversity, maintenance of ecological diversity, conservation of biodiversity and conservation of animal genetic resources.

V. Suggested Readings

- Becker JM, Cold Well GA and Zachgo EA. 2007. *Biotechnology a Laboratory Course*. Academic Press.
- Brown CM, Campbell I and Priest FG. 2005. *Introduction to Biotechnology*. Panima.
- Singh BD. 2006. *Biotechnology Expanding Horiozon*. Kalyani

S No.	Topics	Lecture No.
1.	History and scope of Biotechnology, Application of Biotechnology in agriculture, veterinary sciences, diagnostics and therapeutics, pharmaceutical industry, food industry, chemical industry and environment, plant tissue culture and its applications	1-3
2.	Biofermentation	4
3.	Fermentation technology, aerobic and anaerobic fermentation	5
4.	Different types of fermentations	6
5.	Basic design and construction of fermenter	7



S No.	Topics	Lecture No.
6.	Upstream processing- Media sterilization, inoculum preparation and and Downstream processing	8
7.	Microbes and enzymes of industrial importance, Microbial growth kinetics and products.	9
8.	Immobilized enzymes and cells and immobilization process	10
9.	Vaccines and their immune response	11
10.	Types of vaccines -Conventional and new generation vaccine	12-14
11.	Subunit vaccine, recombinant vaccines	15
12.	Vectored vaccines and DNA vaccine and their immune response	16
13.	Edible vaccine, DIVA strategy and reverse vaccinology	17-20
14.	Biodiversity, genetic diversity, molecular taxonomy, species and population biodiversity	21-22
15.	Quantifying biodiversity, maintenance of ecological diversity	23-25
16.	Conservation of biodiversity and conservation of animal genetic resources	26-28

I. Course Title : Fundamentals of Cell Biology

II. Course Code : BTY602

III. Credit Hours : 2 + 0

IV. Aim of the course

Understanding the functions of cell components and cell signal pathways

V. Theory

Unit I

Origin and evolution of cells – from molecules to first cell – from prokaryotes to eukaryotes – from single to multi cellular organisms – Chemical components of a cell – catalysis and use of energy by cells – techniques used to study cells – microscopy – light microscopy – fluorescent microscopy – electron microscopy – confocal microscopy – cell and cell parts separation techniques – ultracentrifugation – flow cytometry – detection of cell parts - antibodies

Unit II

Structure of cell – Plasma membrane – cytoskeleton – Nucleus – Chromosome- Chromosomal DNA packaging and its implications - endoplasmic reticulum – ribosome - mitochondria –Mitochondrial DNA organization - golgi complex – peroxisome - lysosome

Unit III

Cell Membrane transport – transport of small molecules - macromolecules and particles- exocytosis and endocytosis – Nuclear transport –protein synthesis and sorting – endoplasmic reticulum – golgi complex – peroxisomes – lysosomes – lipid synthesis and sorting – Electron transport chain – chemiosmotic coupling - Transport of metabolites across the inner mitochondrial membrane – Mechanism of muscle contraction – cell crawling – functions of keratin and neurofilaments – organelle transport and separation of mitotic chromosome

Unit IV

Cell signaling – modes of cell-cell signaling- steroid hormones and the steroid



receptor super family – Neurotransmitters - Peptide Hormones and Growth Factors
 - G Protein-Coupled Receptors - Receptor Protein-Tyrosine Kinases - Cytokine Receptors and Non receptor Protein-Tyrosine Kinases - The cAMP Pathway: Second Messengers and Protein Phosphorylation - Cyclic GMP - Phospholipids and Ca²⁺ - Ras, Raf, and the MAP Kinase Pathway - The JAK/ STAT Pathway - Integrins and Signal Transduction - Regulation of the Actin Cytoskeleton - Hedgehog and Wingless - Notch Signaling – Cell signal network - Feedback and crosstalk and networks of cellular signal transduction – cell cycle – regulators of cell cycle – events of M phase

VI. Suggested Readings

- Lewin B. 2008. *Gene IX*. Jones and Bartlett.
- Primrose SB. 2001. *Molecular Biotechnology*. Panima.
- Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific

S. No.	Topic	No. of Lectures
1.	Origin and evolution of cells from molecules to first cell from prokaryotes to eukaryotes from single to multicellular organisms	1
2.	Chemical components of a cell Catalysis and use of energy by cells	2
3.	Techniques used to study cells Principles and applications of microscopy, light microscopy, fluorescent microscopy, electron microscopy and confocal microscopy, Cell and cell parts separation techniques Principles and applications of ultracentrifugation and flow cytometry Detection of cell parts Primary and secondary antibodies used to detect cell parts	3-4
4.	Structure of cell, Plasma membrane, Cytoskeleton	5
5.	Structure of cell, Nucleus, Chromosome Chromosomal DNA packaging and its implications	6
6.	Structure of cell, Endoplasmic reticulum, Ribosome Mitochondria	7
7.	Structure of cell, Mitochondrial organization, Golgi complex Peroxisome, Lysosome	8
8.	Cell Membrane transport, Transport of small molecules, Macromolecules and particles	9
9.	Cell Membrane transport, Exocytosis and endocytosis Nuclear transport	10
10.	Cell Membrane transport, Protein synthesis and sorting into Endoplasmic reticulum Golgi complex	11
11.	Cell Membrane transport, Protein synthesis and sorting into Peroxisomes, Lysomes Lipid synthesis and sorting	12-13
12.	Cell Membrane transport, Electron transport chain Chemiosmotic coupling	14
13.	Transport of metabolites across the inner mitochondrial membrane	15
14.	Mechanism of muscle contraction, cell crawling functions of keratin and neurofilaments	16
15.	Cell Membrane transport, organelle transport separation of mitotic chromosome	17
16.	Cell signaling, Modes of cell-cell signaling Steroid hormones and the steroid receptor super family	18
17.	Cell signaling, Neurotransmitters, Peptide Hormones and Growth Factors	19
18.	Cell signaling, G Protein-Coupled Receptors Receptor Protein-Tyrosine Kinases	20



S. No.	Topic	No. of Lectures
19.	Cell signaling, Cytokine Receptors Non receptor Protein-Tyrosine Kinases	21
20.	Cell signaling, The cAMP Pathway Second Messengers and Protein Phosphorylation	22
21.	Cell signaling, Cyclic GMP Phospholipids and Ca ²⁺	23
22.	Cell signaling Ras, Raf, and the MAP Kinase Pathway The JAK/ STAT Pathway Integrins and Signal Transduction	24
23.	Cell signaling, Regulation of the Actin Cytoskeleton Hedgehog and Wntless Notch Signaling	25-26
24.	Cell signaling, Cell signal network, Feedback and crosstalk Networks of cellular signal transduction	27
25.	Cell cycle, Regulators of cell cycle Events of M phase	28

I. Course Title : Molecular Biology and Genetic Engineering

II. Course Code : BTY 603

III. Credit Hours : 2+0

IV. Aim of the course

Understanding the principles of molecular biology and genetic engineering.

Unit I

History and scope of molecular biology – Discovery of DNA and evidence for DNA as the genetic material - structure of DNA, RNA and proteins – Organization of prokaryotic and eukaryotic genome – Gene transfer in micro organisms like conjugation, transformation, transduction and protoplasmic fusion – DNA replication - genetic code - transcription, RNA processing and alternative splicing - Translation in prokaryotes and eukaryotes - Regulation of gene expression.

Unit II

Enzymes used in molecular biology and recombinant DNA research - Cloning vectors – plasmids, phages, phagemids, cosmids, BAC, YAC - Expression vector – bacterial, viral, baculo and yeast vectors, shuttle vectors - Polymerase chain reaction and different types of PCR - Probes – Synthesis and types, Nucleic acid hybridization and blotting - Construction of gene libraries and cDNA library - Gene mapping and DNA structure analysis.

Unit III

Cloning in bacteria, yeast, plant and animal cells – identification of gene of interest and synthesis of double stranded DNA and complementary DNA - Restriction enzyme digestion – ligation - methods for transfer of cloned DNA - identification and enrichment of recombinant clones - expression of recombinant DNA in prokaryotic and eukaryotic vectors - strategies for purification of expressed protein.

Unit IV

Molecular mechanism of mutation – DNA repair - site directed DNA alterations and gene manipulations - Gene editing techniques - Methods of DNA sequencing - Genetics of tumorigenic region of agrobacteria - Applications of genetic engineering in veterinary science- Ethics, legal issues and safety aspects of genetic manipulation.



V. Suggested Readings

- Kun LY. 2006. *Microbial Biotechnology*. World Scientific.
- Sambrook J and Russel DW. 2001. *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbour Lab. Press.
- Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific.

S. No.	Topic	No. of Lectures
1	History and scope of molecular biology – Discovery of DNA and evidence for DNA as the genetic material	1
2	Structure of DNA, RNA and proteins – Organization of prokaryotic and eukaryotic genome	2
3	Gene transfer in micro organisms like conjugation, transformation, transduction and protoplasmic fusion	3
4	DNA replication - genetic code - transcription, RNA processing and alternative splicing	4-5
5	Translation in prokaryotes and eukaryotes - Regulation of gene expression	6-7
6	Enzymes used in molecular biology and recombinant DNA research	8-9
7	Cloning vectors – plasmids, phages, phagemids, cosmids, BAC, YAC	10-11
8	Expression vector – bacterial, viral, baculo and yeast vectors, shuttle vectors	12-13
9	Polymerase chain reaction and different types of PCR	14-15
10	Probes – Synthesis and types, Nucleic acid hybridization and blotting	16-17
11	Construction of gene libraries and cDNA library - Gene mapping and DNA structure analysis	18
12	Cloning in bacteria, yeast, plant and animal cells – identification of gene of interest and synthesis of double stranded DNA and complementary DNA	19-21
13	Restriction enzyme digestion – ligation - methods for transfer of cloned DNA - identification and enrichment of recombinant clones	22-24
14	Expression of recombinant DNA in prokaryotic and eukaryotic vectors - strategies for purification of expressed protein	25
15	Molecular mechanism of mutation – DNA repair - site directed DNA alterations and gene manipulations	26
16	Gene editing techniques and Methods of DNA sequencing	27-28
17	Genetics of tumorigenic region of agrobacteria	29
18	Applications of genetic engineering in veterinary sciences	30
19	Ethics, legal issues and safety aspects of genetic manipulation	31

I. Course Title : Animal Cell Culture–Principles and Applications

II. Course Code : BTY 604

III. Credit Hours : 2+1

IV. Aim of the course

Understanding the principles and applications of animal cell culture

V. Theory

Unit I

Introduction, History of cell culture development, Methods of sterilization, Different tissue culture techniques including primary culture, Continuous cell lines- anchorage dependent and independent cell lines, Organ culture, Cell bank.

Unit II

Different types of cell culture media, Serum, growth supplements, Balanced salt solution, Serum free media, Enzymes used in cell culture, Factors that affecting the growth of cells.

Unit III

Cell culture contaminants, Cryopreservation of primary culture and cell line, Cell cloning, Types of cell culture bioreactor, Cell counting and cytotoxic assays.

Unit IV

Applications of animal cell culture, Hybridoma technology and monoclonal antibody production, Applications of monoclonal antibodies in diagnostic and cancer research, Isolation and culturing of adult and embryonic stem cells, Therapeutic applications of adult stem cells.

VII. Practicals

- Packaging and sterilization of glass and plastic ware for cell culture
- Preparation of reagents and media for cell culture
- Primary chicken embryo fibroblast
- Primary sheep/ goat kidney culture
- Cultivation of continuous cell lines
- Quantification of cells by trypan blue exclusion dye
- Isolation of lymphocytes and cultivation
- Study of effect of toxic chemicals on cultured mammalian cells
- Study of cytopathic effect of virus on mammalian cells
- Cryopreservation of primary cultures and cell lines
- Isolation and culture of stem cells from bone marrow

VIII. Suggested Readings

- Freshney: *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*, 6th Edition.
- Portner R. 2007. *Animal Cell Biotechnology*. Humana Press.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction, History of cell culture development	1-2
2.	Methods of sterilization	3
3.	Tissue culture techniques- primary culture using various methods	4-5
4.	Continuous cell lines- anchorage dependent and independent cell lines	6
5.	Organ culture	7
6.	Cell bank and role of cell bank.	8
7.	Different types of cell culture media, Serum, growth supplements, balanced salt solution, Serum free media	9-12
8.	Enzymes used in cell culture, Factors that affecting the growth of cells	13
9.	Cell culture contaminants	14
10.	Cryopreservation of primary culture and cell line	15
11.	Cell cloning	16
12.	Types of cell culture bioreactor	17-18
13.	Cell counting and cytotoxic assays	19-21
14.	Applications of animal cell culture	22-24
15.	Hybridoma technology and monoclonal antibody production,	25-26



S. No.	Topic	No. of Lectures
16.	Applications of monoclonal antibodies in diagnostic and cancer research	27
17.	Isolation and culturing of adult and embryonic stem cells and therapeutic applications of adult stem cells	28
Practical		
1.	Packaging and sterilization of glass and plastic ware for cell culture	1
2.	Preparation of reagents and media for cell culture	2
3.	Primary chicken embryo fibroblast	3
4.	Primary sheep/ goat kidney culture	4
5.	Cultivation of continuous cell lines	5
6.	Quantification of cells by trypan blue exclusion dye	6
7.	Isolation of lymphocytes and cultivation	7
8.	Study of effect of toxic chemicals on cultured mammalian cells	8
9.	Study of cytopathic effect of virus on mammalian cells	9
10.	Cryopreservation of primary cultures and cell lines	10
11.	Isolation and culture of stem cells from bone marrow	11

I. Course Title : Molecular Diagnostics

II. Course Code : BTY 605

III. Credit Hours : 2+1

IV. Aim of the courses

Understanding the various diagnostics methods using molecular techniques.

V. Theory

Unit I

Introduction, Importance and historical perspective of development of molecular diagnostic technology, Development and optimisation of Nucleic acid detection assays: OIE guidelines, Concept of development of group specific and strain specific nucleic acid-based diagnostics, Basis for selection of gene/ nucleotide sequence of pathogenic organism to target for detection.

Unit II

Types and application of different molecular diagnostic assays. Restriction endonuclease analysis for identification of pathogens, Principle of development of pathogen specific DNA probes, Blotting techniques e.g. Southern and Northern hybridization.

Unit III

Signal, target and probe based amplification techniques, Transcription based amplification (TBA)/ Nucleic Acid Sequence Based Amplification (NASBA)/ Self-Sustaining Sequence Replication (SSSR/ 3SR), Strand Displacement Amplification (SDA), LAMP, Ligase Chain Reaction (LCR)-Prospects and Applications, History of PCR, principle, Cyclic and thermal parameters in PCR, Real time PCR, Variations in PCR, Applications of PCR for diagnosis of infectious diseases of animals and poultry.

Unit IV

Advancements in diagnostic technology platforms including DNA array technology, biosensors, Nanodiagnostics, Mass spectrometry, Molecular cloning, DNA sequencing

including Next generation sequencing, Bead based assays and lateral-flow device technology.

VI. Practicals

- Preparations of buffers and reagents.
- Collection of clinical and environmental samples from animal and poultry farms for molecular detection of pathogens.
- Extraction of nucleic acids from clinical specimens.
- Qualitative and quantitative analysis of extracted nucleic acid.
- Agarose gel electrophoresis of extracted nucleic acids.
- Restriction endonuclease digestion and analysis in agarose electrophoresis.
- Polymerase chain reaction for detection of pathogens in blood and other animal tissues.
- RT-PCR for detection of RNA viruses
- PCR-RFLP for detection and typing of pathogens
- Real time PCR for detection of pathogens in semen and other animal tissues
- DNA fingerprinting for identification of genetic diseases
- PCR based detection of potential pathogens in milk, eggs and meat
- Sanger sequencing using capillary electrophoresis

Suggested Readings

- Elles R and Mountford R. 2004. *Molecular Diagnosis of Genetic Disease*. Humana Press.
- Rao JR, Fleming CC and Moore JE. 2006. *Molecular Diagnostics. Horizon Bioscience in seed lot systems*.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction, importance and historical perspective of development of molecular diagnostic technology	1-2
2.	Development and optimization of nucleic acid detection assays: OIE guidelines	3-4
3.	Concept of development of group specific and strain specific nucleic acid based diagnostics, basis for selection of gene/ nucleotide sequence of pathogenic organism to target for detection	5-6
4.	Types and application of different molecular diagnostic assays	7-8
5.	Restriction endonuclease analysis for identification of pathogens	9-10
6.	Principle of development of pathogen specific DNA probes Blotting techniques e.g. Southern and Northern hybridization	11
7.	Nucleic Acid Sequence Based Amplification (NASBA)-Prospects and Applications	12-13
8.	Historical background of development of PCR and other diagnostic assays, Signal, target and probe based amplification techniques, Transcription based amplification (TBA)/ Nucleic Acid Sequence Based amplification (NASBA)/ Self-Sustaining Sequence Replication (SSSR/ 3SR), Strand Displacement Amplification (SDA), LAMP, Ligase chain reaction (LCR) - Prospects And Applications PCR principle, cyclic and thermal parameters in PCR, Real time PCR, Variations in PCR, application of PCR for diagnosis of infectious diseases of animals and poultry	14-17
9.	Real-time PCR and its application in diagnosis	18-19
10.	Advancements in diagnostic technology platforms	20
11.	DNA array technology	21



S. No.	Topic	No. of Lectures/ Practicals
12.	Nano-diagnostics	22-23
13.	Biosensors	24
14.	Mass spectrometry in disease diagnosis.	25
15.	Molecular cloning	26
16.	Bead based assays	27
17.	DNA sequencing including Next generation sequencing	28-29
18.	Lateral-flow devices and its applications in diagnosis	30
Practical		
1.	Preparation of buffers and reagents	1
2.	Extraction of nucleic acids and qualitative and quantitative analysis of Nucleic acid	2-3
3.	Agarose gel electrophoresis of Nucleic acids.	4
4.	Amplification of pathogen specific gene using PCR.	5-6
5.	Different types of PCR including RT-PCR, nested PCR, etc.	7-9
6.	Real-time PCR	10
7.	PCR-RFLP	11-12
8.	DNA fingerprinting for identification of genetic diseases	13
9.	Sanger sequencing using capillary electrophoresis	14-16

I. Course Title : Immunology Applied to Biotechnology

II. Course Code : BTY 606

III. Credit Hours : 2+1

IV. Aim of the course

Understanding the basic immunology and various immunoassays

V. Theory

Unit I

Introduction, Principles of immunology, Immune system, Immune response, Major histocompatibility complex: Structure, Functions and gene organization and its association with disease and resistance; Immunity against infectious agents of animals; Immunological tolerance; Autoimmunity; Techniques used in biotechnology.

Unit II

Immunoglobulins: Isotype, Allotype and Idiotype; Antibody production and purification; Application of antibodies in purification, Immunoblotting; Expression of immunoglobulin genes in plants and production of antibodies; Cytokines: classification, Structure, Functions; Industrial production of cytokines and interferon.

Unit III

Application of antibodies in chemiluminescence and florescence assay used for identification of recombinant genes; Antibody based nucleic acid probes and their applications; Immunoinformatics; Transgenic animals and cellular chimeras; Immunodiagnostic tests: Agar gel precipitation, Agglutination reaction based tests, various types of immunoassays, immunofiltration tests, flow cytometry in disease diagnosis.

Unit IV

Chimeric and humanized monoclonal antibodies, Recombinant antibodies; Modern

uses of antibody: Biosensors, Catalysis, *in vivo* imaging, Microarrays, Proteomics; Cancer immunity and its immunotherapy.

VI. Practicals

- Agar gel immunodiffusion test; latex agglutination test
- Immunofiltration assay
- Immunodiffusion assays
- Flow cytometry
- Immunoelectrophoresis.
- Fluorescent antibody test.
- Enzyme immunoassays including various types of ELISA & Immunoblotting.
- Affinity chromatography
- Lymphocyte proliferation assay
- Cultivation of normal lymphocytes and myeloma cell line.
- Somatic cell hybridization and production of hybridoma.
- Screening of hybrids for production of monoclonal antibodies
- Bioinformatics tools for immunological research

VII. Suggested Readings

- Kindt TJ, Goldsby RA and Osbrne BA. 2007. *Kuby Immunology*. WH Freeman.
- Male D, Brostoff J, Roth DB and Roitt I. 2006. *Immunology*. Elsevier.
- Spinger TA. 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to principles of immunology, immune system and immune response	1
2.	Major histocompatibility complex: its structure, functions and gene organization	2
3.	MHC and its association with disease and resistance	3
4.	Immunity against infectious agents of animals	4
5.	Immunological tolerance	5
6.	Autoimmunity: mechanism and control	6
7.	Techniques used in biotechnology	7
8.	Immunoglobulins and its type: Isotype, Allotype and Idiotype	8
9.	Antibody production and purification	9
10.	Application of antibodies in purification	10
11.	Immunoblotting: principle and applications	11
12.	Expression of immunoglobulin genes in plants and production of antibodies	12
13.	Cytokines: classification, structure, functions	13
14.	Industrial production of cytokines and interferon	14
15.	Application of antibodies in chemiluminescence and florescence assay for identification of recombinant genes	15
16.	Antibody based nucleic acid probes and their applications	16
17.	Immunoinformatics: concept and application	17
18.	Transgenic animals and cellular chimeras	18
19.	Immunodiagnostic tests: agar gel precipitation, agglutination reaction based assays	19
20.	Various types of Immunoassays, immunofiltration tests, flow cytometry in disease diagnosis	20
21.	Chimeric and humanized monoclonal antibodies	21



S. No.	Topic	No. of Lectures/ Practicals
22.	Recombinant antibodies: production and application	22
23.	Modern uses of antibody: biosensors, catalysis, <i>in vivo</i> imaging, microarrays, proteomics	23
24.	Cancer immunity and its immunotherapy	24
Practical		
1.	Agar gel immunodiffusion test; latex agglutination	1
2.	Immunofiltration assay	2
3.	Flow cytometry	3
4.	Immuno-electrophoresis	4
5.	Fluorescent antibody test	5
6.	Enzyme immunoassays including various types of ELISA	6
7.	Immunoblotting	7
8.	Affinity chromatography	8
9.	Lymphocyte proliferation assay	9
10.	Cultivation of normal lymphocytes and myeloma cell line	10
11.	Somatic cell hybridization and production of Hybridoma	11
12.	Screening of hybrids for production of monoclonal antibodies	12
13.	Bioinformatics tools for immunological research	13

I. Course Title : Introduction to Bioinformatics

II. Course Code : BTY 607

III. Credit Hours : 2+1

IV. Aim of the course

Understanding the various databases and packages used in Bioinformatics.

V. Theory

Unit I

Introduction, Database searching - Biological Data Acquisition, Retrieval methods for DNA sequence, protein sequence and protein structure information, General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum) Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Data – Access, Retrieval and Submission: Standard search engines; Data retrieval tools – Entrez, DBGET and SRS; Submission of (new and revised) data; Sequence Similarity Searches.

Unit II

DNA sequence analysis, Progressive and hierarchical algorithms for MSA multiple sequence alignment, Local versus global. Distance metrics. Similarity and homology. Scoring matrices. Dynamic programming algorithms, Needleman-wunsch and Smith-waterman. Heuristic Methods of sequence alignment, FASTA, BLAST and PSI BLAST. Multiple Sequence Alignment and software tools for pairwise and multiple sequence alignment; Genome Analysis: Whole genome analysis, Viral vector resources, cDNA libraries and EST, EST analysis, EST contigs resources, Phylogeny: Phylogenetic analysis, Definition and description of phylogenetic trees



and various types of trees, Method of construction of Phylogenetic trees [distance based method (UPGMA, NJ), Maximum Parsimony and Maximum Likelihood method], Comparative genomics, orthologs, paralogs.

Unit III

Secondary database searching, Introduction to concept of secondary data bases and their applications, Genome databases at NCBI, SANGER, TIGR, EBI, AGD and T (Animal genome database and tool), Introduction to animal genome research, RNA databases, protein structural databases, Building search protocol, Introduction to concept chemoinformatics computer aided drug Design–basic principles, Docking, QSAR.

Unit IV

Analysis packages–commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

VI. Practicals

- Usage of NCBI resources
- Retrieval of sequence/ structure from databases
- Visualization of protein structures
- Protein structure modeling/ predictions
- Protein antigenicity predictions
- Docking of ligand receptors
- BLAST exercises.
- Multiple sequence alignment and construction of phylogenetic tree

VII. Suggested Readings

- Attwood TK and Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Education.
- Rastogi SC, Mendiratta N and Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to bioinformatics, concept and history of databases, various primary databases resources	1-4
2.	Nucleic acid databases and their variants	5
3.	Protein databases and its variants	6
4.	Specialized genomic resources	7
5.	DNA sequence analysis, introduction to concept indel, identity, mutations, gaps and penalties	8-9
6.	cDNA library, its applications, EST, gene contings, EST databases, EST analysis tools, sequence assembly tools and clustering EST libraries	10-12
7.	Gene cloning vectors, their databases, tools and resources	13
8.	Similarity vs homology, local and global alignments	14
9.	Introduction to the concept of pair wise sequence alignment and multiple sequence alignment, difference between pair wise sequence alignment and multiple sequence alignment, introduction to various algorithms used in pair wise sequence alignment and multiple sequence alignments	15-16
10.	Applications of phylogenetic analysis, type of phylogenetic trees	17-18



S. No.	Topic	No. of Lectures/ Practicals
11.	Introduction to methods/ matrixes used for construction of phylogenetic trees use of concept bootstrap value	19
12.	Introduction to concept secondary database, their applications	20
13.	Genome databases, animal genome databases	21
14.	RNA database and their variants with applications	22
15.	Building search protocols, use of search tools for homology/ similarity identification	23
16.	Secondary protein databases, their applications, protein sequence structure relationship and patterns protein folding	24-25
17.	Introduction to chemoinformatics and its applications, Applications of computer aided drug designing	26
18.	Basic concept of computer aided drug designing	27
19.	Structure based computer aided drug designing, ligand based computer aided drug designing, databases searching, de novo drug designing	28
20.	Commercial databases and packages	29
21.	GPL software for Bioinformatics	30
22.	Web based analysis tools	31
23.	Applications of bioinformatics in veterinary clinical research	32
Practical		
1.	Usage of NCBI resources, its variants and specialized databases	1-2
2.	Retrieval of sequence/ structure from databases, retrieval of nucleic acid sequences and retrieval of protein sequence and structure studies	3-4
3.	Proteins structure visualization, prediction using software and tools	5-6
4.	Protein modelling.	7
5.	Protein antigenicity prediction tools	8
6.	Using of ligand database tools and ligand docking	9-10
7.	RNA database searching	11
8.	BLAST searching tools generalized and specialized searches	12
9.	Pair wise sequence alignment, multiple sequence alignment, phylogenetic analysis	14-16

I. Course Title : Animal Genomics

II. Course Code : BTY 608

III. Credit Hours : 2 + 1

IV. Aim of the course

Understanding the gene mapping and DNA markers in livestock improvement

V. Theory

Unit I

Historical perspective, Genome organization in eukaryotes-Chromosome numbers in farm animals – Physical and molecular structure of chromosomes -Chromosome abnormalities– High order structures, Cohesions and condensins in chromosome structure. SMC proteins –Importance of repetitive DNA –Classical satellites, microsatellites and mini satellites- SINES and LINES- Minisatellite and microsatellite based fingerprinting techniques.

Unit II

Importance of gene mapping in livestock, Methods and techniques used for gene

mapping, Physical mapping, Linkage analysis, Cytogenetic techniques, FISH technique in gene mapping, Somatic cell hybridization, Radiation hybrid maps, *in-situ* hybridization, Comparative gene mapping.

Unit III

DNA markers – Properties of DNA markers- RFLPs – Minisatellite and Microsatellite markers –PCR based markers- RAPD, PCR-RFLPs, Allele specific – PCR, SSCP, STMS markers, DAMD-PCR, ARMS PCR, AP-PCR, RAMPO, AFLP, SNP, EST, etc. Genetic characterization based on DNA markers, Genetic distance analysis, Quantitative Trait Loci (QTL), Applications of DNA markers in livestock improvement- Marker Assisted Selection (MAS) – Marker Assisted Introgression – Parentage determination – SNP chips - Genomic selection based on SNP typing – Methods of genome editing –ZFN, TALENS, Meganucleases and CRISPR –Cas. Role of genome editing in livestock improvement.

Unit IV

Genome sequencing- Next Generation Sequencing – Metagenomics –RNASeq analysis-Exome sequencing and ddRAD sequencing for genome wide SNP detection- Current status of whole genome sequencing and gene maps of livestock, Role of MHC in disease resistance, Genes influencing production traits, Mitochondrial DNA of farm animals, Evolutionary significance, Applications of genome analysis in animal breeding.

VI. Practicals

- Chromosome preparation (normal karyotyping, different types of banding) in farm animals
- Isolation and purification of animal genomic DNA from blood lymphocytes
- Analysis of DNA by agarose or polyacrylamide gel electrophoresis
- Checking the quality and quantity of genomic DNA
- Restriction digestion and analysis
- Southern hybridization
- DNA testing by microsatellite markers
- Techniques for revealing polymorphism- RFLP, SSCP, AFLP, Microsatellites, SNP chips
- Genomic DNA cloning or cDNA cloning
- Differentiation of tissues of different species by mitochondrial genome analysis.
- NGS data analysis- metagenome, RNASeq, exome and ddRAD sequence data by bioinformatics software

VII. Suggested Readings

- Gibson G and Muse SV. 2004. *A Primer of Genome Science*. Sinauer Associates.
- Primrose SB and Twyman RM. 2007. *Principles of Genome Analysis and Genomics*. Blackwell.
- Sensen CW. 2005. *Handbook of Genome Research*. Vols. I, II. Wiley- CVH.

S. No.	Topic	No. of Lectures/ Practicals
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History

1. Historical perspective, Genome organization in eukaryotes- Chromosome numbers in farm animals – Physical and molecular structure of chromosomes -Chromosome abnormalities in farm animals

1-2



S. No.	Topic	No. of Lectures/ Practicals
2.	High order structures, Role of cohesions and condensins in chromosome structure- SMC proteins	3-4
3.	Importance of repetitive DNA –Classical satellites, microsatellites and mini satellites-SINES and LINES- Minisatellite and microsatellite based fingerprinting techniques	5-6
4.	Importance of gene mapping in livestock, methods and techniques used for gene mapping	7
5.	Physical mapping- cytogenetic techniques, FISH technique in gene mapping,	8
6.	Gene mapping by somatic cell hybridization.	9
7.	Radiation hybrid maps for gene mapping	10
8.	Linkage analysis -comparative gene mapping.	11
9.	DNA markers – Properties of DNA markers- RFLPs – Minisatellite and Microsatellite markers –PCR based markers- RAPD, PCR-RFLPs, Allele specific – PCR, SSCP, STMS markers, DAMD-PCR, ARMS PCR, AP-PCR, RAMPO, AFLP, SNP, EST, etc.	12-13
10.	Genetic characterization based on DNA markers, genetic distance analysis	14
11.	Quantitative Trait Loci (QTL)-Candidate gene approach-QTL mapping approach	15
12.	Applications of DNA markers in livestock improvement- Marker Assisted Selection (MAS)	16
13.	Marker Assisted Introgression –Parentage determination – SNP chips	17
14.	Genomic selection based on SNP typing	18
15.	Methods of genome editing –ZFN, TALENS, Meganucleases and CRISPR –Cas. Role of genome editing in livestock improvement.	19-20
16.	Genome sequencing-Sanger sequencing-Hierarchical shot gun approach	21
17.	Next Generation Sequencing-Pyrosequencing-Semiconductor sequencing-Illumina sequencing-Helicos and SMRT sequencing platforms	22-23
18.	Metagenomics –RNA Seq analysis	24-25
19.	Exome sequencing and ddRAD sequencing for genome wide SNP detection	26-27
20.	Current status of whole genome sequencing and gene maps of livestock	28
21.	Role of MHC in disease resistance	29
22.	Genes influencing production traits	30
23.	Mitochondrial DNA of farm animals, evolutionary significance	31
24.	Applications of genome analysis in animal breeding.	32
Practical		
1.	Chromosome preparation (normal karyotyping, different types of banding) in farm animals	1-2
2.	Isolation and purification of animal genomic DNA from blood lymphocytes	3
3.	Analysis of DNA by agarose gel electrophoresis	4
4.	Analysis of DNA by polyacrylamide gel electrophoresis	5
5.	Checking the quality and quantity of genomic DNA by Spectrophotometer	6
6.	Restriction digestion and analysis	7
7.	Southern hybridization	8
8.	DNA testing by microsatellite markers	9
9.	Techniques for revealing polymorphism- PCR-RFLP	10



S. No.	Topic	No. of Lectures/ Practicals
10.	Single Strand Conformational Polymorphism (SSCP) analysis	11
11.	AFLP, SNP chips	12
12.	Genomic DNA cloning or cDNA cloning	13
13.	Differentiation of tissues of different species by mitochondrial genome analysis	14
14.	NGS data analysis-metagenome, RNASeq, exome and ddRAD sequence data by bioinformatics software	15-16

I. Course Title : Techniques in Molecular Biology and Genetic Engineering

II. Course Code : BTY 609

III. Credit Hours : 0+2

IV. Aim of the course

To develop skill in various molecular biology and genetic engineering techniques

- Isolation of DNA from mammalian cells
- Isolation of bacterial plasmids
- Restriction endonuclease digestion of plasmid and chromosomal DNA
- Agarose gel electrophoresis of RE digested DNA
- PCR using random primers as well as specific primers
- Different types of PCR
- Isolation of mRNA/ RNA, Quantification of nucleic acids
- cDNA synthesis
- Real time polymerase chain reaction
- Synthesis of nucleic acid probes
- Nucleic acid hybridization
- Cloning of bacterial and viral genes into plasmid vectors
- DNA ligation and transformation and confirmation of recombinants
- Purification of recombinant protein
- Polyacrylamide gel electrophoresis (PAGE)
- Western blot analysis

Suggested Readings

- Kun LY. 2006. *Microbial Biotechnology*. World Scientific.
- Sambrook J and Russel DW. 2001. *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbour Lab. Press.
- Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific.

S. No.	Topic	No. of Lectures/ Practicals
1.	Isolation of DNA from blood and mammalian cells	1-2
2.	Isolation of bacterial plasmids	3-4
3.	Restriction endonuclease digestion of plasmid and chromosomal DNA	5-6
4.	Agarose gel electrophoresis of RE digested DNA	7
5.	Polymerase Chain Reaction using random primers as well as specific primers	8-9
6.	Different types of PCR	10-12
7.	Isolation of mRNA/ RNA, Quantization of nucleic acids	13-14



S. No.	Topic	No. of Lectures/ Practicals
8.	cDNA synthesis	15
9.	Real time polymerase chain reaction	16-17
10.	Synthesis of nucleic acid probes and hybridization	18
11.	Cloning of bacterial and viral genes into plasmid vectors	19-20
12.	DNA ligation and transformation and confirmation of recombinants	21-23
13.	Purification of recombinant proteins	24-25
14.	Polyacrylamide gel electrophoresis (PAGE)	26-27
15.	Western blot analysis	28-29

I. Course Title : Reproductive Biotechnology

II. Course Code : BTY 610

III. Credit Hours : 2+1

IV. Aim of the course

Understanding the concept of assisted reproductive technology

V. Theory

Unit I

Assisted Reproductive Technology (ART), History, Role of biotechnology in ART, importance of assisted reproductive technology in human and animals

Unit II

Multiple Ovulation Embryo Transfer (MOET), *in-vitro* fertilization, Micro assisted fertilization, Embryo culture, Micromanipulation of gametes and embryos, preservation of embryos and oocytes

Unit III

Semen sexing technology, Embryo splitting, Different methods of embryo sexing, Transgenic animal production, Application, Limitation and regulatory issues

Unit IV

Somatic cell nuclear transfer of domestic animals and application. Isolation and characterization of embryonic stem cells. Different applications of embryonic stem cells

VI. Practicals

- MOET protocols for domestic animals
- Oocyte and embryo freezing protocol
- Oocyte collection and evaluation from live and slaughter house animals
- *In-vitro* embryo production
- Embryo quality analysis
- Embryo biopsy and embryo sexing

VII. Suggested Reading

- Ball PJH and Peter AR. 2004. *Reproduction in Cattle*. Blackwell.
- Gordon I. 2003. *Laboratory Production of Cattle Embryos*. CABI.
- Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI.



S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	History, role of biotechnology in Assisted reproductive technology(ART)	1-2
2.	Application of ART in human and animals	3-4
3.	Multiple ovulation embryo transfer (MOET)- donor and recipient selection- synchronization-super ovulation-artificial insemination- embryo flushing- embryo evaluation- recipient management	5-6
4.	Oocyte recovery from slaughter house ovaries and live animals, oocytes evaluation and <i>in-vitro</i> maturation	7-8
5.	<i>In-vitro</i> fertilization of oocytes, <i>In-vitro</i> culture and assessment of embryonic developmental stages	9-11
6.	Micro assisted fertilization	12-13
7.	Micromanipulation of gametes and embryos	14
8.	Preservation of embryos and oocytes	15
9.	Semen sexing technology and semen analysis	16
10.	Embryo splitting	17
11.	Different methods of embryo sexing	18-19
12.	Transgenic animal production, application, limitation and regulatory issues	20-22
13.	Somatic cell nuclear transfer of domestic animals and application	23-25
14.	Isolation and characterization of embryonic stem cells	26-27
15.	Different applications of embryonic stem cells	28
Practicals		
1.	MOET protocols for domestic animals	1-2
2.	Oocyte and embryo freezing protocol	3-4
3.	Oocyte collection and evaluation from live and slaughter house animals	5-6
4.	<i>In-vitro</i> embryo production	7-8
5.	Embryo quality analysis	9
6.	Embryo biopsy and embryo sexing	10



Course Title with Credit Load Ph.D. in Veterinary Biotechnology

Course Code	Course Title	Credit
RPE 700	Research and Publication Ethics*	1+1
BTY 701	Genetic Engineering	1+2
BTY 702	Functional Genomics and Proteomics	3+0
BTY 703	Advances in Cell and Molecular Biology	2+0
BTY 704	Diagnostic Platform	1+1
BTY 705	Gene Manipulation and Genome Editing	2+0
BTY 706	Trends in Vaccinology	2+1
BTY 707	Advances in Bioinformatics	1+1
BTY 708	Advances in Reproductive Biotechnology	2+1
BTY 709	Advances in Animal Cell Culture	2+1
BTY710	Industrial Biotechnology	2+1
BTY 711	Rumen and Feed Biotechnology	2 +1
BTY 712	Doctorate Seminar-I	1+0
BTY 713	Doctorate Seminar-II	1+0
BTY 714	Doctorate Research	0+70

*compulsory Major course for Doctorate programme. The other 10 credits can be registered from remaining 700 Series courses listed above

Suggested list of specified Minor subjects (Departments)

Major Subject	Minor subjects (Departments)*
Veterinary Biotechnology	Biochemistry, Physiology, Microbiology, Animal Genetics and Breeding, LPT, Gynaecology and Obstetrics, Pathology, Animal Nutrition, Parasitology and Pharmacology and Toxicology, medicine, surgery, public health, wild life

*The Minor courses may be taken from any number of disciplines/ departments listed against major discipline limiting to credits prescribed as decided by the Chairman of Advisory Committee of the student.

Minor courses may also be taken from the other than those listed above on the recommendations of advisory committee, if essentially required as per the research problem with the concurrence of Head of the Department and Concerned Authorities.

Course Contents

Ph.D. in Veterinary Biotechnology

- I. Course Title** : Genetic Engineering
II. Course Code : BTY 701
III. Credit Hours : 1+2

IV. Aim of the course

Understanding the concept of gene cloning and expression.

V. Theory

Unit I

Cloning vectors- plasmids, Phages, Cosmids, BAC, YAC, Expression vectors-viral, baculo and yeast vectors, Shuttle vectors.

Unit II

Restriction, ligation, Transformation and recombinant selection methods, Construction of genomic and cDNA library, Construction of full length cDNA, Preparation of probe, Nick translation, Random hexamer and nick translation.

Unit III

Linkers, Adapters and cassettes, Screening the library.

Unit IV

Expression of genes, Prokaryotic and eukaryotic expression, Identification of recombinant proteins, Purification of expressed protein.

VI. Practicals

- Preparation of vector
- Restriction enzyme digestion of vector
- Preparation of target DNA and Purification of DNA
- DNA ligation
- Preparation of electro competent cells
- Transformation
- Calculation of transformation efficiency
- Screening by colony PCR
- Selection of recombinant by insert release
- Induction of expressed protein
- Purification of expressed protein
- SDS-PAGE
- Western blotting.

VII. Suggested Readings

- Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA and Struhl K. 2002. *Short Protocols in Molecular Biology*. Wiley



S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Cloning vectors- plasmids, phages, cosmids, BAC, YAC	1-2
2.	Expression vectors- viral, baculo and yeast vectors, shuttle vectors.	3-4
3.	Restriction, ligation, transformation	5-6
4.	Recombinant selection methods	7
5.	Construction of genomic and cDNA library	8
6.	Construction of full length cDNA	9
7.	Preparation of probe	10
8.	Nick translation random hexamer and nick translation	11
9.	Linkers, adapters, Cassettes,	12
10.	Screening the library	13
11.	Expressions of genes, prokaryotic and eukaryotic expression	14-15
12.	Identification of protein, Purification of expressed protein	16
Practical		
1.	Preparation of vector	1-2
2.	Restriction enzyme digestion of vector	3
3.	Preparation of target DNA and Purification of DNA	4-5
4.	DNA ligation	6
5.	Preparation of electro competent cell	7
6.	Transformation	8
7.	Calculation of transformation efficiency	9
8.	Screening by colony PCR	10
9.	Selection of recombinant by insert release	11-12
10.	Induction of expressed protein	13
11.	Purification of expressed protein	14-15
12.	SDS-PAGE	16-17
13.	Western blotting	18-19

I. Course Title : Functional Genomics and Proteomics

II. Course Code : BTY 702

III. Credit Hours : 3+0

IV. Aim of the course

Understanding the principles of functional genomics and proteomics

V. Theory

Unit I

Overview of Mammalian Genome: Mitochondrial genome, Protein coding genes, RNA genes and repeat sequences, Variations in the mammalian genome, Expression of mammalian genome.

Unit II

Overview of Mammalian Transcriptome: Different methods to study gene expression, Single gene analysis, Northern blots, Quantitative PCR, SAGE, MPSS and SSH, Introduction to basic microarray technology, Design of experiments, Types of microarray.

Unit III

Methods to study the mammalian Genome: Chromosome number evolution in



mammalian species, Chromosome territory, Karyotyping, FISH and Spectral karyotyping, Next Generation sequencing platforms chemistries and their applications, Mutation detection methods for single gene and genome wide scale.

Unit IV

Databases such as NCBI, EBI, Nucleotide, Genome, SNP, Gene, Unigene, Homologene, Protein, etc. under NCBI. Service databases under EBI. Genome browsers, The concept of Comparative genomics, Genome BLAST and BLAT. Proteomics technology, Identification and analysis of proteins by 2D analysis, Mass spectrophotometry, Circular Dischorism, Fluorescence Spectroscopy, NMR and X-ray crystallography, MALDI-TOF, Differential display proteomics, Protein -protein interaction, Yeast two hybrid system and phage display.

VI. Suggested Reading

- Gibson G and Muse SV. 2004. *A Primer of Genome Science*. Sinauer Associates.
- Primrose SB and Twyman RM. 2007. *Principles of Genome Analysis and Genomics*. Blackwell.
- Sensen CW. 2005. *Handbook of Genome Research*. Vols. I, II Wiley- CVH.

S. No.	Topic	No. of Lectures
1.	Overview of Mammalian Genome: Mitochondrial genome	1
2.	Protein coding genes	2
3.	RNA genes and repeat sequences	3
4.	Variations in the mammalian genome	4
5.	Expression of mammalian genome	5
6.	Overview of Mammalian Transcriptome	6
7.	Different methods to study gene expression	7-8
8.	Single gene analysis, Northern blots, Quantitative PCR	9-10
9.	SAGE, MPSS and SSH	11-12
10.	Introduction to basic microarray technology, Design of experiments	13-14
11.	Types of microarray	15-16
12.	Mammalian Genome- Chromosome number, evolution in mammalian species	17
13.	Chromosome territory	18
14.	Karyotyping, FISH and Spectral karyotyping	19
15.	Next Generation sequencing platforms chemistries and their applications	20-21
16.	Mutation detection methods for single gene and genome wide scale	22-23
17.	Databases such as NCBI, EBI	24
18.	Nucleotide, Genome, SNP, Gene, Unigene, Homologene, Protein, etc. under NCBI. Service databases under EBI	25
19.	Genome browsers, The concept of Comparative genomics, Genome BLAST and BLAT	26
20.	Proteomics technology, identification and analysis of proteins by 2D analysis	27-29
21.	mass spectrophotometry,	30
22.	Circular Dischorism	31
23.	Fluorescence Spectroscopy	32-34
24.	NMR and X-ray crystallography	35-37
25.	MALDI-TOF	38-39
26.	Differential display proteomics	40-42
28.	Protein -protein interaction, yeast two hybrid system	43-45
29.	Phage display	46



- I. Course Title** : **Advances in Cell and Molecular Biology**
II. Course Code : **BTY 703**
III. Credit Hours : **2 + 0**

IV. Aim of the course

Understanding the latest development in cell and molecular biology

V. Theory

Unit I

Cell chemistry and Biosynthesis pathways – Molecular motors of cell biology – Cell signalling – Signal Transduction – Chemotropic Energy Metabolism – Apoptosis pathways.

Unit II

Structure and functions of Prokaryotic and Eukaryotic Operons – Recombination and Genetic variability – Regulation of Gene Expression – Strategies of nuclear Transport – Carrier Proteins and active membrane transport methodologies.

Unit III

Protein Biosynthesis and Transportation – Protein sorting - Enzymes in Molecular Biology – Post transcriptional control strategies – Plasmids in recombinant DNA technology.

Unit IV

RNA interference technology – Insights into Nanobiology – Biosensors – DNA Microarray – Peptide Synthesis – Reverse Genetics.

VI. Suggested Readings

- Lewin B. 2008. *Gene IX*. Jones and Bartlett.
- Primrose SB. 2001. *Molecular Biotechnology*. Panima.
- Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific

S. No.	Topic	No. of Lectures
1.	Cell chemistry and biosynthesis pathway	1
2.	Molecular motors of cell biology	2
3.	Cell signalling	3
4.	Signal transduction	4
5.	Chemotropic energy metabolism	5
6.	Apoptosis pathways	6
7.	Structure and functions of prokaryotic and eukaryotic operons	7-8
8.	Recombination and genetic variability	9
9.	Regulation of gene expression	10
10.	Strategies of nuclear transport	11
11.	Carrier proteins and active membrane transport methodologies	12
12.	Protein biosynthesis	13
13.	Protein transportation	14
14.	Protein sorting	15
15.	Enzymes in molecular biology	16
16.	Post transcriptional control strategies	17
17.	Plasmids in recombinant DNA technology	18
18.	RNA interference technology	19
19.	Insights into nanobiology	20



S. No.	Topic	No. of Lectures
20.	Biosensor	21
21.	DNA microarray	22-24
22.	Peptides synthesis	25-27
23.	Reverse genetics	28

I. Course Title : Diagnostic Platform

II. Course Code : BTY 704

III. Credit Hours : 1 + 1

IV. Aim of the course

Understanding the concept of various diagnostic platforms.

V. Theory

Unit I

History and evolution of diagnostic platforms- Methods for identifying agents for infection or disease- Point-of-care assays- Point-of-care assays based on proteins- point-of-care assays based on nucleic acids, Principles for specific identification of the analytes or clinical parameters - Various assays for different platform.

Unit II

Catridges- Polymer catridges- Catridge based *in-vitro* diagnostics- Microfluidics/ nanotechnology sensors- Complexity and diversity of samples- Sample preparation- extraction of DNA/ RNA- PCR for marker DNA sequence- POC based on microfluidic chips.

Unit III

Detection principles- Colorimetric- Optical, Electrochemical, Magnetic, Mechanical protein detection methods- Sensitive sensing principles- NASBA- RPA- LAMP with QUASR- Integrated microfluidic system.

Unit IV

Instrumentation for point of care diagnostic platform- Blood protein analyses, the Afinion platform from Axis-Shield- The Verigene® System by Nanosphere- Cepheid's GeneXpert cassette- NorChip- use of smart phone apps for real time monitoring and analysis.

VI. Practicals

- DNA/ protein extraction
- RNA extraction
- Polymerase chain reaction
- NASBA
- RPA
- LAMP
- Microfluidic assay

VII. Suggested Readings

- *Diagnostic Devices with Microfluidics*. 1st Edition. Francesco Piraino, Šeila Selimoviæ. CRC Press
- *Point-of-Care Diagnostics on a Chip*. David Issadore Robert M. Westervelt



S.No.	Topic	No. of Lectures/ Practicals
Theory		
1.	History and evolution of diagnostic platforms	1
2.	Methods for identifying agents for infection or disease, point-of-care assays	2
3.	Point-of-care assays	3
4.	Principles for specific identification of the analytes or clinical parameters, various assays for different platform	4
5.	Catridges, polymer catridges- catridge based <i>in-vitro</i> diagnostics	5
6.	Microfluidics/ nanotechnology sensors, complexity and diversity of samples	6
7.	sample preparation, extraction of DNA/ RNA, PCR for marker DNA sequence	7
8.	POC based on microfluidic chips	8
9.	Detection principles- colorimetric- optical, electrochemical, magnetic	9
10.	Detection principles- colorimetric- optical, electrochemical, magnetic, mechanical protein detection methods	10
11.	Sensitive sensing principles- NASBA- RPA- LAMP with QUASR	11
12.	Integrated microfluidic system	12
13.	Instrumentation for point of care diagnostic platform	13
14.	Blood protein analyses, the Afinion platform from Axis-Shield	14
15.	The Verigene ® System by Nanosphere- Cepheid's GeneXpert cassette	15
16.	NorChip, use of smart phone apps for real time monitoring and analysis	16-17
Practical		
1.	DNA/ protein extraction	1-2
2.	RNA extraction	3
3.	Polymerase chain reaction	4-5
4.	NASBA	6
5.	RPA	7
6.	LAMP	8
7.	Microfluidic assay	9-10

I. Course Title : Gene Manipulation and Genome Editing

II. Course Code : BTY 705

III. Credit Hours : 2 + 0

IV. Aim of the course

Understanding the various method of gene manipulation and genome editing.

V. Theory

Unit I

Genome Overview: Genetic architectures of model organisms: yeast, *C. elegans*, Drosophila, Mouse, Human, Chromosomal and Genomic overviews of cattle, buffalo, sheep, goat, pigs and poultry.

Unit II

Tools to characterize transgene: Identification and characterization of suitable transgene. Vectors used to clone and expression of foreign gene in prokaryotic and eukaryotic systems. Different types of promoters for tissue specific expression of transgene. Detection of transgene in the new-born.

Unit III

Methods of gene transfer: Microinjection of recombinant DNA into fertilized eggs/ stem cells, Transfection of DNA totipotent kerato-carcinoma cells, Electroporation, gene transfer into cultured cells.

Unit IV

Genome editing tools: Zinc finger, TALEN and CRISPR: Their discovery, Types and their mechanism. Applications of these tools for *in vivo* genome engineering. Mono allelic and biallelic gene editing. Screening for genome editing process in cells/ animals. Applications of these tools in animal science for genetic studies, therapeutic potential and transgenic animal as bioreactors. Recent examples of genome edited animals and their applications in animal science.

VI. Suggested reading

- *Human genome editing science, ethics and governance*

S. No.	Topic	No. of Lectures
1.	Genetic architectures of model organisms: yeast, <i>C. elegans</i> , <i>Drosophila</i> , Mouse, human	1-2
2.	Chromosomal and Genomic overviews of cattle, buffalo, yak, Mithun, sheep and goat	3-4
3.	Chromosomal and Genomic overviews of pigs and poultry genome	5
4.	Identification and characterization of suitable transgene	6
5.	Vectors used to clone and expression of foreign gene in prokaryotic systems.	7-8
6.	Vectors used to clone and expression of foreign gene in eukaryotic systems.	9-10
7.	Different types of promoters in prokaryotes and eukaryaotes for tissue specific expression of transgene	11-12
8.	Detection of transgene in the new-born	13
9.	Microinjection of recombinant DNA into fertilized eggs/ stem cells	14-16
10.	Transfection of DNA totipotent/ ES cells and kerato-carcinoma cells,	17-18
11.	Electroporation, gene transfer into cultured mammalian cells.	19-21
12.	Zinc finger and TALEN types and their mechanism	22
13.	CRISPR types and their mechanism	23-24
14.	Applications of these tools for <i>in vivo</i> genome engineering.	25
15.	Mono allelic and biallelic gene editing	26
16.	Screening for genome editing process in cells/ animals.	27
17.	Applications of these tools in animal science for genetic studies, therapeutic potential and transgenic animal as bioreactors.	28
18.	Recent examples of genome edited animals and their applications in animal science	29-30

I. Course Title : Trends in Vaccinology

II. Course Code : BTY 706

III. Credit Hours : 2+1

IV. Aim of the course

Understanding the current trends in vaccine production technologies.



V. Theory

Unit I

Immunity against veterinary infectious agents: Bacteria, Virus, fungi and parasites; Immunoinformatics and its application to epitope mapping of pathogens, etc.; Advancement in vaccinology: Vaccinomics, Adversomics, Systems Vaccinology, reverse vaccinology, Structural Vaccinology and computational vaccinology and its applications.

Unit II

Current trends in vaccine development against animal pathogens; Molecular approaches for vaccine development including: recombinant peptide vaccines, vectored vaccines, Marker vaccines, DNA vaccines, genetically manipulated live vaccines, etc.; Plant expression system based vaccines, idiootype and synthetic peptide based vaccines.

Unit III

Vaccines and Immunotherapeutic for Treating Non-Infectious Diseases: Cancer; obesity, neurodegenerative diseases, addictions, atherosclerosis, etc.; DIVA Vaccines for animal disease; Vaccines for emerging human and animal diseases; Novel immunomodulators and vaccine delivery systems: Immunomodulators including cytokines and new adjuvants; delivery of immunogens through liposomes, microspheres, ISCOMS, nanotechnology based vaccine delivery, etc.

Unit IV

Vaccine formulation: pharmacopeia requirements; Vaccine qualities and its control; Large scale vaccine production technology: cost effectiveness of preventive immunization programmes; Stages of development of vaccine; Clinical trials of vaccine and its regulation; Commercial vaccines available against animal pathogens, its characteristics and immunization schedule; Vaccine stability, Preservation and vaccination failure; Environmental concerns with the use of recombinant vaccines.

VI. Practicals

- Purification of immunoglobulins: gel filtration and ion exchange chromatography
- Hybridoma technique for monoclonal antibody production
- Preparation of gene construct for recombinant and nucleic acid vaccine
- Expression of gene encoding immunogenic protein in prokaryotic/ yeast/ animal cell culture system
- Study of immune response against recombinant vaccine
- Use of modern adjuvants in vaccines
- Isolation and characterization of antigens from viruses, bacteria
- Immunoassays: ELISA, FAT, RIA

VII. Suggested Reading

- Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthc

S. No.	Topic	No. of Lectures/ Practicals
1	Immunity against veterinary infectious agents: bacteria, virus, fungi and parasites	1-3



S. No.	Topic	No. of Lectures/ Practicals
2	Immunoinformatics and its application to epitope mapping of pathogens, etc.	4
3	Advancement in vaccinology: Vaccinomics and Adversomics	5
4	Systems Vaccinology and Reverse vaccinology	6-7
5	Structural Vaccinology, computational vaccinology and its applications	8
6	Current trends in vaccine development against animal pathogens	9
7	Molecular approaches for vaccine development including: recombinant peptide vaccines, vectored vaccines, Marker vaccines, DNA vaccines, genetically manipulated live vaccines, etc.	10-12
8	Plant expression system based vaccines	13
9.	Idiotypic and synthetic peptide based vaccines	14
10.	Vaccines and Immunotherapeutic for treating non-infectious Diseases: Cancer; obesity, neurodegenerative diseases, addictions, atherosclerosis, etc.	15-16
11.	DIVA Vaccines for animal disease	17
12.	Vaccines for emerging human and animal diseases	18
13.	Novel immunomodulators: Immunomodulators including cytokines and new adjuvants	19-20
14.	Novel vaccine delivery systems: delivery of immunogens through liposomes, microspheres, ISCOMS, nanotechnology based vaccine delivery, etc.	21-23
15.	Vaccine formulation: pharmacopeia requirements	24
16.	Vaccine qualities and its control	25
17.	Large scale vaccine production technology: cost effectiveness of preventive immunization programmes	26
18.	Stages of development of vaccine, clinical trials of vaccine and its regulation	27
19.	Commercial vaccines available against animal pathogens, its characteristics and immunization schedule	28-29
20.	Vaccine stability, preservation and vaccination failure	30-31
21.	Environmental concerns with the use of recombinant vaccines	32
Practical		
1.	Purification of immunoglobulins: gel filtration and ion exchange chromatography	1-2
2.	Hybridoma technique for monoclonal antibody production	3-4
3.	Preparation of gene construct for recombinant and nucleic acid vaccine.	5
4.	Expression of gene encoding immunogenic protein in prokaryotic/ yeast/ animal cell culture system.	6
5.	Study of immune response against recombinant vaccine.	7-8
6.	Use of modern adjuvants in vaccines	9
7.	Isolation and characterization of antigens from viruses, bacteria,	10
8.	Immunoassays: ELISA, FAT, RIA	11

I. Course Title : Advances in Bioinformatics

II. Course Code : BTY 707

III. Credit Hours : 1+1

IV. Aim of the course

To impart an introductory knowledge about the subject of Bioinformatics to the students studying any discipline of science.



V. Theory

Unit I

Introduction to Computational Gene Prediction and Genome annotation Basic concepts in Computational Phylogenetic Analysis, Super trees, consensus trees, tree compatibility. Algorithms for evaluating the tree space; Markov Chain Monte Carlo, genetic algorithms. Evaluation of results from phylogenetic analyses, phylogenetic dating Genome annotation; Gene networks (basic concepts). Completed genomes and bioinformatics approaches to analyze the genomes of Viruses, Bacteria and animals.

Unit II

DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools (especially clustering approaches). Methods of Genome sequencing, EST, STS, GSS database and their generation, Whole Genome comparison, RNA folding, RNA loops, conformational study, Whole genome analysis, Whole genome regression and prediction methods, Transcriptome analysis and its applications, Animal QTL databases and SIGENAE analysis of breeding animals genome.

Unit III

Transcriptome and Proteome- General Account; Tools of proteome analysis, Motifs and Folds; Protein structure related databases, Protein Data Bank format, Concepts of B-factor and R-factor, Protein Structural Alignment and Superposition, Structure visualization of proteins. Protein Fold Classification, Protein structure comparison, CATH and SCOP Databases. Protein structure prediction methods. Homology modeling. Molecular Docking and Drug design (Basic concepts) Molecular dynamics and simulation study of protein, Force field concepts.

Unit IV

Protein identification and characterization:- AA CompIdent, TagIdent, PepIdent and MultiIdent, PROSEARCH, PepSea, PepMAPPER, FindPept, introduction to the concept of chemoinformatics, metabolomics and immunoinformatics.

VI. Practicals

- Gene annotation
- Phylogenetic tree construction
- RNA folding
- Genome database searching
- Protein folding and structure predictions
- Analysis of 3D structure of protein using RasMol through command line.
- Molecular Docking of protein and ligand by HEX.
- Analysis of 3D structure of protein and nucleic acid using Cn3D.
- QTL databases

VII. Suggested Readings

- Attwood TK and Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Education.
- Rastogi SC, Mendiratta N and Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.



S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to Computational Gene Prediction and Genome annotation	1
2.	Basic concepts in Computational Phylogenetic Analysis, phylogenetic dating genome annotation; Gene networks	2
3.	Completed genomes and bioinformatics approaches to analyze the genomes of Viruses, Bacteria and Animals	3-4
4.	Understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools	5
5.	Methods of Genome sequencing, EST, STS, GSS database Whole Genome comparison	6-7
6.	RNA folding, RNA loops, conformational study and specialized RNA databases	8
7.	Whole genome analysis, whole genome regression and prediction methods	9
8.	Transcriptome analysis and its applications, Animal QTL databases and SIGENAE analysis of breeding animals genome	10
9.	Tools of proteome analysis, Motifs and Folds; Protein structure related databases, Protein Data Bank format, Concepts of B-factor and R-factor,	11
10.	Protein Structural Alignment and Superposition, Structure visualization of proteins. Protein Fold Classification, Protein structure comparison, CATH and SCOP Databases. Protein structure prediction methods. Homology modeling	12-13
11.	Molecular Docking and Drug design (Basic concepts) Molecular dynamics and simulation study of protein, Force field concepts	14
12.	Protein identification and characterization	15
13.	Introduction to the concept of chemoinformatics, metabolomics and immunoinformatics	16
Practical		
1.	Gene annotation, sequence retrieval specialized searches	1-3
2.	Phylogenetic tree construction and phylogenetic dating	4-5
3.	RNA folding, RNA secondary structure prediction, DNA secondary structure prediction	5-6
4.	Genome database searching, contig preparation	7
5.	Protein folding and structure predictions	8
6.	Analysis of 3D structure of protein using RasMol through command line	9
7.	Molecular Docking of protein and ligand by HEX	10
8.	Analysis of 3D structure of protein and nucleic acid using Cn3D	11
9.	QTL databases	12

I. Course Title : Advances in Reproductive Biotechnology

II. Course Code : BTY 708

III. Credit Hours : 2+1

IV. Aim of the course

Understanding the reproductive techniques in farm animals

V. Theory

Unit I

Micromanipulation of embryos and gametes, Somatic Cell Nuclear Transfer(SCNT),



nuclear reprogramming, Transgenic animal production, Combining Transgenic and SCNT, Gene targeting, Genome editing and disease modeling.

Unit II

In vivo Vs *in-vitro* production of embryos, Embryos quality, Transcriptomics, Metabolomic approach, Sperm sexing technologies and their application, Preimplantation genetic diagnosis and screening, Epigenetic reprogramming, Large offspring syndrome.

Unit III

Sources of stem cells, Embryonic stem cells, Spermatogonial stem cells, Induced pluripotent stem cells, Stem cells application in regenerative medicine and disease therapeutics.

Unit IV

Social, Ethical, Religious and regulatory issues related to assisted reproductive technology, Transgenic and stem cells therapy.

VI. Practicals

- Micro assisted fertilization- ICSI
- Embryo biopsy for PGD and sexing
- Sperm quality analysis by flow cytometry
- Embryo quality analysis
- SCNT protocol
- Isolation and characterization of embryonic stem cells
- Gene expression in sperm and embryos

VII. Suggested Reading

- Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Micromanipulation of embryos and gametes, Somatic cell nuclear transfer (SCNT) and Nuclear reprogramming	1-3
2.	Transgenic animal production and SCNT	4-5
3.	Gene targeting	6
4.	Gene editing and disease modelling	7-8
5.	<i>In vivo vs in-vitro</i> embryos	9-10
6.	Embryos quality – Transcriptomics, Metabolomic approach	11-13
7.	Sperm sexing technologies and their applications	14-15
8.	Pre implantation genetic diagnosis and screening	16-17
9.	Epigenetic reprogramming	18
10.	Large offspring syndrome	19-20
11.	Source of stem cells, embryonic stem cells, spermatogonial stem cells	21-23
12.	Induced pluripotent stem cells	24-25
13.	Stem cells application in regenerative medicine and diseases therapeutics	26
14.	Social, ethical, religious and regulatory issues related to assisted reproductive technology	27
15.	Transgenic and stems cells therapy	28



S. No.	Topic	No. of Lectures/ Practicals
Practical		
1.	Micromanipulator, micro assisted fertilization, ICSI protocol	1-2
2.	Embryo biopsy- sexing	3-4
3.	Sperm preparation and sperm quality analysis by flow cytometry	5-6
4.	Embryo quality analysis- Morphological assessment and Staining technique	7-8
5.	SCNT protocol- enucleation, somatic cell injection, fusion activation and embryo culture	9-10
6.	Isolation of inner cell mass from blastocyst, culture and characterisation of embryonic stem cells	11
7.	Gene expression in sperm and embryos	12

I. Course Title : Advances in Animal Cell Culture

II. Course Code : BTY 709

III. Credit Hours : 2+1

IV. Aim of the course

Understanding the latest development in animal cell culture

V. Theory

Unit I

Development of cell lines using various methods, Characterization of cell lines by morphology, Chromosome analysis, DNA content, Isoenzyme analysis and antigenic markers, DNA fingerprinting.

Unit II

Setting of new cell culture lab, Detection methods for cell culture contaminants, Three dimensional culture- classification of 3D culture methods and microfluidics, Tissue engineering- types of cells, Scaffold materials, Bioprinting, Bioartificial organs, Flow Cytometry and its applications in cell culture.

Unit III

DNA transfer by viral and non viral methods, Expression of recombinant proteins in mammalian and avian cell lines.

Unit IV

Monoclonal antibody production and characterization, Up-stream and downstream processing of cell culture based vaccines, Diagnostic antigens and other pharmaceutical agents, Cell culture fermentors.

VI. Practicals

- Primary and secondary mammalian cell culture
- Development of transformed cells
- Characterization of cell lines by karyotyping
- Transfection of cells with recombinant DNA
- Expression of recombinant proteins
- Scaling-up of cultures
- Flow Cytometry



- Immunization of mice
- Maintenance of myeloma cell lines
- Fusion
- Characterization of mAbs

VII. Suggested Readings

- Freshney RI. 2005. *Culture of Animal Cells*. Wiley Liss.
- Portner R. 2007. *Animal Cell Biotechnology*. Humana Press

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Development of cell lines using various methods	1
2.	Characterisation of cell lines by morphology	2
3.	Characterisation of cell lines by chromosome analysis	3
4.	Characterisation of cell lines by DNA content, isoenzyme analysis and antigenic markers	4
5.	Characterisation of cell lines DNA fingerprinting	5
6.	Setting of new culture lab	6
7.	Detection methods for cell culture contaminants	7
8.	Classification of 3D culture methods and micro fluidics	8
9.	Tissue engineering- types of cells, scaffold materials, bio printing, bio artificial organs,	9
10.	Flow Cytometry and its applications in cell culture	11
11.	DNA transfer by viral and non viral methods	11
12.	Expression of recombinant proteins in mammalian and avian cell lines	12
13.	Monoclonal antibody production and characterisation	13
14.	Upstream and downstream processing of cell culture based vaccines, diagnostic antigens and other pharmaceutical agents	14-15
15.	Cell culture fermentors	16
Practical		
1.	Primary and secondary mammalian cell culture	1
2.	Development of transformed cells	2
3.	Characterization of cell lines by karyotyping	3
4.	Transfection of cells with recombinant DNA	4
5.	Expression of recombinant proteins	5
6.	Scaling-up of cultures	6
7.	Flow Cytometry	7
8.	Immunization of mice	8
9.	Maintenance of myeloma cell lines	9
10.	Fusion	10
11.	Characterisation of Mabs	11

I. Course Title : Industrial Biotechnology

II. Course Code : BTY 710

III. Credit Hours : 2+1

IV. Aim of the course

Understanding the fermentation process and Bioenergy system.

V. Theory

Unit I

Introduction to fermentation process- Microbes and enzymes of industrial importance - screening and genetic improvement of industrially important microorganisms, Microbial metabolites- Microbial growth, Substrate degradation and product formation –Recombinant products.

Unit II

Fermentation systems -Batch culture, Continuous culture, Fed-batch culture, Kinetics of growth and product formation, Design of a fermenter, Basic functions of a fermenter for microbial or animal cell culture, Aseptic operation and containment, Construction and components, Types of fermenters, Fermenters for animal cell culture, Sterilization of reactor.

Unit III

Media for industrial fermentations: Typical media, Medium formulation, Precursors and metabolic regulators, Antifoams. Upstream and Downstream processing- Filtration, Centrifugation, Cell disruption, Liquid-liquid extraction, Chromatography, membrane processes, Drying, Crystallization, Whole broth processing.

Unit IV

Bioenergy- Gaseous fuels: Biohydrogen, Biomethane and Microbial fuel cell; Liquid fuels: Bioethanol, Biodiesel and Biobutanol, Aerobic and Anaerobic wastewater treatment processes—Single cell protein production -Metal leaching- Industrial chemicals- Food additives –Food supplements -Health care products.

VI. Practicals

- Isolation of Industrially important enzyme producing microorganisms
- Strain improvement
- Bioreactor operation
- Production of Industrial compounds, enzymes
- Downstream processing- Filtration, Centrifugation, Cell disruption,
- Liquid-liquid extraction, Chromatography- HPLC
- Microbial fuel cell design and operation for waste water treatment

VII. Suggested Readings

- Alberghina L. 2000. *Protein Engineering for Industrial Biotechnology*. Routledge.
- Kun LY. 2006. *Microbial Biotechnology*. World Scientific.
- Singh, R and Ghosh SK. 2004. *Industrial Biotechnology*. Global Vision Publ. House.
- Thomson J. 2006. *Your Guide to Industrial Biotechnology*. Abhishek Publ

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to fermentation process, history of fermentation process	1
2.	Enzymes of industrial importance, Microbes producing industrially important enzymes	2
3.	Screening of microbes for enzyme production	3
4.	Genetic improvement of microorganism for improved production	4-5
5.	Microbial growth studies and their metabolites-primary and secondary	6
6.	Product formation by substrate degradation	7



S. No.	Topic	No. of Lectures/ Practicals
7.	production of recombinant products	8
8.	Batch, continuous and fed batch fermentation	9-10
9.	Kinetics of growth and product formation	11-12
10.	Design of a fermenter, basic functions, types of fermenters	13
11.	Animal cell culture by using bioreactors, Fermenters for animal cell culture	14
12.	Aseptic operation, Containment, Sterilization	15-16
13.	Medium formulation, precursors, metabolic regulators, antifoams	17-18
14.	Upstream and down stream processing	19
15.	Filtration, Centrifugation	20
16.	Extraction, Chromatography, membrane process	21-22
17.	Drying crystallization, whole broth processing	23-24
18.	Bioenergy production	25
19.	Biohydrogen, biomethane, biodiesel and biobutanol production	26
20.	Microbial fuel cells	27
21.	Aerobic treatment of waste water	28
22.	Anaerobic waste water treatment	29
22.	Singel cell protein production, Metal leaching	30
23.	Food additives	31
24.	Food supplements and health care products	32
Practical		
1.	Isolation of industrially important enzyme producing microorganism	1
2.	Screening for enzyme production	2
3.	Extraction and characterization of enzymes	3
4.	Enzyme kinetics	4
5.	Strain improvement by different methods	5
6.	Bioreactor operation	6
7.	Optimisation of enzyme and industrial compounds production using bioreactor	7
8.	Filtration	8
9.	Cell disruption	9
10.	Chromatography	10-12
11.	Microbial fuel cell design	13
12.	Optimisation of electrodes, catholyte	14
13.	Waste water treatment	15-16

I. Course Title : Rumen and Feed Biotechnology

II. Course Code : BTY 711

III. Credit Hours : 2 + 1

IV. Aim of the course

Understanding the rumen ecosystem and manipulation of rumen microbes.

V. Theory

Unit I

Rumen ecosystem – Classification of rumen microbes – Isolation – Cultural characters – Rumen fermentation – Techniques to increase production of rumen microbes – Metabolic inter-relationship between rumen microbes.

Unit II

Feed processing and preservation, Microbial bioconversion of lignin and cellulose rich feeds -Factors affecting delignification, Large scale bioconversion of substrates, Pretreatment of feeds, Chemical vs microbial treatment of feeds, Anti-nutritional factors present in feeds, Microbial detoxification of aflatoxins, Mimosine and other anti-metabolites present.

Unit III

Manipulation of rumen methane production – Addition of methane inhibitors.– Non-genetic manipulation of rumen microbes – Addition of antibiotics, Selective defaunation, Addition of fats, Addition of protein degradation protectants, Addition of buffer substances – Rumen escape proteins.

Unit IV

Genetic manipulation of rumen microflora to improve feed utilization -Manipulation of rumen microbes by recombinant DNA technology – Inter species H₂ transfer and its importance –Single cell protein (SCP) as animal feed-Rumen metagenomics-Methods of studying rumen metagenome-Conventional cloning and sequencing of metagenomic DNA-NGS based shot gun sequencing – Amplicon sequencing of 16 S/ 18S rRNA hyper variable regions –Bioinformatics analysis of metagenomic sequence data Use of probiotics-Microorganisms and proteins used as probiotics, Mechanism of action of probiotics, Immune response to probiotics, Anti-mutagenic and anti-tumour activities of probiotics.

VI. Practicals

- Introduction to feeds and fodders for ruminants
- Estimation of proximate principles, Fibre fractions in concentrates and roughages
- Methods for evaluating rumen fermentation parameters
- Sampling of rumen contents – Microbial and protozoal count – Fixing and staining of rumen protozoa and bacteria
- Estimation of rumen fermentation parameters-pH, Rumen NH₃-N, Lactic acid
- *In-vitro* Gas Production Test -(IVGPT)
- Rumen liquor analysis – Total volatile fatty acids – Individual volatile fatty acids- Ammonia Nitrogen
- TCA precipitable Nitrogen-Methane production
- Rumen microbial enzyme assay
- Isolation of DNA from rumen samples
- Rumen metagenome and Bioinformatics analysis of metagenomic sequence data

VII. Suggested Readings

- Huffnagle GB and Wernick S. 2007. *The Probiotics Revolution: The Definitive Guide to Safe, Natural Health*. Bantam Books.
- Kalidas S, Paliyath G, Pometto A and Levin RE. 2004. *Functional Foods and Biotechnology*. CRC Press.
- Roger A. 1989. *Food Biotechnology*. Cambridge Univ. Press.
- Hobson PN and Stewart CS. 1997. *The Rumen Microbial Ecosystem*.



S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Rumen ecosystem – Classification of rumen microbes	1-2
2.	Isolation and Cultural characters of rumen microbes	3-4
3.	Rumen fermentation – Techniques to increase production of rumen microbes	5-6
4.	Metabolic inter-relationship between rumen microbes	7
5.	Feed processing and preservation, microbial bioconversion of lignin and cellulose rich feeds -Factors affecting delignification, large scale bioconversion of substrates	8-9
6.	Pretreatment of feeds, chemical vs microbial treatment of feeds, anti-nutritional factors present in feeds	10-11
7.	Microbial detoxification of aflatoxins, mimosine and other anti-metabolites present.	12-13
8.	Manipulation of rumen methane production – addition of methane inhibitors	14-15
9.	Non-genetic manipulation of rumen microbes – addition of antibiotics, selective defaunation, addition of fats, addition of protein degradation protectants, addition of buffer substances – Rumen escape proteins.	16-17
10.	Genetic manipulation of rumen microflora to improve feed utilization -Manipulation of rumen microbes by recombinant DNA technology	18-19
11.	Inter species H ₂ transfer and its importance –Single cell protein (SCP) as animal feed	20
12.	Rumen metagenomics-Methods of studying rumen metagenome-conventional cloning and sequencing of metagenomic DNA	21-22
13.	NGS based shot gun sequencing – amplicon sequencing of 16S/ 18S rRNA hyper variable regions	23-24
14.	Bioinformatics analysis of metagenomic sequence data	25-26
15.	Use of probiotics-Microorganisms and proteins used as probiotics	27-28
16.	Mechanism of action of probiotics, immune response to probiotics.	29-30
17.	Anti-mutagenic and anti-tumour activities of probiotics.	31-32
Practical		
1.	Introduction to feeds and fodders for ruminants	1
2.	Estimation of proximate principles in concentrates and roughages	2
3.	Estimation of fibre fractions in concentrates and roughages	3
4.	Methods for evaluating rumen fermentation parameters	4
5.	Sampling of rumen contents – Microbial and protozoal count	5
6.	Fixing and staining of rumen protozoa and bacteria	6
7.	Estimation of rumen fermentation parameters-pH, Rumen NH ₃ -N, Lactic acid	7
8.	<i>In-vitro</i> Gas Production Test (IVGPT)	8
9.	Rumen liquor analysis – Total volatile fatty acids – Individual volatile fatty acids – Ammonia Nitrogen	9
10.	TCA precipitable Nitrogen-Methane production	10
11.	Rumen microbial enzyme assay	11
12.	Collection, isolation and quality check of DNA from rumen samples	12
13.	Rumen metagenome and Bioinformatics analysis of metagenomic sequence data	13

List of Journals

- *Animal Biotechnology*
- *Animal Genetics*
- *Animal Reproduction*
- *Cellular and Molecular Probe*
- *Current Science*
- *Genome Research*
- *Indian journal of Microbiology*
- *Journal of Clinical Microbiology*
- *Journal of Dairy Science*
- *Journal of Reproduction and Fertility*
- *Methods in Virus Research*
- *Nature*
- *Nature Biotechnology*
- *Nature Genetics*
- *Nucleic Acid Research*
- *PNAS*
- *Reproduction in Domestic Animals Science*
- *Theriogenology*
- *Trends in Biotechnology*
- *Trends in Genetics*
- *Viral Research*

e-Resources

www.cls.casa.colostate.edu/TransgenicCrops/teacherlinks
www.hpc.unm.edu/~aroberts/main/top5%25.htm
www.isaaa.org
www.ciat.cgiar.org/biotechnology/cbn/gines_mera_fund.htm
www.scidev.net/en/agriculture-and-environment/agri-biotech/links/publications-andinformation-services
www.biotechinstitute.org/programs/t_leader_program.html
www.sci-ed-ga.org/modules/dna/analogies.html
www.accessexcellence.org/AE/AEPC/WWC/1993
www.atschool.eduweb.co.uk/trinity/bio2.html
www.pub.ac.za/resources/teach.html
www.bio-link.org/biomaterial.htm
www.biotechnology.gov.au/index.cfm?event=object.showContent&objectID=B35A914C-DE3D-1A59-79F89FAA26F54E44
www.monsanto.com/products/techandsafety/technicalpubs/eduwebsites.asp
www.ejbiotechnology.info/content/vol5/issue3/teaching/01/index.html
www.ncbiotech.org/resource_center/for_educators/online_teaching_resources.html
www.ias.ac.in/currsci/dec252006/1594
www.ccoec.k12.ca.us/stsvcs/newteacher/rop/curr_rop_links2.html
www.scielo.cl/scielo.php?pid=S0717-34582003000100004&script=sci_arttext
www.sunysb.edu/ligase/Forstudents/BiotechTeachingCenter/biotechcenter.html
www.ca.uky.edu/agc/pubs/brei/brei3tg/brei3tg.htm
www.aggie-horticulture.tamu.edu/tisscult/biotech/biotechteach.html
www.ejbiotechnology.info/content/vol6/issue2/issues/2/index.html
<http://science.nhmccd.edu/biol/biolint.htm#dna>



<http://nhscience.lonestar.edu/biol/biolint.htm>
www.ingentaconnect.com/content/tandf/tсед/2000/00000022/00000009/art00007
www.buildingbiotechnology.com/free.php
www.biotechnologist2020.com/2008/04/teaching-jobs-in-bioinformatics.html
www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ613711
www.uq.edu.au/teaching-learning/index.html?page=61920
www.nature.com/nbt/journal/v18/n9/full/nbt0900_913b.html
www.fotodyne.com/literature/datasheets/E10700
www.biotethics.org/conferences/maastricht/partecipants.html
www.brookes.ac.uk/studying/courses/postgraduate/2008/biotech
www.bioweb.usc.edu/courses/2003-spring/documents/bisc406-notes_011603
www.agen.ufl.edu/~chyn/age2062/lect/lect_09/lect_09.htm
www.bioinformaticscourses.com/BIOL358/lectures.html
www.isis.vt.edu/~nstone/LifeSci/lect5.html
www.nwo.nl/nwohome.nsf/pages/NWOA_6Y2LGH_Eng
www.soi.wide.ad.jp/class/20040016
www.sciencetech.technomuses.ca/english/schoolzone/biotech.cfm
www.freevideolectures.com/biotech.html
www.agen.ufl.edu/~chyn/age4660/lect/lect_07/lect_07.htm
www.web.mit.edu/cheme/news/frontiers_2005.html

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Basic Veterinary Sciences

– Veterinary Extension Education

Preamble

(Veterinary Extension Education)

To ensure that academic and scientific developments in all fields of veterinary sciences and Animal Husbandry get translated into adoption by the beneficiaries, framing of contemporary courses in Veterinary Extension became essential. Livestock entrepreneurship course has been introduced at masters level. New courses at doctorate level like theory constructions in social sciences, facilitation for development and Management Extension Organizations were introduced for the first time in view of the importance of the same. Farm journalism has been shifted to Masters level. SSS-600-Statistics for Social Sciences (2+1) is made core course for M.V.Sc.

The national priorities/ international developments are given due importance and are aligned accordingly in the curriculum adequately to build required competencies of the students to meet challenges of current agricultural scenarios. The curriculum development emphasized on outcome-based approach, the social process of curriculum construction (involvement of stakeholders) and matching curriculum with job requirements for employability of students. A significant emphasis on the different developmental programmes and or initiatives of the Government of India are highlighted in the syllabi of the postgraduate and doctoral programmes. The following are the specific inclusions of topics/ units focusing on the recent national priorities/ international developments.

Course	Topic/ Unit Included
EXT 601: Development Perspectives of Extension Education (2 +1)	Extension approaches followed in current livestock development programmes, viz., Rashtriya Gokul Mission, National Livestock Mission, Rashtriya Krishi Vikas Yojana, Livestock Insurance Scheme, Livestock Health and Disease Control, Pashu Sanjivini, National Programme for Dairy Development, National Programme for Bovine Breeding, Aatmanirbhar Bharat Abhiyaan and digital initiatives such as E- Pashudhan Haat, National Animal Disease Reporting System for livestock development, etc.
EXT 607: Livestock Entrepreneurship (1+2)	Role of Government and Non-Government agencies in promoting entrepreneurship in India- eg. Atal Innovation Mission, Startup India, Mudra Bank Scheme, Dairy Entrepreneurship Development Scheme, Agri-Clinics & Agri-Business Centers (ACABC), Entrepreneurship Development and Employment Generation (EDEG)
EXT 609: Gender Empowerment and	Policies and programmes in empowering women



Course	Topic/ Unit Included
Livestock Development (1+0)	in general and livestock development in specific. eg. UJJAWALA, Pradhan Mantri Mahila Shakti Kendra, One Stop Centre Scheme, Mahila E-haat, STEP, etc.
EXT 704 Policies and Regulations in the Livestock Sector (1+0)	State, National and Global policies related to livestock sector WTO, IPR, HACCP, Sanitary and phyto-sanitary measures, Agriculture Produce and Livestock Marketing (APLM) Act, Animal Welfare, etc.
EXT 705 Educational Technology (2+1)	Digital Initiatives in Education, viz., SWAYAM (MOOCs platform) Swayam Prabha, National Digital Library, National Academic Depository, E-Shodh Sindhu, E Acharya, EVidhwaan, Agriculture Education Portal, e-KrishiShiksha, KrishiKosh, CeRA, National Educational Alliance for Technology (NEAT), etc.
EXT 707: Monitoring and Evaluation of Livestock Development Programmes (2+1)	Development of M&E plans and procedures for livestock developmental programmes using the participatory approach.



Course Title with Credit Load

M.V.Sc. in Veterinary Extension Education

Course Code	Course Title	Credit Hours
EXT 601	Development Perspectives of Extension Education	2+1
EXT 602	Communication for Livestock Development	1+1
EXT 603	Diffusion and Adoption of Innovations	2+1
EXT 604	Programme Planning and Evaluation	1+1
EXT 605	Research Methodology	2+1
EXT 606	Social Psychology and Group Dynamics	1+1
EXT 607	Livestock Entrepreneurship	1+2
EXT 608	Human Resource Management in Animal Husbandry Sector	1+1
EXT 609	Gender Empowerment and Livestock Development	1+0
EXT 610	Farm Journalism	1+1
SSS 600	Statistics for Social Sciences	2+1
EXT 611	Masters Seminar	1+0
EXT 612	Masters Research	0+30

Course Contents

M.V.Sc. in Veterinary Extension Education

- I. Course Title** : Development Perspectives of Extension Education
II. Course Code : EXT 601
III. Credit Hours : (2 +1)

IV. Aim of the courses

- To acquaint the students with different extension approaches and their implications in animal husbandry.
- To make students realise the importance of linkages among departments and various institutions.
- To acquaint the students with the recent development in extension.

V. Theory

Unit I

Important concepts in extension science; various schools of thought; Critical review and reflections on the philosophy and principles of extension.

Unit II

Implications of earlier extension efforts. Emerging issues, problems and challenges of animal husbandry extension education.

Unit III

Changing approaches – ToT approach, Education Approach, Farmer Participatory Approaches (PRA, RRA, PLA, PTD, PCD, etc.), Demand Driven approach, Market led extension, FSA, Commodity Specific Approach, Market led Extension; Classification of PRA, Differences between PRA and RRA; Global concepts of extension (SAARC, BRICS, US, Japan, UK, Philippines and Israel) and its application to Indian context. Privatization of extension. Public Private Partnership.

Unit IV

Extension approaches of State and Central Governments, ICAR, SVUs/ SAUs, NGOs, corporate and other organizations. Extension Advisory Services - Meaning, Concept - Challenges in Animal Husbandry Extension Advisory Services. Extension approaches followed in current livestock development programmes, viz., Rashtriya Gokul Mission, National Livestock Mission, Rashtriya Krishi Vikas Yojana, Livestock Insurance Scheme, Livestock Health and Disease Control, Pashu Sanjivini, National Programme for Dairy Development, National Programme for Bovine Breeding, Aatmanirbhar Bharat Abhiyaan and digital initiatives such as E-Pashudhan Haat, National Animal Disease Reporting System for livestock development, etc. Linkages between researcher-extension agent - livestock farmer-industry in the generation, Dissemination and commercialization of animal husbandry practices/ technologies.

VI. Practical

Study of the extension approaches, functions, roles, responsibilities, organizational



set-up of State Animal Husbandry Department/ Livestock Development Agency/ Dairy Federation/ Rural Development agencies, Study of selected FPOs, CIGs, NGOs, SHGs, etc. Critical analysis of cases on linkage between different actors of animal husbandry sector.

VII. Suggested Reading

- Anandajayasekeram P, Puskur R, Sindu Workneh and Hoekstra D. 2008. *Concepts and practices in agricultural extension in developing countries*: A source book. IFPRI (International Food Policy Research Institute), Washington, DC, USA, and ILRI (International Livestock Research Institute), Nairobi, Kenya. 275 pp.
https://cgspace.cgiar.org/bitstream/handle/10568/99/Source_book.pdf
- Ashok G, Sharma P, Anisha S and Prerna T. 2018. *Agriculture Extension System in India Review of Current Status, Trends and the Way Forward*, Indian Council for Research on International Economic Relations (ICRIER).
<http://icrier.org/pdf/Agriculture-Extension-System-in-India-2018.pdf>
- Bitzer V, Wongtschowski M, Hani M and Blum M. 2016. *New directions for inclusive Pluralistic Service Systems. In New Directions for Inclusive Pluralistic Service Systems* Rome (Italy). FAO. <http://www.fao.org/3/a-i6104e.pdf>
- Burton ES and Kristin D. 2014. *Status of Agricultural Extension and Rural Advisory Services Worldwide*. GFRAS: Lindau, Switzerland.
<http://www.g-fras.org/en/knowledge/gfras-publications.html?download=391:status-of-agricultural-extension-and-rural-advisory-services-worldwide>
- Burton ES, Robert PB and Andrew JS. 1997. *Improving agricultural extension A reference manual*, FAO Rome
https://www.oerafrica.org/FTPFolder/Website%20Materials/Agriculture/haramaya/Perspective_Agricultural_Extension/Attachment/Improving%20AgEx.-FAO.pdf
- Dahama OP and Bhatnagar OP. 1987. *Education and Communication for Development*. Cambridge Univ. Press.
- Davis K and Sulaiman RV. 2016. *Extension Methods and Tools*. Module 2 NELK. GFRAS.
<https://www.g-fras.org/en/component/phocadownload/category/70-new-extensionist-learning-kit-nelk.html?download=560:nelk-module-2-extension-methods-and-tools-textbook>
- Dharma OP. 2017. *Development Perspectives in Extension Education* Agro Tech Publishing Academy, Udiapur
- FAO. 2016. *New directions for inclusive Pluralistic Service Systems*. Report of FAO Expert Consultation. Food and Agriculture Organization of the United Nations and Royal Tropical Institute, Rome.
<http://www.fao.org/3/ai6103e.pdf>
- GFRAS. 2016. *The New Extensionist Learning Kit*.
<http://g-fras.org/en/knowledge/new-extensionist-learningkit-nelk.html#module-1-introduction-to-the-new-extensionist>
- Gwyn EJ and Garforth C. n.d. *The history, development, and future of agricultural extension*. FAO. Rome.
<http://www.fao.org/docrep/W5830E/w5830e03.htm>
- Rivera WM and Schram SG. (Ed). 1987. *Agricultural Extension World wide – Issues, Practices and Emerging Priorities*. Croome Helm,
- Roling N. 1988. *Extension science, information systems in agricultural development*. Cambridge University Press
- S Adolph B. 2011. *Rural Advisory Services Worldwide: A Synthesis of Actors and Issues*. GFRAS: Lindau, Switzerland.
<https://www.g-fras.org/en/knowledge/gfras-publications.html?download=6:rural-advisory-services-worldwide&start=40>
- Swanson BE. 2008. *Global Review of Good Agricultural Extension and Advisory Service Practices*. Food and Agriculture Organization of the United Nations. Rome.
<http://www.fao.org/docrep/pdf/011/i0261e/i0261e00.pdf>

- Van den Ban AW and Hawkins HS. 1998. *Agricultural extension- Chapter 10*, BSL, CBS Publishers and Distributors.

Course outlines

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Important concepts in extension science	1
2.	Various schools of thought in extension	2
3.	Critical review and reflections on the philosophy of extension	2
4.	Critical review and reflections on the principles of extension	1
5.	Implications of earlier extension efforts.	1
6.	Emerging issues, problems and challenges of animal husbandry extension education	2
7.	Changing approaches – ToT approach, Education Approach, Demand Driven approach, Market led extension, FSA, Commodity Specific Approach, Market led Extension	3
8.	Farmer participatory approaches (PRA, RRA, PLA, PTD, PCD, etc Classification of PRA, Differences between PRA and RRA;	3
9.	Global concepts of extension (SAARC, BRICS, US, Japan, UK, Philippines and Israel) and its application to Indian context	3
10.	Systems Concepts - FSA, Commodity Specific Approach, Market led Extension, Privatization of extension. Public Private Partnership	3
11.	Extension approaches of State and Central Governments, ICAR, SVUs/ SAUs, NGOs, corporate and other organizations	4
12.	Extension Advisory Services - Meaning, Concept - Challenges in Animal Husbandry Extension Advisory Services	2
13.	Extension approaches followed in current livestock development programmes, viz., Rashtriya Gokul Mission, National Livestock Mission, Rashtriya Krishi Vikas Yojna, Livestock Insurance Scheme, Livestock Health and Disease Control, Pashu Sanjivini, National Programme for Dairy Development, National Programme for Bovine Breeding, Aatmanirbhar Bharat Abhiyaan and digital initiatives such as E-Pashudhan Haat, National Animal Disease Reporting System for livestock development, etc.	2
14.	Linkages between researcher-extension agent - livestock farmer-industry in the generation of animal husbandry practices/ technologies	1
15.	Linkages between researcher-extension agent - livestock farmer-industry in the dissemination and commercialization of animal husbandry practices/ technologies	1
	Total	32
Practicals		
1.	Study of the extension approaches, functions, roles, responsibilities	1
2.	Organizational set-up of State Animal Husbandry Department	1
3.	Organizational set-up dairy/ rural development agencies	2
4.	Organizational set-up of ICAR institutions	2
5.	Study on the formation of FPOs – principles, practices, requirements, procedures	2
6.	Study on the formation of CIGs - principles, practices, requirements, procedures	2
7.	Study on the formation of SHGs principles, practices, requirements, procedures	1



S. No.	Topic	No. of Lectures/ Practicals
8.	Role of NGOs in developmental perspectives	1
9.	Critical analysis of cases on linkage between different actors of animal husbandry sector.	2
10.	Critical analysis of livestock development programmes	2
	Total	16

I. Course Title : Communication for Livestock Development

II. Course Code : EXT 602

III. Credit Hours : (1+1)

IV. Aim of the course

To acquaint students with dynamics of communication and apply in development of livestock sector.

V. Theory

Unit I

Communication- meaning, concept, purpose and process of communication- Models and theories of communication: Aristotle, Berlo, Osgood Schramm, Shanon and Weaver, Johari window, New Comb, Westley and McLean, etc. Critical analysis of models and theories of communication. Recent developments in communication theories and models.

Unit II

Types of communication-intrapersonal, interpersonal, verbal and non-verbal; Criteria of effective communication, Determinants of communication- Empathy, credibility, fidelity, distortion, feedback and barriers to effective communication; Group and mass communication. Key communicators and their role in livestock development. Organizational Communication - formal- informal; downward-upward- horizontal; Problems in organizational communication.

Unit III

Business Communication: Relevance and importance in livestock business development. Features of business communication, Guidelines for business communication, formal and informal business communication, Various types of business communication (Letters, Reports, Proposals, Manuals, Outreach writing (Advertisements, Pamphlets, Signs, Press Release, etc.). Effective business communication.

Unit IV

ICT-concept, importance and types of tools and applications; Role and significance of ICT tools in Animal Husbandry Development - Use and importance of Social Media in livestock development. Overview of emerging technologies.

VI. Practical

Exercises in improving communication skills (Speaking skill – Public speaking, Persuasive speech, Informative speech, etc.) Exercises on Listening, Exercises on Reading, Exercises on Non-verbal communication, Writing of Business Communication, Identification of key communicators, Communication barriers,

distortion and fidelity in livestock development. Identification of different social media tools used for livestock development; Comparative study of different tools and their areas of applications in animal husbandry sector; Hands on experience in writing blogs; ICT tools in Animal Husbandry Extension delivery system; Analysis of web portals – KVK portals, Knowledge portal, ICAR, SAUs, etc.

VII. Suggested Reading

- Bhagat Amit K. *Communication as a Management Tool: Principles and Practices*. Akhand Publishing House, New Delhi. 2012
- Cragan FJ and Wright WD. 1999. *Communication in Small Groups – Theory, Process, Skills*. Wadsworth Publ.
- Mcquail D and Windahl S. 1993. *Communication Models for the Study of Mass Communications*. Longman Publ.
- Ray GL. 2011. *Extension, Communication and Management*. Kalyani Publishers, Ludhiana.
- Rogers EM and Shoemaker FF. 1971. *Communication of Innovations: A Cross – Cultural Approach*. The Free Press.
- Roloft Michael F. 1981. *Interpersonal Communication*. Sage Publ.
- Ruben Brent D. *Communication and Human Behaviour*. McMillan Publishing Company. New York. 1984.
- Sehgal MK and Khetrapal V. 2008. *Business Communication*. Excel Books. New Delhi.
- Srinivasa Raju Melkote and H Leslie Steeves. 2001. *Communication for Development Theory and Practice for empowerment and social justice*. Sage Publications
- Andres D and Woodard J. 2013. *Social media handbook for agricultural development practitioners*. Publication by FHI360 of USAID.
<http://ictforag.org/toolkits/social/SocialMedia4AgHandbook.pdf>
- Barber J, Mangnus E and Bitzer V. 2016. *Harnessing ICT for agricultural extension*. KIT Working Paper 2016: 4.
https://213ou636sh0ptphd141fqi1-wpengine.netdna-ssl.com/sed/wp-content/uploads/sites/2/2016/11/KIT_WP2016-4_Harnessing-ICT-for-agricultural-extension.pdf
- Bheenick K and Bionyi I. 2017. *Effective Tools for Knowledge Management and Learning in Agriculture and Rural Development*. CTA Working paper.
https://publications.cta.int/media/publications/downloads/1986_PDF.pdf
- FAO 2011. *E-learning methodologies a guide for designing and developing e-learning courses*. Food and Agriculture Organization of the United Nations.
<http://www.fao.org/docrep/015/i2516e/i2516e.pdf>
- George T, Bagazonzya H, BallantyneP, Belden C, Birner R, Del CR and Treinen S. 2017. *ICT in agriculture: connecting smallholders to knowledge, networks, and institutions*. Washington, DC: World Bank.
https://openknowledge.worldbank.org/handle/10986/12613_16
- Mayer RE. 2005. *The Cambridge handbook of multimedia learning*. New York: University of Cambridge.
- Mittal N, Surabhi, Gandhi, Sanjay and Gaurav T. 2010. *Socio-Economic Impact of Mobile Phones on Indian Agriculture*. ICRIER Working Paper No. 246, Indian Council for Research on International Economic Relations (ICRIER), New Delhi.
- Saravanan R and Suchiradipta B. 2016. *Social media policy guidelines for agricultural extension and advisory services, GFRAS interest group on ICT4RAS, GFRAS: Lindau, Switzerland*.
www.g-fras.org/en/knowledge/gfras-publications.html?download=415:social-media-policy-guidelines-for-agricultural-extension-and-advisory-services
- Saravanan R. 2010. (Ed.) *ICTs for Agricultural Extension: Global Experiments, Innovations and Experiences*, New India Publishing Agency (NIPA), New Delhi.



http://www.saravananraj.net/wp-content/uploads/2014/12/32_India ICTs-for-Agricultural-Extension_Saravanan.pdf

- World Bank. 2017. *ICT in Agriculture (Updated Edition): Connecting Smallholders to Knowledge, Networks, and Institutions*. Washington, DC: World Bank.
<https://openknowledge.worldbank.org/handle/10986/27526>

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Communication – meaning, concept, purpose of communication	1
2.	Models and theories of communication: Aristotle, Berlo, Osgood Schramm, Shanon and Weaver, Johari window, New Comb, Westley and McLean, etc.	1
3.	Critical analysis of models and theories of communication.	1
4.	Recent developments in communication theories and models	1
5.	Types of communication-intrapersonal, interpersonal, verbal and non-verbal;	1
6.	Criteria of effective communication, Determinants of communication-Empathy, credibility, fidelity, distortion, feedback	1
7.	Barriers for effective communication	1
8.	Group and mass communication. Key communicators and their role in livestock development	1
9.	Organizational Communication - formal- informal; downward-upward-horizontal; Problems in organizational communication	1
10.	Key communicators and their role in livestock development	1
11.	Business Communication: Relevance and importance in livestock business development	1
12.	Features and guidelines for business communication, Formal and informal business communication	1
13.	Various types of business communication (Letters, Reports, Proposals, Manuals, Outreach writing (Advertisements, Pamphlets, Signs, Press Release, etc.) Effective business communication	1
14.	ICT-concept, importance and types of tools and applications; Role and significance of ICT tools in Animal Husbandry Development	1
15.	Use and importance of Social Media in livestock development.	1
16.	Overview of emerging technologies	1
	Total	16
Practicals		
1.	Exercises in improving communication skills – Oral Communication	1
2.	Exercises in improving communication skills – Public speaking	1
3.	Exercises in improving communication skills – Persuasive speech	1
4.	Exercises in improving communication skills –Informative speech	1
5.	Exercises on Listening skills	1
6.	Exercise on Reading skills	1
7.	Exercise on Non-verbal communication	1
8.	Writing of Business Communications	1
9.	Identification of key communicators	1
10.	Role of key communicators	1
11.	Communication barriers	1
12.	Distortion and Fidelity of communication in livestock development.	1
13.	Importance of feedback in communication	1
14.	Identification of different social media tools used for livestock development	1
15.	Comparative study of different tools and their areas of applications in animal husbandry sector	1



S. No.	Topic	No. of Lectures/ Practicals
16.	ICT tools in Animal Husbandry Extension delivery system- analysis of web portals – KVK portals, Knowledge portal, ICAR, SAUs, etc.	1
	Total	16

I. Course Title : Diffusion and Adoption of Innovations

II. Course Code : EXT 603

III. Credit Hours : (2+1)

IV. Aim of the course

To sensitize the students to technology generation, dissemination and its adoption through effective communication

V. Theory

Unit I

Concept, meaning, importance of diffusion. Elements in diffusion process; Models and theories of diffusion.

Unit II

Concept, meaning, importance of adoption. Steps in adoption process. Adoption models; Stages in diffusion-adoption process; Innovation- Decision Process, Adopter categories and their characteristics. Factors influencing adoption. Attributes of innovations, Factors affecting the rate of adoption and sources of information. Consequences of innovations.

Unit III

Adopter categories and their characteristics. Identification and evaluation of innovations in livestock sector – Attributes, Reason for adoption, Non-adoption and Discontinuance, Consequences. Diffusion and adoption of livestock sectoral innovations.

Unit IV

Agricultural Innovation System – Origin of innovation system - Concepts and elements; Innovation vs Invention, Innovation and types of innovation; Innovations in livestock sector; Role of enabling environment; Methodologies for AIS Diagnosis; Capacity Development in AIS.

VI. Practical

Identification of adopter categories in the selected village, Study on attributes of innovation of selected dairy farming technologies/ sheep/ goat/ poultry farming technologies. Identification of sources of information at different stages of adoption on selected livestock technologies; Study of factors increasing or retarding the rate of adoption; Consequences of adoption of livestock technologies; Case studies in of Agricultural Innovation System, Presentation of reports on adoption and diffusion of innovations

VII. Suggested Reading

- Brown Lawrence A. 1981. *Innovation Diffusion: A New Perspective. Communication for Social Change.* Sage Publ.



- Cragan FJ and Wright WD. 1999. *Communication in Small Groups – Theory, Process, Skills*. Wadsworth Publ.
- Dasgupta. 1989. *Diffusion Agricultural Innovations in Village India*.
- Hall A, Sulaiman RV, Beshah T, Madzudzo E and Puskur R. 2009. *Agricultural innovation system capacity development: Tools, principles or policies?* Capacity.org (37): 16-17. http://www.capacity.org/en/journal/practice_reports/tools_principles_or_policies
- ILRI. 2014. *Innovation Platform practice briefs*. International Livestock Research Institute. <https://clippings.ilri.org/2014/02/03/ipbrief1/>
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- Ray GL. 2005. *Extension Communication and Management*. Kalyani Publishers, AA. 1987.
- Rogers EM. 2003. *Diffusion of Innovations*. Free Press.
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- World Bank. 2006. *Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems*. Washington, DC: World Bank. © World Bank. <https://openknowledge.worldbank.org/handle/10986/7184>
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Course outlines

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Concept, Meaning, Importance of diffusion with special reference to Livestock Sector	1
2.	Elements in diffusion process	1
3.	Models and theories of diffusion	2
4.	Concept, meaning, importance of adoption	1
5.	Steps in adoption process. Adoption models	2
6.	Stages in diffusion-adoption process; Innovation- Decision Process	2
7.	Adopter categories and their characteristics.	1
8.	Factors influencing adoption	1
9.	Attributes of innovations	1
10.	Factors affecting the rate of adoption and sources of information.	1
11.	Consequences of innovations.	2
12.	Adopter categories and their characteristics	2
13.	Identification and evaluation of innovations in livestock sector – attributes, reason for adoption, non-adoption and discontinuance, Consequences.	3
14.	Diffusion and adoption of livestock sectoral innovations	2
15.	Agricultural Innovation System – origin of innovation system - concepts and elements	2
16.	Innovation vs Invention, Innovation and types of innovation	2
17.	Innovations in livestock sector	1
18.	Role of enabling environment; Methodologies for AIS Diagnosis	3
19.	Capacity Development in AIS	2
	Total	32



S. No.	Topic	No. of Lectures/ Practicals
Practicals		
1.	Identification of adopter categories in the selected village	2
2.	Study on the attributes of innovation of selected dairy farming technologies	2
3.	Attributes of innovation of selected sheep/ goat/ poultry farming technologies	2
4.	Identification of sources of information at different stages of adoption on a selected livestock technologies	2
5.	Study of factors increasing or retarding the rate of adoption	2
6.	Consequences of adoption of livestock technologies	2
7.	Case studies in of Agricultural Innovation System	2
8.	Presentation of reports on adoption and diffusion of innovations	2
	Total	16

I. Course Title : Programme Planning and Evaluation

II. Course Code : EXT 604

III. Credit Hours : 1+1

IV. Aim of the course

To expose the students to programme planning, Monitoring and evaluation of animal husbandry development programmes.

V. Theory

Unit I

Genesis and importance of programme planning. Objectives, principles and steps in programme planning process. Role of animal husbandry extension agencies and stakeholders in planning and implementation of Animal Husbandry Extension programmes.

Unit II

Participatory Programme planning: Meaning, Role and Benefits; Stakeholders Participation in Development - Identify Key Stakeholders, Examine Stakeholder's Interests and Impact of the Project, Assess Stakeholder Power and Interest, Outline a Stakeholder Participation Strategy.

Unit III

Meaning and Scope of Monitoring; Basic Concepts and Elements in Monitoring; Types of Monitoring; Techniques of Monitoring; What is Evaluation? Appraisal vs. Monitoring vs. Evaluation vs. Impact Assessment – Major differences; Types of Evaluation, Evaluation Designs.

Unit IV

Project Management Techniques- Gantt chart, Programme Evaluation and Review Technique (PERT). Critical Path Method (CPM). Project formulation. Project appraisal in terms of social benefit analysis, logical frame work. Various stakeholders in livestock development; stakeholder analysis, and report writing.

VI. Practical

Preparation of comprehensive livestock development programme for a village.



Developing instruments for monitoring and evaluation of on-going development programme at village level (Logical Frame Work). Participatory techniques (RRA, PRA, Case study, etc.). SWOT analysis of a livestock development programme.

VII. Suggested Reading

- Bagno IB. 2014. *Conducting participatory monitoring and evaluation*. Pages 81-85 in FAO, Decision tools for family poultry development.
- Baker H. 1984. *The program planning process*. Pages 50-64 in D. Blackburn (ed.), Extension handbook. Guelph, Ontario, Canada: University of Guelph.
- Baum WC and Tolbert SM. 1985. *Investing in Development: Lessons of the World Bank Experience*, Oxford University Press.
- Bennett CF. 1979. *Analyzing impacts of extension programs*. Washington, D.C., USA: U.S. Department of Agriculture.
- Choudhary S. 1988. *Project Management*, New Delhi: Tata McGraw Hill.
- Dale R. 2004. *Evaluating Development Programmes and Projects*, New Delhi, India: Sage Publications
- Fear FA. 1988. *Community needs assessment: A crucial tool for adult educators*. Paper presented at the MAACE Midwinter Conference, February 1988, Lansing, Michigan, USA.
- GFRAS. 2017. *The New Extensionist Learning Kit*. 13 Learning Modules for Extension Professionals. Lausanne, Switzerland, Global Forum for Rural Advisory Services GFRAS.
- Harold Kerzner. 2013. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*. Wiley
- Hoffman V, Christinck A and Lemma M. (eds.). 2009. *Rural Extension*. Margraf Publishers GmbH.
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- Mukherjee N. 2002. *Participatory Learning and Action with 100 field Methods*. Concept Publishing Company, New Delhi.
- Rietbergen MJ and Narayan D. 1997. *Participatory tools and techniques: A resource kit for participation and social assessment*. Washington, D.C., USA: The World Bank. Accessed at: www.fao.org/ag/againfo/programmes/en/lead/toolbox/Refer/STkHold.htm
- Roling N. 1988. *Extension science: information systems in agricultural development*, Cambridge University Press.
- Scott Bercun. 2008. *Making Things Happen – Mastering Project Management*. O'Reilly Publishers
- Somesh K. 2002. *Methods for Community Participation - A Complete Guide for Practitioners*. Vistar Publications New Delhi.
- Suvedi M and Kaplowitz MD. 2016. *Process Skills and Competency Tools – What Every Extension Worker Should Know – Core Competency Handbook*. Urbana, IL, USAID-MEAS.
- Van den Ban AW and Hawkins HS. 2002. *Agricultural extension*, CBS Publishers and Distributors, New Delhi.

Course outlines

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Genesis and importance of programme planning in Animal Husbandry Sector	1
2.	Objectives, principles and steps in programme planning process	1
3.	Role of animal husbandry extension agencies and stakeholders in planning and implementation of animal husbandry extension programmes	1
4.	Participatory Programme planning – Meaning, Role and Benefits	1



S. No.	Topic	No. of Lectures/ Practicals
5.	Stakeholders Participation in Development - Identify Key Stakeholders, Examine Stakeholder's Interests and Impact of the Project	1
6.	Assess Stakeholder Power and Interest, Outline a Stakeholder Participation Strategy;	1
7.	Meaning and Scope of Monitoring; Basic Concepts and Elements in Monitoring; Types of Monitoring;	2
8.	Techniques of Monitoring; What is Evaluation? Appraisal vs. Monitoring vs. Evaluation vs. Impact Assessment – Major differences;	1
9.	Types of Evaluation, Evaluation Designs;	1
10.	Project Management Techniques- Gantt chart, Programme Evaluation and Review Technique (PERT). Critical Path Method (CPM)	2
11.	Project formulation, Project appraisal in terms of social benefit analysis, logical frame work	1
12.	Various stakeholders in livestock development;	2
13.	Stakeholder analysis, and report writing.	1
	Total	16
Practicals		
1.	Preparation of comprehensive livestock development programme for a village	3
2.	Developing instruments for monitoring and evaluation	2
3.	Identification of key stakeholders in the livestock development	1
4.	Application of developed instruments for monitoring and evaluation of on-going development programme at village level (Logical Frame Work)	2
5.	Data collection and analysis of on-going development programme of a village	2
6.	Simulated exercises on Project Management Techniques - Gantt chart, PERT, CPM	3
7.	SWOT analysis of a livestock development programmes	1
8.	Report preparation and presentation	2
	Total	16

I. Course Title : Research Methodology

II. Course Code : EXT 605

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge and skills in formulating and conducting an independent research in the field of Animal Husbandry Extension.

V. Theory

Unit I

Concept, nature and scope of research in social sciences. Types of research-fundamental, applied and action research, experimental and non-experimental research. Identification of concepts, constructs, variables. Hypothesis– importance, selection criteria (qualities of a workable hypothesis), formulation and testing of hypothesis. Selection and formulation of research problem.

Unit II

Measurement and levels of measurement; Research designs- exploratory,



experimental, and ex-post-facto research design. Sampling -Sampling methods- probability and non-probability sampling. Sources of errors.

Unit III

Methods of data collection– survey method, observation method, interview/questionnaire method, case study, content analysis, sociometry, focus group discussion, projective techniques, Online tools of data collection, Reliability and validity of measuring instruments.

Unit IV

Social statistics – designs in data analysis, Parametric and Non-Parametric statistical methods. Data analysis and interpretation and inference, Report writing. Review of studies in social research.

VI. Practical

Construction of data collection tools, GPS-enabled data collection, Development of online tools of data collection (Google Forms, Survey Monkeys, etc.) Application of statistical software for data analysis and interpretation. Creative scientific thinking, selecting a research problem and working it out with all the steps; report writing and presentation of the reports.

VII. Suggested Reading

- Arlene Fink (Ed). 2003. *The Survey Kit* (10 booklets). Sage Publ.
- Babbie E. 2008. *The basics of social research*. 4th ed. Belmont, CA, USA; Thompson Wordsworth.
- Creswell JW. 2009. *Research design: Qualitative, quantitative, and mixed methods approaches*. Third edition. Thousand Oaks: Sage Publications.
- Creswell John W. 1994. *Research Design – Qualitative and Quantitative Approaches*. University of Nebraska, Lincoln.
- Creswell JW. 2012. *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Fourth edition. Boston, MA: Pearson.
- Edwards AL. 1969. *Techniques of Attitude Scale Construction*. Vakil, Feffer and Simons
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- Goode WJ and Hatt PK. 1952. *Methods in Social Research*. McGraw-Hill.
- Guilford JP. 1971. *Psychometric Methods*. TATA McGraw Hill.
- Henerson EM, Morris LL. and Gibbon CT. 1987. *How to Measure Attitudes*. Sage Publ.
- Kerlinger FN and Lee HB. 2000. *Foundations of Behavioral Research*. Orlando, FL: Harcourt College Publishers.
- Kumar R. 2014. *Research Methodology: A Step –by - Step Guide for Beginners*. Fourth Edition. Thousand Oaks, California: Sage Publications.
- Miller Delbert C. 1991. *Handbook of Research Design and Social Measurement*. Indiana University. Sage Publ.
- Neuman WL. 2006. *Social Research Methods: Qualitative and Quantitative Approaches*. Toronto: Pearson.
- Oppenheim AN. 1979. *Questionnaire Design and Attitude Measurement*. Heinemann Educational Books.
- Sekaran U and Bougie R. 2013. *Research Methods for Business A Skill-Building Approach*. 6th Edition, Wiley, New York.
- Sivakumar PS, Sontakki BS, Sulaiman RV, Saravanan R and Mittal N. (eds). 2017. *Good Practices in Agricultural Extension Research. Manual on Good Practices in Extension Research and Evaluation. Agricultural Extension in South Asia*. Centre for research on innovation and science and policy (CRISP), Hyderabad. India.

**Course Outline**

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Concept, nature and scope of research in social sciences, scientific vs nonscientific approaches,	1
2.	Research - Characteristics of research, Approaches of Research	1
3.	Types of Research (Pure/ Basic; Evaluative, Fundamental, applied and action research)	1
4.	Experimental and non-experimental research	1
5.	Identification of concepts, constructs, variables	1
6.	Hypothesis and its importance, Characteristics and sources and Classification of hypothesis	1
7.	Selection criteria (qualities of a workable hypothesis)	1
8.	Formulation and testing of hypothesis	1
9.	Selection and formulation of research problem	1
10.	Measurement and levels of measurement	1
11.	Research Designs - Exploratory research design	1
12.	Research Designs Experimental research design	1
13.	Research Designs Ex-post-facto research design	1
14.	Sampling- concept, meaning importance in social sciences	1
15.	Sampling methods - Probability Sampling and Non-Probability sampling	1
16.	Sources of errors	2
17.	Methods of data collection: Over view of different tools of data collection, selection of appropriate method	1
18.	Survey method – Purpose, Types, Planning a survey, advantages and limitations	1
19.	Observation Method - Purpose, Types, Planning for observation, advantages and limitations	1
20.	Interview/ questionnaire method - Purpose, Types, Planning an Interview/ questionnaire, advantages and limitations	1
21.	Case study - Purpose, Planning a case study, advantages and limitations	1
22.	Content analysis	1
23.	Focus Group Discussion	1
24.	Sociometry and projective techniques	1
25.	Online tools of data collection – concept, meaning, importance and types in social research	1
26.	Reliability of measuring instruments – definition, importance in social sciences, Methods to test reliability	1
27.	Validity of measuring instruments - definition, importance in social sciences, Types of validity	1
28.	Social statistics – designs in data analysis – criteria for choosing a right a right design and analysis	1
29.	Parametric and Non-Parametric statistical methods – use and significance; types of tests used in social research with implications	1
30.	Data analysis and interpretation and inference	2
31.	Report writing	1
32.	Review of studies in social research	1
	Total	32
Practicals		
1.	Construction of different data collection tools relevant to livestock sector	2
2.	GPS-enabled data collection	3



S. No.	Topic	No. of Lectures/ Practicals
3.	Development of online tools of data collection (Google Forms, Survey Monkeys, etc.)	2
4.	Application of statistical software for data analysis and interpretation	3
5.	Creative scientific thinking	1
6.	Selecting a research problem and working it out with all the steps	3
7.	Report writing and presentation of the report.	2
	Total	16

I. Course Title : Social Psychology and Group Dynamics

II. Course Code : EXT 606

III. Credit Hours : 1+1

IV. Aim of the course

To acquaint the students with the structure and functioning of social groups and socio psychological aspects in interacting with livestock farmers.

V. Theory

Unit I

Concepts, scope and importance of psychology and social psychology in animal husbandry extension, Perception - nature, laws and selectivity in perception, factors in perception, importance of perception in extension work, Attitude - nature, theories, measurement and change of attitude towards livestock farming, Importance of attitude scales in livestock research and development.

Unit II

Motivation- nature, characteristics, theories, types and techniques of motivating farmers, Learning- principles, theories of learning and experiential learning and adult learning (andragogy).

Unit III

Intelligence- nature, theories and measurement, Personality- nature, traits, types, biological and socio-cultural determinants of personality, Group and individual behaviour.

Unit IV

Concept and types of groups; Group behaviour and dynamics: structures - attraction, coalition, communication and power; group mobilisation – social capital, group decision making, Factors affecting group performance; Conflict management in groups; Group belongingness, Community Mobilization, Importance of coordination among livestock development organisations.

VI. Practical

Study of groups and group dynamics (eg.: Self Help Groups (SHGs), Milk Cooperative Societies, Commodity groups and Farmer producer Company/ organization (FPO), Joint Liability Group (JLG), youth clubs, etc.). Exercises on measurement of motivation, perception and personality traits.

VII. Suggested Reading

- Cragan FJ and Wright WD. 1999. *Communication in Small Groups – Theory, Process, Skills*. Wadsworth Publ.
- Donelson R. Forsyth, *Group Dynamics* 2018 7th Edition, Cengage Learning
- Joseph Bohac and Stan Dekoven 2013. *Group Dynamics*. Vision Publishing (Ramona, CA)
- Kagan J and Havemann E. 1980. *Psychology – An Introduction*. Harcourt Brace Javanovich Inc.
- Morgan CT, King RA and Robinson NM. 1979. *Introduction to Psychology*. Tata McGraw-Hill.
- Napier RW and Gershenfeld MK. 2006. *Groups – Theory and Experience*. AITBS Publ.
- Robert A Baron. *Social Psychology*. 2016. 13th Edition Pearson Education
- Secord PF and Backman CW. 1964. *Social Psychology*. McGraw-Hill.

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Concepts, scope and importance of psychology and social psychology in animal husbandry extension	1
2.	Perception - nature, laws and selectivity in perception	1
3.	Attitude - nature, theories, measurement and change of attitude towards livestock farming. Importance of attitude scales in livestock research and development.	1
4.	Motivation– nature, characteristics, theories, types and techniques of motivating farmers.	2
5.	Learning- principles, theories of learning and experiential learning and adult learning (andragogy).	2
6.	Intelligence- nature, theories and measurement.	1
7.	Personality- nature, traits, types, biological and socio-cultural determinants of personality.	1
8.	Group and individual behaviour.	1
9.	Concept and types of groups; Group behaviour and dynamics: structures - attraction, coalition, communication and power; group mobilisation – social capital, group decision making	2
10.	Factors affecting group performance;	1
11.	Conflict management in groups;	1
12.	Group belongingness, Community Mobilization,	1
	Total	16
Practicals		
1.	Study of Self Help Groups and their group dynamics	2
2.	Study of Milk Cooperative Societies and their group dynamics	2
3.	Study of Commodity Interest groups (CIGs)	2
4.	Study of Farmer Producer Company/ organization (FPO)	2
5.	Study of Joint Liability Group (JLG) and youth clubs, etc.	2
6.	Exercises on measurement of motivation	2
7.	Exercises on measurement of perception	2
8.	Exercises on measurement of personality traits	2
	Total	16



- I. Course Title : Livestock Entrepreneurship**
II. Course Code : EXT 607
III. Credit Hours : 1+2

IV. Aim of the courses

- To orient the students on basic concepts of entrepreneurship and the initiatives in promoting livestock as an enterprise.
- To impart knowledge in the various facets of entrepreneurial management and consumer behaviour for establishment of livestock ventures.

V. Theory

Unit I

Entrepreneurship - Role of Entrepreneurship in Economic Development of the country and current scenario and future prospects; Factors influencing Entrepreneurship (Internal factors, External factors, Political factors, Socio-Cultural Environment, Legal and Technological Environment); Role of Government and Non-Government agencies in promoting entrepreneurship in India- eg: Atal Innovation Mission, Startup India, Mudra Bank Scheme, Dairy Entrepreneurship Development Scheme, Agri-Clinics and Agri-Business Centers (ACABC), Entrepreneurship Development and Employment Generation (EDEG), etc.

Unit II

Livestock -Business Plan: Business Idea Generation, Brainstorming and evaluation of ideas, Competition, Scalability of the product, Price feasibility, Distribution and logistics, Ease of technology, Opportunities and threats, Internal strengths and weaknesses (SWOT analysis) Government regulations and statutory compliances, Sources of financial assistance.

Unit III

Livestock Business Evaluation: Evaluating financial feasibility, Cost of production and marketing, Project cost determination and fund requirement, Assessing working capital requirement, Non-fund based requirements (BG, LC), Cost of capital sources and cost of finance. Technical feasibility, Patents, Make or buy decision, Plant size and location, Machinery requirement, Outsourcing requirements, Project report and appraisal techniques- Net present value, Payback period, Break even analysis, CB Ratio.

Unit IV

Consumer Behaviour: Consumer behaviour- Definition, Consumer and customers, Buyers and users, Consumer behaviour and its applications in livestock marketing; Consumer behaviour models; Consumer motivation, Consumer perception, Consumer behaviour and marketing communications, Consumer decision-making process, Organizational buying behaviour, Modern marketing information system (marketing intelligence, communicating and acting on marketing intelligence).

VI. Practical

Exposure visits to commercial livestock enterprises- Dairy, Poultry, Meat/ Dairy/ Feed Processing Units. Analysis of successful cases of livestock entrepreneurship, Development of livestock business plans, Presentation of livestock business development plans, Study of consumer behavior, Critical analysis of livestock markets/ super markets/ malls.

VII. Suggested Reading

- Khanka SS. 1999. *Entrepreneurial Development*. S. Chand and Co.
- Gupta CB. 2001. *Management Theory and Practice*. Sultan Chand and Sons.
- Grover I. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public
- Nandan H. 2013. *Fundamentals of Entrepreneurship*, PHI publishers
- Reading material of Course AEM-202 *Agri-Business and Entrepreneurship Development*. <http://www.manage.gov.in/pgdaem/studymaterial/aem202.pdf>
- Hisrich RD, Peters MP and Shepherd A. 2007. *Entrepreneurship*, 6th Edition, Tata McGraw Hill
- Singh D. 1995. *Effective Managerial Leadership*. Deep and Deep Publ.
- Tripathi PC and Reddy PN. 1991. *Principles of Management*. Tata McGraw Hill.
- Desai V. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House.

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Entrepreneurship and its role in Economic Development of the country and current scenario and future prospects	1
2.	Factors influencing Entrepreneurship (Internal factors, External factors, Political factors, Socio - Cultural Environment, Legal and Technological Environment)	1
3.	Role of Government and Non-Government agencies in promoting entrepreneurship in India- eg: Atal Innovation Mission, Startup India, Mudra Bank Scheme, Dairy Entrepreneurship Development Scheme, Agri-Clinics and Agri-Business Centers (ACABC), Entrepreneurship Development and Employment Generation (EDEG), etc.	1
4.	Livestock -Business Plan: Business Idea Generation, Brainstorming and Evaluation of ideas, Competition, scalability of the product, Price feasibility, Distribution and Logistics Ease of Technology, Opportunities and Threats, Internal Strengths and Weaknesses (SWOT analysis)	2
5.	Government Regulations and statutory compliances, Sources of Financial Assistance	1
6.	Livestock Business Evaluation: Evaluating Financial Feasibility, Cost of Production and Marketing, Project Cost Determination and Fund requirement, assessing Working Capital Requirement, Non-fund based Requirements (BG, LC), Cost of Capital Sources and Cost of Finance	2
7.	Technical Feasibility, Patents, Make or Buy Decision, Plant Size and Location, Machinery Requirement, Outsourcing Requirements,	2
8.	Project Report and Appraisal Techniques- Net Present Value, Payback period, Break even analysis, CB Ratio	2
9.	Consumer Behaviour: Consumer Behaviour- Definition, Consumer and Customers, Buyers and Users, Consumer Behaviour and its Applications in Livestock Marketing;	1
10.	Consumer behaviour models; Consumer Motivation, Consumer Perception, Consumer Behaviour and Marketing Communications, Consumer Decision-making Process, Organizational Buying Behaviour,	2
11.	Modern marketing information system (marketing intelligence, communicating and acting on marketing intelligence).	1
	Total	16



S. No.	Topic	No. of Lectures/ Practicals
Practical		
1.	Visit to commercial livestock enterprises – Dairy, Poultry, any other economically important species of the region	5
2.	Visit to Meat/ Dairy/ Feed Processing Units	5
3.	Visit to any agri/ livestock start up	3
4.	Analysis of successful cases of livestock entrepreneurship	4
5.	Development of livestock business plans	4
6.	Presentation of livestock business development plans	3
7.	Study of consumer behavior	3
8.	Visit to livestock markets/ super markets/ malls and analysis	5
	Total	32

I. Course Title : Human Resource Management in Animal Husbandry Sector

II. Course Code : EXT 608

III. Credit Hours : 1+1

IV. Aim of the course

To make students understand human resource management techniques and deal organizational challenges effectively

V. Theory

Unit I

Concept, importance and functions of human resource management in animal husbandry sector. Process of management- planning, organizing, staffing, directing, coordination, reporting and budgeting. Principles, levels and types of organizations.

Unit II

Supervision- meaning, process and techniques. Work motivation. Job efficiency and job satisfaction.

Unit III

Organizational communication. Organizational climate. Conflict management.

Unit IV

Training– models, methods, Identification of training needs, Training evaluation and developing strategies for human resource development in animal husbandry sector. Capacity need assessment and personnel management in animal husbandry organizations.

VI. Practical

Training needs assessment farmers/ extension personnel, Development of training modules, Organization and evaluation of a training programme

VII. Suggested Reading

- Khanka SS. 1999. *Entrepreneurial Development*. S. Chand and Co.
- Gupta CB. 2001. *Management Theory and Practice*. Sultan Chand and Sons.
- BJ Lathi, Parag Narkhede and Vivek Yawalkar 2015. *Human Resource Management*, Prashant Publications.



- Noe RA, Hollenbeck JR, Gerhart B and Wright PM. 1997. *Human Resources Management: Gaining a competitive advantage*.
- Grover I. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public.
- Nandan H. 2013. *Fundamentals of Entrepreneurship*, PHI publishers.
- Reading material of Course AEM-202 *Agri-Business and Entrepreneurship Development*. <http://www.manage.gov.in/pgdaem/studymaterial/aem202.pdf>
- Hisrich RD, Peters MP and Shepherd A. 2007. *Entrepreneurship*, 6th Edition, Tata McGraw Hill.
- Singh D. 1995. *Effective Managerial Leadership*. Deep and Deep Publ.
- Tripathi PC and Reddy PN. 1991. *Principles of Management*. Tata McGraw Hill.
- Vasanta Desai. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House.

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Concept, importance and functions of human resource management in animal husbandry sector	1
2.	Process of management- planning, organizing, staffing, directing, coordination, reporting and budgeting	1
3.	Principles, levels and types of organizations	1
4.	Supervision- meaning, process and techniques	1
5.	Work motivation	1
6.	Job efficiency and job satisfaction	1
7.	Organizational communication	1
8.	Organizational climate	1
9.	Conflict management	1
10.	Training– concept, meaning, importance of training in Animal Husbandry	1
11.	Training models and methods	2
12.	Identification of training needs	1
13.	Training evaluation	1
14.	Capacity need assessment and Personnel management in animal husbandry organizations	1
15.	Developing strategies for human resource development in animal husbandry sector	1
	Total	16
Practical		
1.	Training needs assessment of livestock farmers	2
2.	Training needs assessment of poultry farmers	2
3.	Training needs assessment of extension personnel	2
4.	Development of training module	2
5.	Planning for training programme	3
6.	Organization of training programme	3
7.	Evaluation of training programme	2
	Total	16

I. Course Title : Gender Empowerment and Livestock Development

II. Course Code : EXT 609

III. Credit Hours : 1+0

IV. Aim of the course

To acquaint students with gender perspectives, empowerment and its importance



in livestock development, policies and programmes.

V. Theory

Unit I

Gender and empowerment: meaning and importance in livestock sector, Gender related concepts and importance of empowering women in livestock development; Need and focus on gender sensitization, Gender in community diversity and its implication for empowerment.

Unit II

Gender perspectives in development of women, Social characteristics, Roles, Responsibilities, Resources, Constraints, Legal issues and opportunities; Economical, educational and other parameters with special reference to livestock development.

Unit III

Gender tools and methodologies: Dimensions and methodologies for empowerment; Gender budgeting; Gender analysis framework- context, activities, Resources and programme action profile; Technologies and empowerment, Gender specific technologies, Household technology interface, Socio-cultural interface and women as consumers of technologies.

Unit IV

Policies and programmes in empowering women in general and livestock development in specific eg: UJJAWALA, Pradhan Mantri Mahila Shakti Kendra, One Stop Centre Scheme, Mahila E-haat, STEP, etc.

VI. Suggested Reading

- Grover I and Grover D. 2002. *Empowerment of Women*. Agrotech Publ. Academy.
- Porter F, Smyth I and Sweetman C. 1999. *Gender Works: Oxfarm Experience in Policy and Practice*. Oxfarm Publ.
- Raj MK. 1998. *Gender Population and Development*. Oxford Univ. Press.
- Sahoo RK and Tripathy SN. 2006. *SHG and Women Empowerment*. Anmol Publ.
- Sinha K. 2000. *Empowerment of Women in South Asia*. Association of Management Development Institution in South Asia, Hyderabad.
- Thakur Joshi S. 1999. *Women and Development*. Mittal Publ. Vishwanathan M. 1994. *Women in Agriculture and RD*. Rupa Books.
- Ramkumar S, Garforth C, Rao SVN and Waldie K. (Ed). 2001. *Landless Livestock Farming - Problems and Prospects*. RAGACOVAS, Pondicherry.
- Seth Mira 2001. *Women and Development – Indian Experience*. Sage Publ.
- Samanta RK. (Ed). *Women in Agriculture – Perspectives, Issues and Experiences*. MD Publ.
- Waldie K and Ramkumar S. 2002. *Landless Women and Dairying – Opportunities for Development within a Poverty Perspective*. RAGACOVAS, Pondicherry.
- *Gender and empowerment: Definitions, approaches, and implications for policy*
<http://genderandenvironment.org/resource/gender-and-empowerment-definitions-approaches-and-implications-for-policy/>
- Njuki, J., Waithanji, E., Bagalwa, N. and Kariuki, J. 2013. *Guidelines on integrating gender in livestock projects and programs*. Nairobi, Kenya: ILRI.
- <https://cgspace.cgiar.org/bitstream/handle/10568/33425/GenderInLivestock.pdf>
- <http://wcd.nic.in/womendevlopment/national-policy-women-empowerment>

**Course Outline**

S. No.	Topic	No. of Lectures
Theory		
1.	Gender and empowerment: meaning, importance in livestock sector	1
2.	Gender related concepts	1
3.	Importance of empowering women in livestock development	1
4.	Need and focus on gender sensitization,	1
5.	Gender in community diversity and its implication for empowerment	1
6.	Gender perspectives in development of women	1
7.	Gender- Social characteristics, roles, responsibilities, resources, constraints, legal issues and opportunities; economical, educational and other parameters with special reference to livestock development	2
8.	Gender tools and methodologies: Dimensions and methodologies for empowerment	1
9.	Gender budgeting	1
10.	Gender analysis framework- context, activities, resources and programme action profile	1
11.	Technologies and empowerment - Gender specific technologies	1
12.	Household technology interface, Socio-cultural interface	1
13.	Women as consumers of technologies	1
14.	Policies and programmes in empowering women in general and livestock development in specific - Eg: UJJAWALA, Pradhan Mantri Mahila Shakti Kendra, One Stop Centre Scheme, Mahila E-haat, STEP etc	2
	Total	16

I. Course Title : Farm Journalism

II. Course Code : EXT 610

III. Credit Hours : 1+1

IV. Aim of the course

To sensitize students about the role of print, electronic, digital and internet media for promoting animal husbandry sector.

V. Theory**Unit I**

Concept of farm journalism and communication. Journalism as a means of mass communication and its role in livestock development. Opportunities, strength and limitations. Ethics and principles of journalism for effective writing.

Unit II

Writing skills –Principles of writing - art of writing, News items, News stories, feature articles, Success stories, Magazines, bulletins, folders, etc. Fundamentals of lay-out in writing. Writing of research papers and popular articles in journals, Farm magazines and e-journals. Methods and techniques of broadcasting of farm programmes. Writing scripts for radio and televisions.

Unit III

Rapport building with different categories of clients involved in veterinary and animal husbandry extension programmes. Art of speaking. Importance of listening and reading. Writing for press news. Relations with press media. Event management,



Organization of press meet. Qualities of a good public relations manager. Role and importance of art of speaking, listening and reading skills

Unit IV

Types of internet based media- Writing for web- concepts, Writing for social media (Blogs, etc.) – Ethics and values. Development of Multimedia Modules.

VI. Practical

Designing and preparation of news stories, feature articles, success stories related to animal husbandry. Designing and preparation of Magazines, Pamphlets, folders, popular research articles, radio, T.V. scripts. Visit to Agricultural Technology Information Centre (ATIC) centre to record the activities of preparation, editing and publication of news articles and research publications.

VII. Suggested Reading

- Bhaskaran C, Prakash R and Kishore Kumar N. 2008. *Farm Journalism in Media Management*. Agro-Tech Publ. Academy.
- Chatterjee PC. 1991. *Broadcasting in India*. Sage Publ.
- Chiranjeev A. 1999. *Electronic Media Management*. Authors Press.
- D'Souza YK. 1998. *Principles and Ethics of Journalism and Mass Communication*. Commonwealth Publ.
- Defleur ML and Dennis EE. 2001. *Understanding Mass Communications*. Goyalsaab Publ.
- Jaico Publ. Malhan PN. 2004. *Communication Media: Yesterday, Today and Tomorrow*. Directorate of Publication Division, New Delhi.
- Jain SC. 2006. *International Marketing Management*. CBS Publ.
- Keval J Kumar. 2004. *Mass Communication in India*.
- Mehta DS. 1992. *Mass Communication and Journalism in India*. Allied Publ.
- Panigrahy D. 1993. *Media Management in India*. P. K. Biswasroy (Ed.). Kanishka Publ.
- Singh AK 2014. *Agricultural Extension and Farm Journalism*, Agrobios Publications

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Concept of farm Journalism and communication	1
2.	Journalism as a means of mass communication and its role in livestock development.	1
3.	Role journalism in livestock development	1
4.	Opportunities, Strength and limitations in farm journalism in livestock sector	1
5.	Ethics and principles of journalism for effective writing	1
6.	Writing skills –Principles of writing, art of writing, news items, news stories, feature articles, success stories, magazines, bulletins, folders, etc.	1
7.	Fundamentals of lay-out in writing	1
8.	Writing of research papers and popular articles in journals, farm magazines and e-journals	1
9.	Methods and techniques of broadcasting of farm programmes.	1
10.	Writing scripts for radio and televisions	1
11.	Writing for press news; Organization of press meet and Event management	1
12.	Relations with press media Qualities of a good public relations manager	1
13.	Types of internet based media- Writing for web- concepts, Writing for social media (Blogs, etc.) – Ethics and values.	1



S. No.	Topic	No. of Lectures/ Practicals
14.	Development of Multimedia Modules	1
15.	Rapport building with different categories of clients involved in veterinary and animal husbandry extension programmes	1
16.	Role and importance of art of speaking, listening and reading skills	1
	Total	16
Practicals		
1.	Designing and preparation of news stories related to animal husbandry.	1
2.	Designing and preparation of feature articles related to animal husbandry	1
3.	Designing and preparation of success stories related to animal husbandry	1
4.	Designing and preparation of Magazines	1
5.	Designing and preparation of Pamphlet	1
6.	Designing and preparation of Folders	1
7.	Designing and preparation of Popular research articles	1
8.	Writing of Radio script	1
9.	Preparation of TV script	2
10.	Development of Short film and feature film;	2
11.	Visit to editor office of farm journals of State Veterinary University	1
12.	Field visit to Successful Livestock farmer and documenting success story	1
13.	Visit to ATIC to record the activities of preparation, editing and publication of news articles and research publications	2
	Total	16

I. Course Title : Statistics for Social Sciences

II. Course Code : SSS 600

III. Credit Hours : 2+1

IV. Aim of the course

To equip the students with knowledge and skills in the applications of statistics in the field of veterinary and Animal Husbandry Extension.

V. Theory

Unit 1

Descriptive statistics- measures of central tendency, Measures of dispersion, Coefficient of variance, Standard error, Skewness and kurtosis, Contingency tables, Normal distribution, Test of significance – One sample t test, Independent t test, paired t test, ANOVA and z - one tailed and two tailed tests.

Unit 2

Population versus sample, Sampling errors, Sample size determination, Survey instruments, Open ended and closed ended questions, and online survey tools.

Unit 3

Dependency among the variables, correlation- Pearson, Spearman and Kendall, point biserial correlation, Regression analysis, Assumptions, Multiple linear Regression, Regression diagnostics-outlier, Multicollinearity, Heteroscedasticity and autocorrelation, logit/ probit model.

Unit 4

Scaling Techniques: Ranking, Rating and Paired Comparison. Scaling techniques -



Likert, Thurston and Guttman Scales. Construction and standardization; Knowledge test, Test of reliability and validity. Non-parametric tests- Signed Rank, Rank sum and Kruskal-Wallis tests. Test for independence and homogeneity. Multivariate techniques – cluster analysis, discriminant analysis and Factor analysis: Different rotations and interpretation of results.

VI. Practical

Exercises on different statistical tools and their interpretations

VII. Suggested Reading

- Cunningham BJ. 2012. *Using SPSS: An Interactive Hands-on approach*
- Edwards Allen L. 1969. *Techniques of Attitude Scale construction*. Vakils, Feffer and Simons Pvt. Ltd, Bombay
- Gupta SC and VK Kapoor. 2007. *Fundamentals of Mathematical Statistics*. Sultan Chand and Sons.
- Hair Joseph F, William C Black, Barry J Babin and Rolph E. Anderson. 2010. *Multivariate Data Analysis*. Pearson Pub.
- Hogg RV, AT Craig and JW. Mckean. 2005. *Introduction to Mathematical Statistics*, Pearson Education.
- Sukhatme PV, BV Sukhatme, S Sukhatme and C Ashok. 1984. *Sampling Theory of Surveys with Applications*, Iowa State University Press, Iowa, USA.



Course Title with Credit Load

Ph.D. in Veterinary Extension Education

Course Code	Course Title	Revised Credits
RPE 700	Research and Publication Ethics	1+1 #
EXT 701	Organizational Leadership and Management	2+0
EXT 702	Recent Trends in Research Techniques in Social Sciences	2+1
EXT 703	Training for Development	1+1
EXT 704	Policies and Regulations in Livestock Sector	1+0
EXT 705	Educational Technology	2+1
EXT 706	Dynamics of Social Change	2+0
EXT 707	Monitoring and Evaluation of Livestock Development Programmes	2+1
EXT 708	Theory Constructions in Social Sciences	1+0
EXT 709	Facilitation for Development	2+1
EXT 710	Managing Extension Organizations	2+1
EXT 711	Doctoral Seminar-I	1+0
EXT 712	Doctoral seminar-II	1+0
EXT 713	Doctoral Research	0+75

Mandatory Major course for all Ph D students. Other Core Courses to the extent of 10 credits are to be taken from remaining 700 series courses listed above

List of specified Minor subjects (Departments)

Major Subject	Minor subjects (Departments)*
Veterinary Extension Education	Animal Nutrition, Poultry Science, Livestock Production Management, Public Health and Epidemiology, Livestock Economics, Statistics, LPT.

*The Minor courses may be taken from any number of disciplines/ departments listed against major discipline limiting to credits prescribed as decided by the Chairman of Advisory Committee of the student.

Minor courses may also be taken from the disciplines/ departments other than those listed above on the recommendations of advisory committee, if essentially required as per the research problem with the concurrence of Head of the Department and Concerned Authorities.



Course Contents

Ph.D. in Veterinary Extension Education

- I. Course Title** : **Organizational Leadership and Management**
II. Course Code : **EXT 701**
III. Credit Hours : **2+0**

IV. Aim of the course

To orient students with leadership and management perspectives for organizational change and development.

V. Theory

Unit I

Organizational Leadership – Introduction, Definition, Importance, Distinguishing differences between leadership and management within an organization, Theories of leadership, Current trends in leadership development, Competencies needed to be an effective leader and develop strategies for improving effective leadership potential.

Unit II

Concept, Approaches and functions of management, Principles and process of organization, hierarchy of organization, departmentalisation, Authority and responsibility. Components of individual behaviour in organization, Organizational climate, Decision making by consensus and participation by subordinates, Organization development– history, nature, characteristics, assumptions and process, Organization development interventions.

Unit III

Organizational communication, Communication network, Essentials of organizational communication. Conflict – types and management, Leadership and its role in conflict resolution, Morale in organizations, organizational factors affecting morale, attitude and productivity, methods of improving moral and evaluation of morale. Performance appraisal processes.

Unit IV

Supervision– principles, techniques and functions of supervision. Qualities of supervisor, supervisor-subordinate relationship and interaction process. Changing organizational structure and system, changing organizational climate and interpersonal style, issues and choice involved in making organizational climate effective.

VI. Suggested Reading

- Bhattacharyya DK. 2011. *Organizational Change and Development*, Oxford University Press.
- Hellriegel D, Slocum JW and Woodman. 2001. *Organizational Behaviour*.
- Luthans F. 2002. *Organizational Behaviour*. Tata McGraw-Hill, New York
- Newstrom JW and Davis K. *Organizational Behaviour: Human behaviour at Work*. Tata-McGraw Hill, New Delhi.

- Peter MS. 1998. *The Fifth Discipline: The Art and Practice of Learning Organization*. Random House, London.
- Pradip NK. 1992. *Organisational Designs for Excellence*. Tata McGraw Hill, New Delhi.
- Shukla Madhukar. 1996. *Understanding Organisations*. Prentice Hall of India, New Delhi.
- Thomas GC and Christopher GW. 2013. *Organizational development and change* (10th edition), South-Western college publishing.
- Wendell LF and Cecil HB. 1999. *Organisational Development: Behavioural Science Interventions for Organization Improvement*, Pearson. 368 pp.
- Gary A Yukl. 2013. *Leadership in Organizations* (8th edition), Pearson
- Anita Satterlee. 2018. *Organizational Management and Leadership* (3rd edition, Synergistics Inc.
- Patricia D Witherspoon. 1997. *Communicating Leadership: An Organizational Perspective*, Allyn and Bacon, Inc.

Course Outline

S. No. Topic	No. of Lectures
Theory	
1 Introduction, Definition and Importance of Organizational Leadership with special reference to Animal Husbandry Organizations	1
2 Distinguishing differences between leadership and management within an organization	1
3 Theories of leadership, Current trends in leadership development	2
4 Competencies needed to be an effective leader and develop strategies for improving effective leadership potential.	2
5 Concept, approaches and functions of management with special reference to Animal Husbandry organizations	2
6 Principles and process of organization, hierarchy of organization, departmentalisation, Authority and responsibility.	3
7 Components of individual behaviour in organization.	1
8 Organizational climate, decision making by consensus and participation by subordinates.	1
9 Organizational development – history, nature, characteristics, assumptions and process.	1
10 Organization development interventions.	2
11 Organizational communication, Communication network, Essentials of organizational communication.	2
12 Conflict – types and management.	2
13 Leadership and its role in conflict resolution.	1
14 Morale in organizations, organizational factors affecting morale, attitude and productivity, methods of improving morale and evaluation of morale.	2
15 Performance appraisal processes	2
16 Principles, techniques and functions of supervision.	1
17 Qualities of supervisor, supervisor-subordinate relationship and interaction process.	1
18 Changing organizational structure and system	2
19 Changing organizational climate and interpersonal style, issues and choice involved in making organizational climate.	3
Total	32



- I. Course Title** : **Recent Trends in Research Techniques in Social Sciences**
- II. Course Code** : **EXT 702**
- III. Credit Hours** : **2+1**

IV. Aim of the course

To train the students on research and management techniques/ methods applicable to animal husbandry research.

V. Theory

Unit I

Importance and relevance of scales, Tests, Index, Quotient in social science research. Techniques of attitude scale construction, viz., paired comparison, equal appearing interval, successive interval, summated ratings, scalogram analysis.

Unit II

Measurement of reliability and validity of tests and scales. Sociometry. Qualitative, quantitative and mixed methods of research. Critical incidence techniques. Q-sort technique, Observation techniques, Case studies, etc.

Unit III

Experimental and quasi experimental research designs and randomized control trials. Delphi techniques, Propensity score matching, Content analysis and projective techniques.

Unit IV

Multivariate analysis, Systems analysis, Conjoint analysis, Panel data analysis, Principal component analysis, Discriminant analysis, Non-parametric tests and their application in extension research.

VI. Practical

Exercises on scaling techniques, attitude scale construction – Paired Comparison, Equal Appearing interval, Summated Rating Scale, Critical Incident Technique, Exercise on construction of Knowledge Test. Assessing the reliability and validity of measuring instruments Exercise on observation skills.

VII. Suggested Reading

- Babbie E. 2008. *The basics of social research* (4th Edition), Belmont, CA, USA; Thompson Wordsworth.
- Creswell JW. 2009. *Research design: Qualitative, quantitative, and mixed methods approaches*. Third edition. Thousand Oaks: Sage Publications.
- Creswell JW. 2012. *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th edition). Boston, MA: Pearson.
- Kerlinger FN and Lee HB. 2000. *Foundations of Behavioral Research*. Orlando, FL: Harcourt College Publishers.
- Kumar R. 2014. *Research Methodology: A Step- by- Step Guide for Beginners*. (4th Edition). Thousand Oaks, California: Sage Publications.
- Malhotra NK. 2010. *Marketing research: An applied orientation. Sixth Edition*. Upper Saddle River NJ: Prentice Hall.
- Neuman WL. 2006. *Social Research Methods: Qualitative and Quantitative Approaches*. Toronto: Pearson.
- Sekaran U and Bougie R. 2013. *Research Methods for Business A Skill-Building Approach*. (6th Edition), Wiley, New York.



- Sivakumar PS, Sontakki BS, Sulaiman RV, Saravanan R and Mittal N. (eds). 2017. *Good Practices in Agricultural Extension Research. Manual on Good Practices in Extension Research and Evaluation. Agricultural Extension in South Asia*. Centre for research on innovation and science and policy (CRISP), Hyderabad. India.

Course outlines

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Importance and relevance of scales, tests, index, quotient in social science research.	3
2.	Techniques of attitude scale construction, viz., paired comparison, equal appearing interval, successive interval, summated ratings, scalogram analysis.	5
3.	Measurement of reliability and validity of tests and scales.	2
4.	Sociometry.	1
5.	Qualitative, quantitative and mixed methods of research.	3
6.	Critical incidence techniques, Q-sort technique, observation techniques, case studies	3
7.	Experimental and quasi experimental research designs and randomized control trials.	2
8.	Delphi techniques, propensity score matching, content analysis and projective techniques.	3
9.	Multivariate analysis	2
10.	Systems analysis	1
11.	Conjoint analysis	1
12.	Panel data analysis	1
13.	Principal component analysis	1
14.	Discriminant analysis	1
15.	Non-parametric tests and their application in extension research.	3
	Total	32
Practicals		
1.	Scaling techniques	2
2.	Attitude scale construction – Paired Comparison, Equal Appearing interval, Summated Rating Scale, Critical Incident Technique	6
3.	Construction of Knowledge Test	3
4.	Assessing the reliability and validity of measuring instruments	3
5.	Exercise on observation skills	2
	Total	16

I. Course Title : Training for Development

II. Course Code : EXT 703

III. Credit Hours : 1+1

IV. Aim of the course

To impart knowledge on planning, implementation and evaluation of various training programmes.

V. Theory

Unit I

Concept of training and education. Role of institution, Organization, Trainer and



participants in success of training programme. Training infrastructure for extension personnel and livestock farmers.

Unit II

Planning, Development and execution of training programmes. Concept of need Assessment; Approaches in need Analysis- Performance Analysis, Task Analysis, Competency Study; Needs Survey.

Unit III

Training curriculum design and development. Training models, Methods and methodologies and strategies - Evaluation of Training (Kirkpatrick model, CIPP Model, Logic Model, etc.), and follow-up of training programmes. Training Transfer- Barriers and factors effecting transfer of training (training design, trainee characteristics, Trainer capabilities, Training environment, Organization role, etc.).

Unit IV

Training, Capacity building, Capacity development and HRD-Meaning and differences; Need and principles of capacity development; Types and levels of capacities. Approaches in Capacity Development -Informative approach, Participatory approach, Experimental approach/ Experiential, Performance based approach; Capacity Development Strategies - Academic strategy, Laboratory strategy, Activity strategy, Action strategy, Personal development strategy, Organizational development strategy.

VI. Practical

Exercise on Training Need Assessment. Development of training modules. Organization of training programmes for farmers, Evaluation of training programmes. Impact assessment of training programmes. Analysis of training institutions. Studies on training transfer.

VII. Suggested Reading

- Bentaya GM and Hoffmann V (Eds). 2011. *Rural Extension Volume 3 -Training Concepts and Tools*, Margraf Publishers GmbH, Scientific books, KanalstraBe 21; D-97990, weikersheim, 191 pp.
- DFID. 2003. *Promoting Institutional and Organisational Development. A Source Book of Tools and Techniques*, Department for International Development, United Kingdom
- FAO 2010. *FAO. Capacity Assessment Approach and Supporting Tools - Discussion Draft*, Food and Agriculture Organisation of the United Nations
- FAO 2012. *Capacity Development: Learning Module 2*. FAO Approaches to Capacity Development in Programming. Processes and Tools, Food and Agriculture Organisation of the United Nation
- GFRAS. 2012. *The New Extensionist: Roles, Strategies, and Capacities to Strengthen Extension and Advisory Services*, Global Forum for Advisory Services
- GFRAS. 2015. *The New Extensionist: Core Competencies for Individuals*, GFRAS Brief 3.
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- Mishra DC. 1990. *New Directions in Extension Training*. Directorate of Extension, Ministry of Agriculture, Govt. of India, New Delhi.
- OECD/DAC. 2006. *The Challenge of Capacity Development: Working Towards Good Practice*, Organisation for Economic Cooperation and Development.



- Pretty JN, Gujit I, Thompson J, and Scoones I. 1995. *A Trainer's Guide for Participatory Learning and Action*. IEED Participatory Methodology Series.
- Rolf PL and Udai P. 1990. *Training for Development*, (3rdedn) by (West Hartford, Kumarian Press, 1990, pp. 333.
- Rolf PL and Udai P. 1992. *Facilitating Development: Readings for Trainers, Consultants and Policy-makers*, New Delhi: Sage Publications, pp. 359

Course outlines

S. No.	Topic	No. of classes
Theory		
1.	Concept of training and education.	1
2.	Role of institution, organization, trainer and participants in success of training programme.	1
3.	Training infrastructure for extension personnel and livestock farmers	1
4.	Planning, development and execution of training programmes – importance, scope and relevance to animal husbandry sector	1
5.	Concept of Need Assessment – Scope and Importance in animal husbandry sector	1
6.	Approaches in Need Analysis- Performance Analysis, Task Analysis, Competency Study; Needs Survey.	2
7.	Training curriculum design and development.	1
8.	Training models, methods and methodologies and strategies	1
9.	Training Evaluation (Kirkpatrick model, CIPP Model, Logic Model, etc.) and follow-up of training programmes.	2
10.	Training Transfer– Barriers and Factors effecting transfer of training (training design, trainee characteristics, trainer capabilities, training environment, organization role, etc.)	1
11.	Training, capacity building, capacity development and HRD -Meaning and differences;	1
12.	Need and principles of capacity development; Types and levels of capacities.	1
13.	Approaches in Capacity Development -Informative approach, Participatory approach, Experimental approach/ Experiential, Performance based approach;	1
14.	Capacity Development Strategies - Academic strategy, Laboratory strategy, Activity strategy, Action strategy, Personal development strategy, Organizational development strategy.	1
	Total	16
Practicals		
1.	Training Need Assessment of farmers, entrepreneurs/ AHD functionaries	3
2.	Development of training modules – for farmers/ entrepreneurs	2
3.	Organization of training programmes for farmers/ entrepreneurs	3
4.	Evaluation of training programmes of farmers/ entrepreneurs	2
5.	Impact assessment of training programmes	3
6.	Analysis of training institutions	2
7.	Identification of Capacity Development approaches and strategies followed by Animal Husbandry Department/ other related organization	2
	Total	16



- I. Course Title : Policies and Regulations in Livestock Sector**
II. Course Code : EXT 704
III. Credit Hours : 1+0

IV. Aim of the course

To sensitize students on policies and regulations in animal husbandry sector.

V. Theory

Unit I

Concept, importance of development of policies and its framework. State, National and Global policies related to livestock sector. World Trade Organization in relation to livestock sector. Impact of WTO on Indian international trade of food products of animal origin, Intellectual Property Rights in relation to animal husbandry.

Unit II

HACCP, Sanitary and phyto-sanitary measures to protect the animals' life and health, Food safety uses in relation to animal husbandry sector. Introduction to Agreement on Technical Barriers to Trade (ATBT).

Unit III

Indian livestock sector related policies, National Livestock Policy, Regional Trade Agreements (RTAs) and Indian Livestock sector; Case studies – Impact of global trade agreements on livestock sector. Food safety acts and institutional arrangements for implementation; Agriculture Produce and Livestock Marketing (APLM) Act. Livestock products pricing policy. Government of India Systems, viz., Sanitary Import Permit System for livestock products

Unit IV

Animal welfare - Philosophical bases of animal welfare; Evolution of basic animal welfare principles; Animal Welfare laws- legislations in veterinary and animal sciences.

VI. Suggested Reading

- Jessica Vapnek Megan Chapman. 2010. *Legislative and regulatory options for animal welfare* (FAO Legislative Study 104) <http://www.fao.org/docrep/013/i1907e/i1907e00.pdf>
- Richard A Sprenger 2018. *The HACCP Handbook* (7th Edition)
- Sara E Mortimore and Carol A. Wallace. 2015. *HACCP: A food industry briefing*, Second Edition Sara E. Mortimore and Carol A Wallace
- World Society for the Protection of Animals. 2007. *Universal Declaration on Animal Welfare* https://www.worldanimalprotection.ca/sites/default/files/ca_-_en_files/case_for_a_udaw_tcm22-8305.pdf
- <https://awbi.org/awbi-pdf/APL.pdf>
- <https://www.petaindia.com/wp-content/uploads/2017/05/Prevention-of-Cruelty-to-Animals-Dog-Breeding-and-Marketing-Rules-2017.pdf>
- <https://www.wto.org/>

Course Outlines

S. No.Topic	No. of Lectures
Theory	
1. Concept, importance of development of policies and its framework.	1
2. State, National and Global policies related to livestock sector.	1



S. No.	Topic	No. of Lectures
3.	World Trade Organization in relation to livestock sector.	1
4.	Impact of WTO on Indian international trade of food products of animal origin.	1
5.	Intellectual Property Rights in relation to animal husbandry.	1
6.	HACCP, Sanitary and phyto-sanitary measures to protect the animals' life and health, food safety uses in relation to animal husbandry sector.	1
7.	Introduction to Agreement on Technical Barriers to Trade (ATBT).	1
8.	Indian livestock sector related policies.	2
9.	Regional Trade Agreements (RTAs) and Indian Livestock sector	1
10.	Case studies – Impact of global trade agreements on livestock sector.	1
11.	Case studies – Food safety acts and institutional arrangements for implementation;	1
12.	Agriculture Produce and Livestock Marketing (APLM) Act.	1
13.	Livestock products pricing policy.	1
14.	Animal Welfare - Philosophical bases of animal welfare; Evolution of basic animal welfare principles	1
15.	Animal Welfare laws- legislations in veterinary and animal sciences	1
	Total	16

I. Course Title : Educational Technology

II. Course Code : EXT 705

III. Credit Hours : 2+1

IV. Aim of the course

To acquaint students with different concepts of education technology for the enhancement of quality of education.

V. Theory

Unit I

Educational Technology – Meaning, Nature, Scope Concepts and Components of Educational Technology- Basics of Teaching and Learning- Theories of teaching and learning. Curriculum development at macro and micro levels. Formulation of instructional objectives. Teaching Competencies –Need and Importance in teaching – competency mapping and development.

Unit II

Preparation of course outline for instructions, lesson planning. Designing instructions for theory and practical, Innovative Teaching Methods/ methodologies – Student Centric and Teacher Centric; Instructional tools and devices in class room instruction, computer aided learning. Understanding learner's behaviour, learning styles, motivating learners. Measurement of learning outcomes.

Unit III

Students' counselling, guidance and mentoring – concepts, types and importance in higher education- Student evaluation – meaning and methods, construction of measuring instrument – question banking. Performance appraisal of teachers – meaning and methods, construction of assessment instruments. Use of library for effective learning.



Unit IV

Emerging Educational Technologies- Open and Distance Learning (ODL) for quality Veterinary Education; Concepts of ODL – Implications to Veterinary Education. Online Education - Synchronous and Asynchronous learning – models – eLearning, Massive Open Online Courses – SWAYAM, Open Education Resources (OERs), RLOs, Digital Initiatives in Education, viz., Swayam Prabha, National Digital Library, National Academic Depository, E-Shodh Sindhu, E Acharya, EVidhwaan, Agriculture Education Portal, e-KrishiShiksha, KrishiKosh, CeRA, National Educational Alliance for Technology (NEAT) etc.

VI. Practical

Preparation of lesson plans, Planning and preparation of instructional aids, Individual classroom instructional exercises, Micro Teaching Exercise, Development and testing of student evaluation instrument, Development of performance appraisal instrument for teachers., Critical analysis of different online education platforms.

VII. Suggested Reading

- Aggarwal JC. 2000. *Essential of Educational Technology: Teaching Learning Innovations in Education*. New Delhi: Vikas Publishing House.
- Alston, Antoine JW, Wade Millerand, David L Williams. 2003. *The future role of instructional technology in agricultural education in North Carolina and Virginia*. Journal of Agricultural Education, Volume 44, Number 2, 2003.
- Breslow L, Pritchard DE, DeBore J, Stump GS, Ho AD, Seaton DT. 2013. *Studying Learning in the Worldwide Classroom Research into edX's First MOOC*.
- Davies IK. 1971. *The Management of Learning*. New York: McGraw-Hill Publications.
- Fred Percival and Phil Race. 2005. *Handbook of Educational Technology 3rd Edition*. New Jersey: Nichols Publishing Company.
- Holz-Clause MS and Guntuku D. 2010. *Global Agricultural Knowledge Initiative: Strengthening the global competence of students, faculty and extension agents*.
- Kumar KL. 2000. *Educational Technology*. New Delhi: New Age International Publishers.
- Leith GO et al. 1966. *A Hand Book of Programmed Learning and Birmingham*.
- Mangal SK. 2002. *Foundation of Educational Technology*. Ludhiana: Tondan Publication. 137.
- Mangal SK. 2006. *Essentials of Educational Technology*. New Delhi: Prentice-Hall Publications.
- Mithra, Shiv K. 1968. *Proceeding of Symposium on Educational Technology*. IPAL, NCERT. P.4.
- Purabi Jain. March 1968. *Educational Technology*. New Delhi: Dominant Publishers and Distributors.
- Sampath K, Panneerselvam A, Santhanam M. 2001. *Introduction to Educational Technology*. New Delhi: Sterling Publishers Pvt. Ltd.
- Sharma RA. 2007. *Educational Technology and Management*. Agra: Vinod Pustak Mandir.

Course Outlines

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Meaning, nature, Scope, Concepts and Components of Educational Technology	2
2.	Basics of Teaching and Learning	1
3.	Theories of teaching and learning	2
4.	Curriculum development at macro and micro levels	2



S. No.	Topic	No. of Lectures/ Practicals
5.	Formulation of instructional objectives	1
6.	Teaching Competencies – Need and Importance in teaching	2
7.	Competency mapping and development	1
8.	Lesson planning – definition, importance, steps in preparation	1
9.	Preparation of course outline for instructions, Designing instructions for theory and practical	2
10.	Innovative Teaching Methods/ methodologies – Student Centric and Teacher Centric	2
11.	Instructional tools and devices in class room instruction, computer aided learning	
12.	Understanding learner's behaviour, learning styles, motivating learners.	2
13.	Measurement of learning outcomes	1
14.	Students' counselling, guidance and mentoring – concepts, types and importance in higher education	2
15.	Student evaluation – meaning and methods, construction of measuring instrument – question banking	1
16.	Performance appraisal of teachers –meaning and methods, construction of assessment instruments.	2
17.	Use of library for effective learning	1
18.	Emerging Educational Technologies - Open and Distance Learning (ODL) for quality Veterinary Education	2
19.	Concepts of ODL – Implications to Veterinary Education.	1
20.	Online Education - Synchronous and Asynchronous learning – models – eLearning,	2
21.	Massive Open Online Courses – SWAYAM, Open Education Resources (OERs), RLOs, Digital Education and its application in Veterinary Education	2
	Total	32
Practicals		
1.	Preparation of lesson plans	3
2.	Planning and preparation of instructional aids	3
3.	Individual classroom instructional exercises	2
4.	Exercise on Micro teaching	2
5.	Development and testing of student evaluation instrument	2
6.	Development of performance appraisal instrument for teachers.	2
7.	Critical analysis of different online education platforms	2
	Total	16

I. Course Title : Dynamics of Social Change

II. Course Code : EXT 706

III. Credit Hours : 2+0

IV. Aim of the course

To provide understanding on the dynamics of social change and its implications to livestock development.

V. Theory

Unit I

Definition of change, development, social and cultural change. Dimensions,



characteristics, Types, rate and directions of social change. General conditions of social change. New dynamics in social change.

Unit II

Concept, importance and problems of planned change. Role of change agents. Approaches of change agents towards planned change. Acceptance and rejection to planned change in animal husbandry. Techniques for accelerating change.

Unit III

Theories of change: Darwin, Kurt, Lewin and Ogburn: Process of change, assessment of resources, fixation of change objective, evaluating change effect. Barriers to change-psychological, Social and economic, Stimulants to change: psychological, social and economic.

Unit IV

Social Change and its implication with reference to livestock development. Temporal changes in livestock development – national and global, Climate change and its impact on livestock development.

VI. Suggested Reading

- Chandra Shekhar. 2009. *Dynamics of Social Change*. Popular Prakashan.
- Johannes Dragsbaek Schmidt, Jacques Hersh. 2000. *Globalization and Social Change*, Routledge.
- John Solomos, Les Back. 1995. *Race, Politics, and Social Change*, Routledge.

Course outlines

S. No.	Topic	No. of Lectures
Theory		
1.	Definition of change, development, social and cultural change	2
2.	Dimensions, characteristics, types, rate and directions of social change	2
3.	General conditions of social change	2
4.	New dynamics in social change	1
5.	Concept, importance and problems of planned change	2
6.	Role of change agents in social change and Approaches of change agents towards planned change	2
7.	Acceptance and rejection to planned change in animal husbandry	2
8.	Techniques for accelerating change	1
9.	Theories of change: Darwin, Kurt, Lewin and Ogburn	3
10.	Process of change	1
11.	Assessment of resources	2
12.	Fixation of change objective	1
13.	Evaluating change effect	2
14.	Barriers to change-psychological, social and economical	1
15.	Stimulants to change: psychological, social and economic	2
16.	Social Change and its implications with reference to livestock development	2
17.	Temporal changes in livestock development – national and global	2
18.	Climate change and its impact on livestock development	2
	Total	32



- I. Course Title** : **Monitoring and Evaluation of Livestock Development Programmes**
- II. Course Code** : **EXT 707**
- III. Credit Hours** : **2+1**

IV. Aim of the course

To appraise the students about the monitoring and evaluation of livestock development programmes.

V. Theory

Unit I

Monitoring, evaluation and impact assessment - Importance and scope in livestock based developmental programmes; Approaches and Types of Monitoring Indicators- Approaches to Monitoring Indicators, Types of Monitoring Indicators; Indicators of Monitoring in Development Programmes - Capability Indicators, Performance Indicators; Monitoring and Progress Reporting; Evaluation: Data Collection Methods - Conventional Methods, Participatory Methods; Evaluation Approaches; Challenges in Programme Evaluation.

Unit II

Conceptual framework, result framework and logic models; Quantitative and qualitative indicators – characteristics and their selection criteria; indicators and information systems for sustainable livestock development - Testing and improving indicators; Integration of M and E systems into development programs.

Unit III

Difference between outcome and impact; Types of impact assessment: Climate impact assessment; Demographic impact assessment; Development impact assessment; Ecological and environmental impact assessment; Economic and fiscal impact assessment; Risk assessment; Social impact assessment; Strategic impact assessment; technology assessment, Project evaluation, Public participation and consultation.

Unit IV

Impact assessment methods: Formative and summative evaluation, Types-within-without; before-after; case study; social auditing; performance audit; quantifying the impact parameters.

VI. Practical

Development of M and E plans and procedures for livestock developmental programmes using participatory approach. Developing indicators (social and economic) and information system for sustainable livestock development; analysis of different reports, conducting impact assessment exercises, case studies, data generation, report writing.

VII. Suggested Reading

- Carlson GA, Miranowski J and Zilberman D. 1998. *Agricultural and Environmental Resource Economics*. Oxford Univ. Press. 63
- Hanley N, Shogren J and White B. 2007. *Environmental Economics in Theory and Practice*. Palgrave, London.
- Kolstad C. 1999. *Environmental Economics*. Oxford Univ. Press.
- Little IMD and Mirlees JA. 1974. *Project Appraisal and Planning for Developing Countries*. Oxford and IBH Publ.



- Prato T. 1998. *Natural Resource and Environmental Economics*. Iowa State Univ. Press.
- Sterner T. 2003. *Policy Instruments for Environmental and Natural Resource Management. Resources for the Future*. The World Bank and SIDA.

Course Outlines

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Monitoring, evaluation and impact assessment - importance and scope in livestock based developmental programmes	2
2.	Approaches to Monitoring Indicators	1
3.	Types of Monitoring Indicators	1
4.	Indicators of Monitoring in Development Programmes Capability Indicators, Performance Indicators	2
5.	Monitoring and Progress Reporting	1
6.	Evaluation: Data Collection Methods - Conventional Methods, Participatory Methods	3
7.	Evaluation Approaches	1
8.	Challenges in Programme Evaluation	1
9.	Conceptual framework, result framework and logic models	2
10.	Quantitative and qualitative indicators – characteristics and their selection criteria	2
11.	Indicators and information systems for sustainable livestock development - testing and improving indicators	2
12.	Integration of M and E systems into development programs	1
13.	Difference between outcome and impact	1
14.	Types of impact assessment: climate impact assessment; demographic impact assessment; development impact; assessment; ecological and environmental impact assessment; economic and fiscal impact assessment; risk assessment; social impact assessment; strategic impact assessment; technology assessment	5
15.	Project evaluation	1
16.	Public participation and consultation	1
17.	Impact assessment methods: Formative and summative evaluation	2
18.	Types of impact assessment -within-without; before-after; case study; social auditing; performance audit	2
19.	Quantifying the impact parameters	1
	Total	32
Practicals		
1.	Development of M and E plan for livestock developmental programmes using participatory approach.	3
2.	Development of procedures for livestock developmental programmes using participatory approach	2
3.	Developing indicators (social and economic) and information system for sustainable livestock development	3
4.	Analysis of different reports	2
5.	Conducting impact assessment exercises	2
6.	Case studies	1
7.	Data generation	1
8.	Report writing	2
	Total	16



- I. Course Title : Theory Constructions in Social Sciences**
II. Course Code : EXT 708
III. Credit Hours : 1+0

IV. Aim of the course

To provide the foundation for construction of theories in social science.

V. Theory**Unit I**

Importance of theory construction in Extension. Hypothesis, Theory, Principle and Law; Meaning, elements, Ideal Criteria, Functions, Types of theories. Definitions: Meaning, types and Rules.

Unit II

Generalizations: Meaning, Classification. Relationship: Meaning Types.

Unit III

Terminologies used in theory constructions: Axiom, Postulate, Proposition, Theorem, Fact, Concept, Construct, Probability and Measurement Basic Derived.

Unit IV

Steps in theory building - Axiomatic techniques, Historical approaches and scientific application. Theoretical concept in social sciences. Test of Theory: Applying appropriate statistical tests.

VI. Suggested Reading

- Blalock HM. 1969. *Theory Construction: Form verbal to Mathematical Formulations*. Prentice Hall.
- Dubin R. 1978. *Theory Building*. The Free Press, New York.
- Hage J. 1973. *Techniques and Problems of Theory Constructions in Sociology*. John Wiley and Sons
- Jack P Gibbs. 1972. *Sociological Theory Construction*. The Dryden Press, Illionis.
- Stinchcombe AL. 1968. *Construction of Sociological Theories*. Harcourt, Brace and World.
- Wionton CA. 1974. *Theory and Measurement in Sociology*. John Wiley and Sons.

Course Outlines

S. No.	Topic	No. of classes
Theory		
1.	Importance of theory construction in Extension. Hypothesis, Theory, Principle and Law	2
2.	Theory construction definitions - Meaning, types and Rules.	1
3.	Theory - Meaning, elements, Ideal Criteria, Functions, Types	1
4.	Generalizations: Meaning, Classification.	2
5.	Relationship - Meaning Types.	1
6.	Terminologies used in theory constructions: Axiom, Postulate, Proposition, Theorem, Fact, Concept, Construct, Probability and Measurement Basic Derived	3
7.	Steps in theory building - Axiomatic techniques, historical approaches and scientific application.	2
8.	Theoretical concept in social sciences.	2
9.	Test of Theory: Applying appropriate statistical tests	2
	Total	16



- I. Course Title : Facilitation for Development**
II. Course Code : EXT 709
III. Credit Hours : 2+1

IV. Aim of the courses

- To orient students on the importance facilitation.
- To inspires students to understand facilitation tools to influence change at the individual, group and organisational levels.
- To develop capacities in multi-stakeholder engagement, facilitation and networking.

V. Theory

Unit 1

Facilitation for development in the AIS; Understanding facilitation for development; Importance of facilitation as a core function of extension within the Agricultural Innovation Systems (AIS); Basic principles of facilitation for development; Desired attributes of facilitator for development- Cognitive attributes, Emotional attributes (Emotional intelligence), Social, behavioural and attitudinal attributes; Technical skills of a facilitator for development- Design processes, Facilitation techniques and tools, the art of questioning and probing, Process observation and documentation, Visualisation.

Unit 2

Facilitating Change in Individuals, Groups And Organisations - Self-discovery to realize our potentials, Tools for self-discovery, formulating a personal vision, Taking responsibility for your own development; Understanding the dynamics of human interaction, Group dynamics and power relations, Managing relationships, Shared vision and collective action, Tools for team building; Organizational change process, Organisational learning to adapt to changing environments, Enhancing performance of organisations, Leadership development, Tools for organisational change.

Unit 3

Facilitating Operational Level Multi-Stakeholder Engagements - Defining stakeholders, Development of collective and shared goals, Building trust and accountability, Tools for stakeholder identification and visioning; Visualising innovation platforms (IPs), Why are IPs important?, Different models of IPs for multi-stakeholder engagement, policy engagement platforms, Generating issues and evidence for policy action, Advocacy for responsive policy processes.

Unit 4

Brokering Strategic Partnerships, Networking And Facilitation- Brokering linkages and strategic partnerships, Identification of critical links, Knowledge brokering, Creating linkages with markets, Learning alliances and networking, Coordination of pluralistic service provision within the AIS, The concept of action learning and reflective practitioners, Networking; Facilitating Capacity Development-Facilitate participation and learning in development programs and projects. Virtual platforms-skills for strengthening dialogue, collaboration, shared commitment amongst diverse actors and stakeholders.



Course Outlines

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Facilitation for development in the AIS; Understanding facilitation for development;	1
2.	Importance of facilitation as a core function of extension within the Agricultural Innovation Systems (AIS);	1
3.	Basic principles of facilitation for development; Desired attributes of facilitator for development- Cognitive attributes, Emotional attributes (Emotional intelligence), Social, behavioural and attitudinal attributes;	2
4.	Technical skills of a facilitator for development- Design processes, Facilitation techniques and tools, the art of questioning and probing,	2
5.	Process observation and documentation, Visualisation	1
6.	Facilitating Change In Individuals, Groups And Organisations - Self-discovery to realize our potentials,	2
7.	Tools for self-discovery, formulating a personal vision, Taking responsibility for your own development;	1
8.	Understanding the dynamics of human interaction, Group dynamics and power relations, Managing relationships, Shared vision and collective action,	2
9.	Tools for team building;	1
10.	Organizational change process, Organisational learning to adapt to changing environments, Enhancing performance of organisations,	2
11.	Leadership development, Tools for organisational change	1
12.	Facilitating Operational Level Multi-Stakeholder Engagements - Defining stakeholders, Development of collective and shared goals, Building trust and accountability,	2
13.	Tools for stakeholder identification and visioning;	1
14.	Visualising innovation platforms (IPs), Why are IPs important?, Different models of IPs for multi-stakeholder engagement	2
15.	Policy engagement platforms, Generating issues and evidence for policy action,	2
16.	Advocacy for responsive policy processes	1
17.	Brokering Strategic Partnerships, Networking and Facilitation- Brokering linkages and strategic partnerships, Identification of critical links, Knowledge brokering, Creating linkages with markets,	2
18.	Learning alliances and networking, Coordination of pluralistic service provision within the AIS,	1
19.	The concept of action learning and reflective practitioners, Networking;	1
20.	Facilitating Capacity Development-Facilitate participation and learning in development programs and projects.	2
21.	Virtual platforms- skills for strengthening dialogue, collaboration, shared commitment amongst diverse actors and stakeholders	2
	Total	32
Practicals		
1.	Practicing facilitation techniques	1
2.	Self discovery exercises	1
3.	Working together and interaction (task based)	1
4.	Arrangement for multi-stakeholder interactions	1
5.	Understanding organisational change process tools and techniques	1



S. No.	Topic	No. of Lectures/ Practicals
6.	Case analysis on organisational change process	1
7.	Participating with innovation platforms	1
8.	Policy engagement platforms	1
9.	Stakeholder analysis mapping	2
10.	Exercise on networking skills	2
11.	Facilitating capacity building programmes	1
12.	Facilitating virtual platforms	1
13.	Filed visit to multi-stakeholder partnership projects	2
	Total	16

VI. Suggested Reading

- Account Ability 2005. AA 1000, *Stakeholder Engagement Standard Exposure draft*.
http://www.empresa.org/doc/AA1000_STHEngagement.pdf
- Anonymous..n.d. *Facilitation Tools for Meetings and Workshops*.
<https://seedsforchange.org.uk/tools.pdf>
- Clarke S, Blackman R and Carter I. 2004. *Facilitation skills workbook -Training material for people facilitating small group discussions and activities using PILLARS Guides*. Tearfund, England.
https://www.tearfund.org/~/_media/files/tilz/fac_skills_english/facilitation__e.pdf
- Davis S. 2014. Using the Socratic Method as a Learning Facilitator
<https://facilitatoru.com/training/using-the-socratic-method-as-a-learning-facilitator/>
- Hanson L and Hanson C. *Transforming participatory facilitation: Reflections from practice*.
<http://pubs.iied.org/pdfs/G01950.pdf>
- Jost C, Alvarez S and Schuetz T. 2014. *CCAFS Theory of Change Facilitation Guide*. CGIAR Research Program on Climate Change, Agriculture and Food Security.
<https://cgspace.cgiar.org/bitstream/handle/10568/41674/CCAFS%20TOC%20facilitation%202014%20FINAL.pdf>
- Kennon N, Howden P and Hartley M. 2002. *Who really matters? A stakeholder analysis tool*. Extension Farming Systems Journal volume 5 number 2.
https://www.csu.edu.au/_data/assets/pdf_file/0018/109602/EFS_Journal_vol_5_no_2_02_Kennon_et_al.pdf
- Koutsouris A. 2012. *Exploring the emerging facilitation and brokerage roles for agricultural extension education*. AUA Working Paper Series No. 2012-4. Agricultural University of Athens. Department of Agricultural Economics and Rural Development.
http://aoatools.aua.gr/RePEc/aua/wpaper/files/2012-4_koutsouris.pdf
- Krick T, Forstater M, Monaghan P, Sillanpaa M. 2005. *The Stakeholder Engagement Manual: Volume 2, the Practitioner's Handbook on Stakeholder Engagement*. AccountAbility, United Nations Environment Programme, Stakeholder Research Associates Canada Inc.
- Linden J. 2015. *Innovation in Layer Housing: From Drawing Board to Reality*.
<http://www.thepoultrysite.com/articles/3494/innovation-in-layer-housing-from-drawing-board-to-reality/>
- Lindynorris. *How to Develop Your Personal Vision Statement: A Step-by-Step Guide to Charting Your Future With Purpose and Passion*
<http://static1.squarespace.com/static/5765deb1be659449f97fcbf5/t/5770b309579fb313164a7a37/1467003657818/LINDYNORRIS.COM+-+How+to+Develop+a+Personal+Vision+Statement.pdf>
- Lundy M, Gottret MV and Ashby J. *Learning alliances: An approach for building multistakeholder innovation systems*.
<http://documents.worldbank.org/curated/en/564521467995077219/pdf/103509-BRI-PUBLIC-ADD-series-ILAC-brief.pdf>
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<http://www.g-fras.org/en/knowledge/new-extensionist-learning-kit-nelk.html#module-7-introduction-for-facilitation-for-development>
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<https://www.aafp.org/fpm/2006/0100/p47.pdf>
 - Van Rooyen A, Swaans K, Cullen B, Lema Z and Mundy P. 2013. *Facilitating Innovation Platforms in: Innovations platforms practice* brief 10.
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I. Course Title : Managing Extension Organizations

II. Course Code : EXT 710

III. Credit Hours : 2+1

IV. Aim of the courses

- To orient students on the importance of knowledge and skills on various management functions, as applicable to extension organizations
- Discuss ways of running extension services as managers of livestock -ventures
- To develop capacities for becoming effective managers of livestock -ventures



V. Theory

Unit 1

Management- An Over view - Management and Extension management – Meaning, concept, nature and importance; Management, administration and supervision - meaning, definition and scope; Approaches to management, Principles, functions and levels of management; Qualities and skills of a manager; Interpersonal relations in the organization; Reporting and budgeting; Extension Management in public, private sector and other sectors - Extension management (POSDCORB) in public sector, Department of Agriculture, Agricultural Technology Management Agency (ATMA), Krishi Vigyan Kendra (KVK), SAUs, ICAR Institutes, Private sector, Cooperatives, NGOs, FPOs, etc. Organisational Structure, Relations between different units- Challenges in management.

Unit 2

Concepts in Management - Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions; Human Resource Management: Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development; Dealing with fund and staff shortages in different extension organizations (KVK, ATMA, etc.); Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles; Authority and responsibility, Delegation and decentralization, line and staff relations.

Unit 3

Challenges of co-ordination in extension organizations; Managing interdepartmental coordination and convergence between KVK, ATMA and line departments; Co-ordinating pluralism in extension services; Challenges in managing public-private partnerships (PPPs) at different levels in agricultural development in general and extension in particular; Performance appraisal – Meaning, Concept, Methods.

Unit 4

Motivation and Communication- Managing work motivation – Concept, Motivation and Performance, Approaches to motivation, team building; Organizational Communication – Concept, Process, Types, Networks, Barriers to Communication; Mentoring, Time management, Team work and team-building strategies; Modernization of information handling; Supervision and Control - Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision; Managerial Control – Nature, Process, Types, Techniques of Control, Observation, PERT and CPM, Management Information Systems (MIS): Concept, tools and techniques, MIS in extension organisations.

VI. Practicals

- Simulated exercises on techniques of decision making
- Study the structure and function of agro-enterprises, Designing organizational structure/organograms
- Group activity on leadership development skills
- Simulated exercise to understand management processes
- Field visit to extension organizations (ATARI, KVKs, NGOs), FPOs, dairy cooperatives to understand the functions of management
- Practical exercises on PERT and CPM

- Group exercise on development of short term and long term plans for agro-enterprises
- Developing model agriculture-based projects including feasibility study, financial planning and cost-benefit analysis

VII. Suggested Reading

- Bitzer V. 2016. *Incentives for enhanced performance of agricultural extension systems*, KIT Working Paper 2016-6, Royal Tropical Institute, Amsterdam
<https://www.kit.nl/wp-content/uploads/2018/08/Incentives-for-enhanced-performance-of-agricultural-extension-systems.pdf>
- Bitzer V, Wennik B and de Steenhuijsen B. 2016. *The governance of agricultural extension systems*, KIT Working Paper 2016-1 Royal Tropical Institute, Amsterdam.
<https://www.kit.nl/wp-content/uploads/2018/08/The-governance-of-agricultural-extension-systems.pdf>
- Chand S. *Modern Management Theory: Quantitative, System and Contingency Approaches to Management*.
<http://www.yourarticlelibrary.com/management/modern-management-theory-quantitative-system-and-contingency-approaches-to-management/25621>
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- Fahimifard SM and Kehkha AA. 2009. *Application of Project Scheduling in Agriculture* (Case Study: Grape Garden Stabilization) *American-Eurasian J. Agric. and Environ. Sci.*, 5(3): 313-321.
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- Gabathuler E, Bachmann F and Klay A. 2011. *Reshaping Rural Extension Learning for Sustainability: An integrated and learning based advisory approach for rural extension with small scale farmers*- Chapter 4. Margraf Publishesrs, Kanalstr.
- GFRAS 2017. Module 3: *Agricultural Extension Programme Management, The New Extensionist Learning Kit, Global Forum for Rural Advisory Services* (GFRAS)
<http://www.g-fras.org/fr/component/phocadownload/category/70-new-extensionist-learning-kit-nelk.html?download=564:nelk-module-3-agricultural-extension-programme-management-textbook>
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<http://www.manage.gov.in/pgdaem/studymaterial/aem203.pdf>
- Mind Tools. *Core Leadership Theories: Learning the Foundations of Leadership*
- *Why are some leaders successful, while others fail?* Available online
<https://www.mindtools.com/pages/article/leadership-theories.htm>
- Qamar KM. 2005. *Modernizing National Agricultural Extension Systems: A Practical Guide for Policy-Makers of Developing Countries*, Food and Agriculture Organization of the United Nations
<http://www.fao.org/uploads/media/modernizing%20national.pdf>
- Swanson BE, Bentz RP and Sofranko AJ. 1997. *Improving Agricultural Extension. A Reference Manual*. Food and Agriculture Organization of the United Nations, Rome.
- Van den Ban AW and Hawkins HS. 1998. *Agricultural extension*- Chapter 10, BSL, CBS Publishers and Distributors.



S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	Management- An Over view - Management and Extension management – Meaning, concept, nature and importance;	1
2	Management, administration and supervision - meaning, definition and scope;	1
3	Approaches to management, Principles, functions and levels of management;	1
4	Qualities and skills of a manager; Interpersonal relations in the organization;	1
5	Reporting and budgeting; Extension Management in public, private sector and other sectors	2
6	Extension management (POSDCORB) in public sector, Department of Agriculture, Agricultural Technology Management Agency (ATMA), Krishi Vigyan Kendra (KVK), SAUs, ICAR Institutes, Private sector, Cooperatives, NGOs, FPOs, etc.	2
7	Organisational Structure, Relations between different units- Challenges in management	1
8	Concepts in Management - Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process	2
9	Guidelines for making effective decisions; Human Resource Management: Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development	2
10	Dealing with fund and staff shortages in different extension organizations (KVK, ATMA, etc.)	1
11	Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles; Authority and responsibility, Delegation and decentralization, line and staff relations	2
12	Challenges of co-ordination in extension organizations	1
13	Managing interdepartmental coordination and convergence between KVK, ATMA and line departments; Co-ordinating pluralism in extension services	2
14	Challenges in managing public-private partnerships (PPPs) at different levels in agricultural development in general and extension in particular	2
15	Performance appraisal – Meaning, Concept, Methods	2
16	Motivation and Communication- Managing work motivation – Concept, Motivation and Performance, Approaches to motivation, team building	2
17	Organizational Communication – Concept, Process, Types, Networks, Barriers to Communication; Mentoring, Time management, Team work and team-building strategies	2
18	Modernization of information handling; Supervision and Control - Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision	2
19	Managerial Control – Nature, Process, Types, Techniques of Control, Observation, PERT and CPM, Management Information Systems (MIS): Concept, tools and techniques, MIS in extension organisations	3
	Total	32
Practicals		
1	Simulated exercises on techniques of decision making	2



S. No.	Topic	No. of Lectures/ Practicals
2	Study the structure and function of agro-enterprises, Designing organizational structure/ organograms	2
3	Group activity on leadership development skills	2
4	Simulated exercise to understand management processes	1
5	Field visit to extension organizations (ATARI, KVKs, NGOs), FPOs, dairy cooperatives to understand the functions of management	3
6	Practical exercises on PERT and CPM	2
7	Group exercise on development of short term and long term plans for agro-enterprises	2
8	Developing model agriculture-based projects including feasibility study, financial planning and cost-benefit analysis	2
	Total	16

List of Journals

- *Communicator*
- *Development communication*
- *Indian Dairyman*
- *Indian journal of Adult Education*
- *Indian Journal of Dairy Science*
- *Indian Journal of Extension Education*
- *Indian Journal of Psychology*
- *Indian Journal of Public Administration*
- *Journal of Dairy Research*
- *Journal of Extension Systems*
- *Journal of Rural Development*
- *Journal of Training and Development*
- *The Indian Journal of Animal Sciences*
- *The Indian Veterinary Journal*
- *Journal of Agriculture Extension and Education*
- *Indian Journal of Animal Research*
- *Indian Journal of Gender of Studies*
- *Kurukshetra*
- *Yojana*
- *Economic and Political weekly*
- *Indian Farming*

e-Resources

- www.informaworld.com (Journal of Agricultural Education and Extension)
- www.blackwellpublishing.co (International Journal of Training and Development)
- www.blackwellpublishing.co Educational Measurement: Issue and Practices
- www.academicjournals.net (International Journal of Dairy Science)
- www.cipav.org.co (Livestock Research for Rural Development)
- www.joe.org Journal of Extension

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Basic Veterinary Sciences

– Veterinary Physiology

Preamble

At Masters level in Veterinary Physiology new courses, Endocrinology of domestic animals and Physiology of wild animals are introduced. Similarly at Doctorate level new courses, Recent Trends in ruminant digestion, Cellular and molecular physiology and Recent trends in reproductive physiology are introduced keeping in view of the importance of these fields.



Course Title with Credit Load

M.V.Sc. in Veterinary Physiology

Course Code	Course Title	Credit Hours
VPY 601	Physiology of Digestion	2+1
VPY 602	Cardiovascular and Respiratory Physiology	2+1
VPY 603	Renal Physiology and Body Fluid dynamics	2+1
VPY 604	Haematology	2+1
VPY 605	Growth and Environmental Physiology	2+0
VPY 606	Physiology of Animal Reproduction	2+1
VPY 607	Clinical Physiology	1+1
VPY 608	Neuromuscular Physiology	2+0
VPY 609	Endocrinology of Domestic Animals	2+0
VPY 610	Instrumentation and Research Techniques in Veterinary Physiology	0+2
VPY 611	Physiology of Wild Life	1+0
VPY 612	Masters Seminar	1+0
VPY 613	Masters Research	0+30



Course Contents

M.V.Sc. in Veterinary Physiology

I. Course Title : Physiology of Digestion

II. Course Code : VPY 601

III. Credit Hours : 2+1

IV. Aim of the course

To teach comparative physiology of digestive system of monogastric animals, ruminants and birds, and basic techniques.

V. Theory

Unit I

Basic characteristics and comparative physiology of digestive system of monogastric and polygastric animals. Appetite and control of feed intake.

Unit II

Gastro-intestinal motility, secretory functions of gastro-intestinal tract, their regulation and gastro-intestinal hormones.

Unit III

Digestion, absorption and metabolism of carbohydrate, protein and fat in simple and compound stomach. Absorption of water and electrolytes.

Unit IV

Development of ruminant stomach, rumen microbiology and rumen environment. Ruminant microbial digestion, its advantages and disadvantages. Fate of rumen fermentation products. Rumino-reticular motility, its significance and control. Digestion in birds.

VI. Suggested Reading

- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O Reece, Howard H Erickson, Jesse P Goff, Etsuro E Uemura. 2015.
- *Cunningham's Textbook of Veterinary Physiology* 5th Edn. Bradley G. Klein 2012
- *Digestive Physiology and Nutrition of Ruminants* by D C Church, 1975
- *The Rumen Microbial. Ecosystem.* 2nd Edn. Ed. by. P.N. HOBSON and C.S Stewart 1997
- Hungate RE. 1966. *Rumen and its Microbes.* Acad. Press. N.Y.
- *Rumen Microbiology*, Burk A Dehority. 2003. Nottingham University Press

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Basic characteristics and comparative physiology of digestive system of domestic animals. Classification of animals on the basis of feeding habits, differences in the anatomy of digestive tract	1
2.	General functions of Gastrointestinal tract and its control	1
3.	Functional anatomy of digestive tract of monogastric animals- structural differences among the monogastric animals	1



S. No.	Topic	No. of Lectures/ Practicals
4.	Functional anatomy of digestive tract of ruminants: Development of ruminant stomach	1
5.	Structural details of rumen, reticulum, omasum and abomasum, Rumino-reticular motility, its significance and control	1
6.	Pseudoruminants, reticular groove reflex, rumination process and its phases.	1
7.	Prehension, prehensile organs in different animals, grazing, browsing, rooting, mastication, deglutition, feed intake, water requirements and intake, drinking habits of water in different animals	1
8.	Motility of esophagus, gastro-intestinal motility, primary peristalsis and secondary peristalsis, functions and zones of stomach	1
9.	Rate of gastric emptying, interdigestive motility patterns, migrating myoelectric complex, emesis or vomiting	
10.	Motility in small intestine, nervous and hormonal control, peristaltic reflex and segmentation reflex. Motility in large intestine: caecum, colon, haustral contractions, oral and aboral peristaltic contractions, antiperistaltic contractions, Rate of passage of digesta and its estimation	1
11.	Appetite and control of feed intake, hunger contractions, thirst, constipation, defecation, diarrhea	1
12.	Regulation of GIT functions, gastro-intestinal hormones and their functions	1
13.	Salivary secretion, its composition and functions	1
14.	Secretion of gastric juice, phases of gastric secretion, composition, zymogen, autocatalysis and digestion in stomach	1
15.	Pancreatic juice, secretion, control and composition,	1
16.	Proteases, lipases, amylases and other enzymes of pancreatic juice.	1
17.	Trypsin inhibitor and end products of pancreatic digestion	1
18.	Liver, structure of liver lobule: secretion of bile and its regulation bile acids, bile salts, bile pigments: functions of bile	1
19.	Enterohepatic recirculation: gall bladder function and contractions.	1
20.	Intestinal juices, their secretions, composition and functions	1
21.	Absorption of nutrients in the digestive tract and the effect of nutrient interactions	1
22.	Bacterial fermentation in large intestine, fermentative products, absorption of end products of fermentation	1
23.	Metabolism and excretion of various nutrients,	1
24.	Development of ruminant system and rumen environment	1
25.	Rumen microbiology, Rumen microbes: classification of rumen bacteria, protozoa, fungi	2
26.	Ruminant microbial digestion, Fermentation pathways: fermentation of carbohydrates, protein and fat, microbial activities in ruminant stomach and intestine	2
27.	Rumen degradable proteins, rumen undegradable proteins and urea feeding	1
28.	Volatile fatty acids, Absorption of end products and place of absorption and mechanism of absorption	1
29.	Advantages and disadvantages of ruminant digestion, artificial rumen	1
30.	Digestion in birds: functional anatomy of avian digestive system, swallowing, crop, proventriculus, ventriculus, caeca, nitrogen metabolism	1
	Total	32



S. No.	Topic	No. of Lectures/ Practicals
Practicals		
1.	Collection of saliva and its enzymatic studies	1
2.	Gastric and intestinal motility, Rate of passage of digesta and its estimation	1
3.	Rumino-reticular movements	1
4.	Activity of pepsin and trypsin enzymes	1
5.	Estimation of digestive metabolites such as glucose and ketone bodies,	1
6.	Estimation of triglycerides, cholesterol	1
7.	Estimation of urea nitrogen and total proteins	1
8.	Liver function tests	2
9.	Pancreatic function tests	1
10.	Methods of collection of rumen liquor, merits and demerits	1
11.	Determination of pH, total volatile fatty acids in rumen liquor	1
12.	Determination of ammonia-nitrogen and total-nitrogen in strained rumen liquor	2
13.	Counting of protozoa and bacteria in rumen liquor	1
14.	Demonstration of fermentation of feed-stuff in artificial rumen	1
	Total	16

I. Course Title : Cardiovascular and Respiratory Physiology

II. Course Code : VPY 602

III. Credit Hours : 2+1

IV. Aim of the course

To teach function and regulation of heart, recording of ECG and respiration in different animals and basic techniques.

V. Theory

Unit I

Functional anatomy of heart and properties of cardiac muscle, Origin and propagation of cardiac impulses. Rhythmic excitation of heart, Electrophysiology of heart, Cardiac cycle, Cardiac sounds.

Unit II

Cardiac output and its measurements, Factors affecting cardiac output. Venous return and its regulation. Regulation of the cardiac functions.

Unit III

Normal electrocardiogram, Electrocardiographic interpretation in common cardiac disorders. Cardiac murmurs and cardiac arrhythmias. Echocardiography.

Unit IV

Circulation - coronary, systemic and pulmonary circulation and their regulation. Regional circulation. Pathophysiology of circulation. Hemodynamics. Arterial pressure. Capillary exchanges. Lymphatic circulation.

Unit V

Respiration, Mechanism of ventilation, Transport and exchange of respiratory gases at alveolar and tissue level, Respiratory adjustments at high altitude, Stress and

exercise. Pulmonary volumes and capacities. Neural and chemical control of respiration. Respiration in birds.

VI. Suggested Reading

- Guyton and Hall *Textbook of Medical Physiology* 13th Edn John E. Hall Ph.D. 2015
- *Ganong's Review of Medical Physiology*, 26th Edn Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks, 2019
- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O. Reece, Howard H. Erickson, Jesse P. Goff, Etsuro E. Uemura 2015.
- *Cunningham's Textbook of Veterinary Physiology* 5th Edn. Bradley G. Klein 2012.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	Functional anatomy of heart	1
2	Electrophysiology of heart	1
3	properties of cardiac muscle	1
4	Origin and propagation of cardiac impulses	1
5	Rhythmic excitation of heart	1
6	Cardiac cycle	1
7	Cardiac sounds	1
8	Cardiac output and its measurements	1
9	Factors affecting cardiac output	1
10	Regulation of the cardiac functions	1
11	Venous return and its regulation	1
12	Normal electrocardiogram	1
13	Electrocardiographic interpretation in common cardiac disorders.	1
14	Cardiac murmurs	1
15	Cardiac arrhythmias	1
16	Echocardiography	1
17	Hemodynamics	1
18	Blood pressure - factors affecting it and measurement	1
19	Regulation of blood pressure	1
20	Systemic circulation and pulmonary circulation	1
21	Coronary circulation	1
22	Regional circulation	1
23	Introduction to respiration	1
24	mechanism of ventilation	1
25	Pulmonary volumes and capacities	1
26	Transport and exchange of respiratory oxygen at alveolar and tissue level	1
27	Transport and exchange of respiratory carbondioxide at alveolar and tissue level	1
28	Neural and chemical control of respiration	1
29	Respiratory adjustments at high altitude	1
30	Respiratory adjustments to stress	1
31	Respiratory adjustments to exercise	1
32	Respiration in birds	1
	Total	32
Practical		
1.	Determination and recording of cardiac output	1
2.	Measurement of blood pressure by sphygmomanometer	1
3.	Recording of heart rate by physiograph	1



S. No.	Topic	No. of Lectures/ Practicals
4.	Effect of various ions and electrolytes on heart	1
5.	Effect of hormones on heart	1
6.	Effect of temperature on heart	1
7.	Recording and interpretation of normal ECG	1
8.	Recording and interpretation of cardiac disorders by ECG	1
9.	Determination of blood volume	1
10.	Effect of exercise on heart rate, pulse rate rate	1
11.	Estimation of cardiac marker enzymes	1
12.	Determination of lung volumes and capacities by spirometry	1
13.	Estimation of blood gases	1
14.	Estimation of blood pyruvate	1
15.	Estimation of blood lactate	1
16.	Effect of exercise on respiration rate	1
	Total	16

I. Course Title : Renal Physiology and Body Fluid Dynamics

II. Course Code : VPY 603

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge regarding excretory system of mammals and birds, maintenance of body fluid homeostasis

V. Theory

Unit I

An overview of nephron structure and function. Renal function in mammals.

Unit II

Renal haemodynamics. Glomerular filtration, Tubular reabsorption and secretion. Urine formation- stages and factors affecting different stages.

Unit III

Role of kidney in acid-base balance, Physiology of micturition, Endocrine control of renal function- Renin angiotensin aldosterone system. Non excretory functions of kidney.

Unit IV

Excretory system in birds.

Unit V

Body fluids – various body fluid compartments, Different types of body fluids and their functions, Composition of different body fluids and their regulation.

VI. Suggested Reading

- Guyton and Hall *Textbook of Medical Physiology* 13th Edn John E Hall Ph.D.. 2015
- *Ganong's Review of Medical Physiology*, 26th Edn Kim E Barrett, Susan M Barman, Scott Boitano, Heddwon Brooks. 2019.
- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O Reece, Howard H Erickson, Jesse P Goff, Etsuro E Uemura. 2015.
- *Cunningham's Textbook of Veterinary Physiology* 5th Edn. Bradley G Klein. 2012.
- Klahar S. 1983. *The Kidney and Body Fluids in Health and Diseases*. Plenum Press.



S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to physiology of mammalian kidney	1
2.	Theories of renal formation and Functional anatomy of kidney	1
3.	Renal homeostatic function	1
4.	Renal circulation and Pressures in renal function	1
5.	Glomerular filtration	1
6.	Solute reabsorption	1
7.	Tubular secretion	1
8.	Water excretion	1
9.	Absorbptive capabilities of different segments of nephron	1
10.	Renal mechanism for concentration of urine	1
11.	Renal mechanism for dilution of urine	1
12.	Autoregulation of renal blood flow and GFR	1
13.	Renal function tests	1
14.	Hormonal regulation of kidney function	1
15.	Characteristics of urine in different species	1
16.	Renin-angiotensin-aldosterone system	1
17.	Micturition	1
18.	Non excretory functions of kidney	1
19.	Acids and bases in the body	1
20.	Buffers in the body	1
21.	Role of buffers in acid base balance	1
22.	Disturbances in acid base balance	1
23.	Urine formation in birds	1
24.	Characteristics of avian urine	1
25.	Body fluid compartments	1
26.	Regulation of ECF osmolality and volume	1
27.	Regulation of ECF electrolytes	1
28.	Water balance	1
29.	Measurement of body water	1
30.	Water loss from routes other than kidney	1
31.	Water conservation in domestic animals	1
32.	Diuretics	1
33.	Determining the degree of dehydration in an animal	1
34.	Fluid therapy	1
	Total	34
Practical		
1.	Collection and preservation of urine	1
2.	Qualitative analysis of physiological constituents of urine	1
3.	Qualitative analysis of pathological constituents of urine	1
4.	Quantitative analysis of BUN in blood and urine	1
5.	Quantitative analysis of creatinine in blood and urine	1
6.	Quantitative analysis of phosphate and glucose in blood and urine	1
7.	Determination of sodium, potassium in serum	1
8.	Determination of calcium and chloride in serum	1
9-16.	Demonstration of various kidney function tests- glomerular filtration rate, creatinine clearance rate, urea clearance rate and glucose tolerance test.	8
	Total	16



- I. Course Title : Hematology**
II. Course Code : VPY 604
III. Credit Hours : 2+1

IV. Aim of the course

To acquaint the students about haematology of different animals including hands-on training.

V. Theory

Unit I

Hematopoietic stem cells, Blood cells and hematological indices, Anaemia, Different types of anaemia, Polycythemia and their effect on circulation in mammals and birds. Fate of erythrocytes. Porphyrias.

Unit II

Resistance of the body to infection, Leukocytes, tissue macrophage system and inflammatory response.

Unit III

Haemoglobin and its types, Iron binding proteins in blood, Haemoglobin disorders. Hemophilias. Immunity, Ommunoglobulins complement system.

Unit IV

Hemostasis and coagulation factors, Role of platelets, Fibrinolysis. Conditions causing bleeding disorders. Blood groups, transfusion of blood.

VI. Suggested Reading

- Jain NC. 1993. *Essentials of Veterinary Hematology*. Lea and Febiger.
- *Schalm's Veterinary Hematology* 6th Ed - D Weiss J Wardrop, Wiley-Blackwell. 2010.
- *Guyton and Hall Textbook of Medical Physiology* 13th Edn John E Hall Ph.D. 2015.
- *Cunningham's Textbook of Veterinary Physiology* 5th Edn. Bradley G Klein. 2012.
- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O Reece, Howard H Erickson, Jesse P Goff, Etsuro E Uemura. 2015.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Haematology- blood - composition-solutes of blood-plasma- interstitial fluid-lymph	1
2.	Functions of blood-general characteristics of blood-haematocrit-ESR- viscosity-temperature- volume-pH- colour- lifespan	1
3.	Haematocrit-methods of determination -colour index- icterus index- blood volume- methods of determination	1
4.	Plasma proteins – fractions- electrophoretic separation- general functions	1
5.	Functions of pre albumin-albumin-globulins and its fractions-	1
6.	Haematopoiesis- multipotent stem cells-definition-organs of hematopoiesis- red and yellow marrow	1
7.	Multipotent lymphoid and myeloid stem cells- differentiation and maturation	1
8.	Bone marrow micro environment for haematopoiesis- stages of erythropoiesis	1
9.	Erythropoiesis- its regulation- vitamins and erythropoietin- haematinics	1



S. No.	Topic	No. of Lectures/ Practicals
10.	Haemoglobin- stages of Hb synthesis- regulation	1
11.	Types of Hb	1
12.	Iron metabolism- Fe requirement- hepcidin	1
13.	Intravascular and extravascular haemolysis	1
14.	Catabolism of Hb	1
15.	Plasma bilirubin- types- hyperbilirubinemia	1
16.	Jaundice - types- etiology - differential diagnosis	1
17.	Anisocytosis- poikilocytosis- RBC membrane structure- composition of RBC membrane	1
18.	RBC metabolism-physiological and pathological conditions associated with polycythemia and oligocythemia	1
19.	Anemias- classification- defective formation-excessive destruction- abnormal heme- abnormal globin chains- causes	1
20.	Erythrocyte indices- cytometric classification of anemias- causes- Red cell distribution width	1
21.	Leucocytopoiesis- granulocytopoiesis- lymphopoiesis	1
22.	Functions of neutrophils- phagocytosis- opsonisation-eosinophils- basophils-monocytes	1
23.	Conditions associated with altered number of neutrophils, eosinophils, basophils, monocytes and lymphocytes	1
24.	Hemostasis- blood fluidity maintenance- injury leading to primary hemostatic plug formation	1
25.	Secondary hemostatic pathways- intrinsic and extrinsic pathways- regulation-stabilisation of clot	1
26.	Fibrinolysis- retraction of clot- haemostatic disorders	1
27.	Types of immunity-innate-acquired- types of acquired immunity- Passive immunity-types-antibody-mechanism of actions of Ab-	1
28.	NK cells-functions-T-cell lymphocytopoiesis- thymus- functions- thymosin-thymopoietin-maturation of T cells- T cell receptors-blood thymus barrier	1
29.	Formation of T helper, cytotoxic and regulatory cells	1
30.	Plasma cells-structure – formation and functions	1
31.	Blood group antigens- cross reactivity- transfusion immunology	1
32.	Rh blood group- erythroblastosisfoetalis-treatment	1
	Total	32
Practical		
1.	Enumeration of RBC, WBC	1
2.	Enumeration of platelets	1
3.	Enumeration of reticulocytes	1
4.	Enumeration of differential leucocytes	1
5.	Special staining techniques for leucocytes	1
6.	Haemogram by automated blood cell counter	1
7.	Anemic blood: Hb, PCV	1
8.	Icterus index calculation using plasma and standard	1
9.	Colour index calculation using plasma and standard	1
10.	Band cell count and arneth count	1
11.	Blood viscosity and RBC fragility determination	1
12.	Activated partial thromboplastin time	1
13.	Prothrombin time	1



S. No.	Topic	No. of Lectures/ Practicals
14.	Avian blood: haemogram-I (erythrocyte relates parameters using special stain)	1
15.	Avian blood-haemogram-II (leucocyte relates parameters using special stain)	1
16.	Preparation of blood cells for electron microscopic analysis	1
	Total	16

I. Course Title : Growth and Environmental Physiology

II. Course Code : VPY 605

III. Credit Hours : 2+0

IV. Aim of the course

To teach the Growth process and its regulation, effect of mineral and vitamins on body functions and influence of environmental conditions on homeothermy.

V. Theory

Unit I

Growth - Introduction and Concepts. Hormonal regulation of growth. Growth promoters.

Unit II

Minerals - Classification-functions and disorders. Chelated minerals, nanominerals.

Unit III

Vitamins - Classification-functions and disorders. Synthetic vitamins.

Unit IV

Environment - Introduction and concepts. Weather and climate. Homeothermy, Poikilothermy. Hibernation and estivation. Thermoregulation, thermal stress. Effect of environment on production and reproduction.

VI. Suggested Reading

- Samuel Brody. 1945. *Bioenergetics and growth*. Reinhold Publishing Corp., New York
- Hossner KL. 2005. *Hormonal Regulation of Farm Animal Growth*. CABI.
- McDowell LR. 1989. *Vitamins in Animal Nutrition*. Academic Press.
- Underwood EJ. 1977. *Trace Elements in Human and Animal Nutrition*. Academic Press.
- ESE Hafez. 1968. *Adaptation of Domestic Animals*. Lea and Febiger.
- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O Reece, Howard H Erickson, Jesse P Goff, Etsuro E Uemura 2015.

S. No.	Topic	No. of Lectures/ Practicals
1.	Growth - Definition, concepts, terminologies used in expression of growth	1
2.	Hormonal regulation of growth	2
3.	Commercial and synthetic hormones used in growth regulation	1
4.	Growth promoters used in livestock	1
5.	Growth promoters used in poultry	1
6.	Minerals - Introduction, Classification, sources	1
7.	Bioavailability of different minerals	1



S. No.	Topic	No. of Lectures/ Practicals
8.	Physiological role of minerals	1
9.	Disorders of mineral metabolism in livestock	1
10.	Disorders of mineral metabolism in poultry	1
11.	Chelated minerals	1
12.	Nanotechnology in mineral supplementation	1
13.	Vitamins - Introduction, Classification, sources	1
14.	Physiological role of fat soluble vitamins	1
15.	Physiological role of water soluble vitamins	1
16.	Disorders of fat soluble vitamins	1
17.	Disorders of water soluble vitamins	1
18.	Synthetic vitamins in animal production	1
19.	Environment - Introduction, physical components	1
20.	Physical principles of heat exchange	1
21.	Weather and climate	1
22.	Homeothermy, Poikilothermy, endothermy and ectothermy	1
23.	Hibernation and estivation	1
24.	Body temperature in different species	1
25.	Thermoregulation in livestock	1
26.	Thermoregulation in poultry	1
27.	Thermal stress	1
28.	Heat tolerance coefficient	1
29.	Effect of weather variables on production - Milk, meat, wool	2
30.	Effect of weather variables on reproduction	1
	Total	32

I. Course Title : Physiology of Animal Reproduction

II. Course Code : VPY 606

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge of male and female reproductive system of different species of animals including birds.

V. Theory

Unit I

Functional histomorphology of male and female reproductive system. Development of male and female sex organs in different domestic animals. Neuro-endocrine reflexes.

Unit II

Puberty and its endocrine control. Sexual cycles and mating behaviours in females, oogenesis, folliculogenesis and ovulation. Secretions of female reproductive tract in different species of animals. Endocrine regulation of female reproduction.

Unit III

Male mating behaviour, Spermatogenesis, Spermiogenesis, Spermatogenic cycles. Spermatozoa- structure and composition, Maturation and transportation. Secretions of male reproductive tract. Endocrine regulation of male reproduction.



Unit IV

Transport of male and female gametes, Fertilization, implantation. Early embryo development and maternal recognition of pregnancy. Hormones of pregnancy. Placentation, parturition and Uterine Involution. Avian reproduction and formation of egg.

VI. Suggested Reading

- *Reproduction in Farm Animals*, 7th Edn ESE Hafez, B Hafez. 2013.
- *McDonald's Veterinary Endocrinology*, Pineda and Doley. Iowa State University Press, Ames, 2003.
- *Physiology of Reproduction and Artificial Insemination*, Salisbury GW and Demark NL. WB Saunders, 1978.
- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O Reece, Howard H Erickson, Jesse P Goff, Etsuro E Uemura. 2015.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	Functional histomorphology of male reproductive system	1
2	Functional histomorphology of female reproductive system	1
3	Development of male sex organs in different domestic animals	1
4	Development of female sex organs in different domestic animals	1
5	Neuro-endocrine reflexes	1
6	Puberty and its endocrine control in male domestic animals	1
7	Puberty and its endocrine control in female domestic animals	1
8	Sexual cycles in females	1
9	Mating behaviour in females	1
10	Oogenesis	1
11	Folliculogenesis	1
12	Ovulation	1
13	Secretions of female reproductive tract in different species of animals	1
14	Endocrine regulation of female reproduction in different species of animals	1
15	Spermatogenesis	1
16	Spermiogenesis	1
17	Spermatogenic cycles	1
18	Spermatozoa- structure and composition	1
19	Spermatozoa- maturation and transportation	1
20	Secretions of male reproductive tract.	1
21	Endocrine regulation of male reproduction in different species of animals	1
22	Transport of male and female gametes	1
23	Fertilization	1
24	Implantation	1
25	Early embryo development	1
26	Maternal recognition of pregnancy	1
27	Hormones of pregnancy	1
28	Placentation	1
29	Gestation	1
30	Parturition and Uterine Involution	1
31	Post-partum recovery in different species of domestic animals	1
32	Avian reproduction and formation of egg	1
	Total	32
Practical		
1.	Methods of heat detection in different species of domestic animals	1



S. No.	Topic	No. of Lectures/ Practicals
2.	Palpation of reproductive organs	1
3.	Examination of fern pattern in cervical mucus	1
4.	Semen evaluation - Gross	1
5.	Semen evaluation - Microscopical	1
6.	Semen evaluation - Biochemical	1
7.	Demonstration of preservation of semen	1
8.	Isolation of different follicles	1
9.	Collection of oocytes and their grading	1
10.	Estimation of reproductive hormones	3
11.	Demonstration of estrus behaviour	1
12.	Demonstration of mating	1
13.	Demonstration of parturition	1
14.	Demonstration of oviposition	1
	Total	16

I. Course Code : Clinical Physiology

II. Course Title : VPY 607

III. Credit Hours : 1+1

IV. Aim of the course

To teach physiological basis of clinical abnormalities in body functions.

V. Theory

Unit I

Introduction and basic concepts of understanding of alteration in system functions
Relationship of cardiovascular, renal, respiratory systems and liver in healthy domestic animals and compensatory mechanisms during failure/ disorder of one or other systems
Clinical Haematology and enzymology.

Unit II

Metabolism of carbohydrate, protein, lipid, vitamin and minerals in health and disease of various species of domestic animals and poultry.

Unit III

Evaluation of common endocrine disorders – pituitary, thyroid, parathyroid, pancreas in domestic animals (with reference to species and profile). Reproductive function alterations in male and female domestic animals during stress- productive, environmental, nutritional.

Unit IV

Clinical evaluation of Gastrointestinal tract; Clinical evaluation of Special Senses; Neuromuscular disorders and clinical correlation; Assessment of acid base and electrolyte balance.

VI. Suggested Reading

- *Clinical Biochemistry of Domestic Animals* 6th Edn, Jiro Jerry Kaneko, John W Harvey, Michael L Bruss, Academic Press. 2008.
- *Hawk's Physiological Chemistry*. Oser BL Tata McGraw-Hill. 1976.
- *Clinical Biochemistry: An Illustrated Colour Text*. Allan Gaw; Michael Murphy; Robert Cowan; Denis O'Reilly; Michael Stewart; James Shepherd, 2004



- *Clinical Physiology of Acid Base and Electrolyte Disorders*. Rose BD. McGraw-Hill. 1989.
- *Clinical Physiology: An Examination Primer*. 1st Edn, Ashis Banerjee, Cambridge University Press. 2005.
- *Textbook of Veterinary Physiological Chemistry* 3rd Edn, Larry R Engelking. 2014.
- *Practical Clinical Biochemistry: Methods and Interpretations*. 4th Edn. Chawla Ranjna. 2014.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	Introduction and basic concepts of understanding of alteration in system functions	1
2	Relationship of cardiovascular, renal, respiratory systems and liver in healthy domestic animals and compensatory mechanisms during failure/ disorder of one or other systems	2
3	Clinical Haematology	1
4	Clinical enzymology	1
5	Metabolism of Carbohydrate in health and disease of various species of domestic animals and poultry	1
6	Metabolism of protein in health and disease of various species of domestic animals and poultry	1
7	Metabolism of lipid in health and disease of various species of domestic animals and poultry	1
8	Metabolism of vitamins in health and disease of various species of domestic animals and poultry	1
9	Metabolism of minerals in health and disease of various species of domestic animals and poultry	1
10	Evaluation of common endocrine disorders – pituitary, thyroid, parathyroid, pancreas in domestic animals (with reference to species and profile)	2
11	Reproductive function alterations in male and female domestic animals during stress- productive, environmental, nutritional	1
12	Clinical evaluation of Gastrointestinal tract and special senses	1
13	Neuromuscular disorders and clinical correlation	1
14	Acid base and electrolyte balance	1
15	Biological fluid analysis	1
	Total	17
Practical		
1	Hematological analysis of clinically recovered animals	2
2	Liver function tests of clinically recovered animals	2
3	Electrocardiography and interpretations of clinically recovered animals	2
4	Sphygmomanometry of clinically recovered animals	1
5	Respiratory Function tests of clinically recovered animals	1
6	Digestive function tests of clinically recovered animals	1
7	Renal function tests of clinically recovered animals	1
8	Estimation of serum enzymes related to cardiovascular functions of clinically recovered animals	1
9	Estimation of serum enzymes related to liver functions of clinically recovered animals	1
10	Estimation of serum enzymes related to kidney functions of clinically recovered animals	1
11	Clinical Examination of endocrinology disorder animals Bioassay of steroid hormones of clinically recovered animals	2
12	Physiographic study of body parameters of clinically recovered animals	1
	Total	16



I. Course Title : Neuromuscular Physiology

II. Course Code : VPY 608

III. Credit Hours : 2+0

IV. Aim of the course

To impart knowledge of coordination of body functions and regulation of brain functions and sense organs.

V. Theory

Unit I

Functional anatomy, types and classification of muscles, of muscles. Properties of skeletal muscle, Contractile elements, Membrane and action potential, Molecular mechanism of muscle contraction, Myoneuronal junction and transmission of impulse, Smooth muscle contraction.

Unit II

Length and tension relationship, Force and velocity relationship. Skeletal muscle energetics, Metabolism and lactate shuttle. Exercise, adaptation to training and performance.

Unit III

Classification of nervous system. Neuron and its classification, Properties. Development of action potential and transmission of nerve impulse in nerve and synapse. Regulatory centres in brain. Reflexes. Functions of Cerebrum, Cerebellum, Hypothalamus, Limbic system.

Unit IV

Receptors and its types. Special senses.

VI. Suggested Reading

- *Guyton and Hall Textbook of Medical Physiology* 13th Edn John E Hall Ph.D. 2015.
- *Ganong's Review of Medical Physiology*, 26th Edn Kim E Barrett , Susan M Barman, Scott Boitano, Heddwen Brooks, 2019.
- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O Reece, Howard H Erickson, Jesse P Goff, Etsuro E Uemura. 2015.
- *Cunningham's Textbook of Veterinary Physiology* 5th Edn. Bradley G. Klein. 2012.
- *Fundamentals of Neurophysiology*. Smith RF Springer Verlag. 1978.

S. No.	Topic	No. of Lectures
1.	Introduction, Organisation of Nervous system	1
2.	Cellular communication- concept of membrane potential	1
3.	Synapse and its properties, Synaptic transmission	1
4.	Neurotransmitters	1
5.	Sensory systems and Receptors	1
6.	Pain Physiology	1
7.	Cerebral cortex –Anatomy and Physiology	1
8.	Interbrain, thalamus and hypothalamus	1
9.	Midbrain – Physiological capability	1
10.	Brain stem – Physiological anatomy	1
11.	Sleep and EEG	1
12.	Memory and its types	1
13.	Pons and medulla – Anatomy and Physiology	1



S. No.	Topic	No. of Lectures
14.	Cerebellum – Anatomy and Physiology	1
15.	Spinal cord - Anatomy and Physiology	1
16.	Spinal reflexes and properties	1
17.	Postural reflexes	1
18.	Peripheral nervous system	1
19.	Autonomic nervous system – Sympathetic nervous system	1
20.	Autonomic nervous system – Parasympathetic nervous system	1
21.	Enteric nervous system	1
22.	Overall motor control	1
23.	Sensory Physiology – Photoreception	1
24.	Sensory Physiology – Auditory and equilibrium maintenance	1
25.	Sensory transduction – Gustation and olfaction	1
26.	Muscle structure and types	1
27.	Physiological properties of muscle	1
28.	Mechanism of muscle contraction	1
29.	Properties of muscle contraction	1
30.	Muscle metabolism	1
31.	Anatomy of Neuromuscular junction	1
32.	Smooth muscle physiology	1
	Total	32

I. Course Title : Endocrinology of Domestic Animals

II. Course Code : VPY 609

III. Credit Hours : 2+0

IV. Aim of the course

To impart knowledge of chemical integration of body functions.

V. Theory

Unit I

Methods of study of bioregulation including methods of endocrine analysis. Manipulation and disruption of biorhythms in homeostatic and natural ecosystem.

Unit II

Hormonal relationship in animal production. Concepts in hormone function, classification and methods of study, Hormonal assay, Mechanism of hormone synthesis, Release and transport. Mechanisms of hormone action, Target cell interactions.

Unit III

Genetic and genomic approaches in endocrinology. Animal models and alternate uses of animal model. Regulation and metabolism of hypothalamic, hypophyseal, thyroid and adrenal hormones.

Unit IV

Gonadal and placental hormones, their regulation and mechanism of action. Hormonal principles of pineal gland and its role in production.

Unit V

Endocrine control of carbohydrate and calcium homeostasis. Hormones and

adaptation to environment. Hormonal regulation of gastro-intestinal activity. Prostaglandins. Hormones in fertility regulation and production augmentation. Avian endocrinology.

VI. Suggested Reading

- *McDonald's Veterinary Endocrinology*, Pineda and Doley. Iowa State University Press, Ames, 2003
- *General Endocrinology*. Turner CD and Bagnara JT, WB Saunders. 1976
- *Canine and Feline Endocrinology and Reproduction*, 3rd Edition, Edward C Feldman, Richard W Nelson. 2003.
- *Applied Animal Endocrinology* 2nd Edn. E James Squires. 2010

S. No.	Topic	No. of Lectures
1	Introduction to bioregulation <ul style="list-style-type: none"> – Scientific methods – Controlled experimental testing – Representative sampling – Dose response Relationship – Biological Rhythm – Endocrine–Nervous -Immune system interaction 	1
2	Methods of endocrine secretion analysis <ul style="list-style-type: none"> – Extirpation -observation: Replacement –observation – Imaging – Radioimmunoassay – Enzyme immunoassay – High Performance Liquid Chromatography/ spectroscopy – Immunohistochemistry – Bioassays – Techniques for determining the number and characteristics of hormone receptor 	1
3	Disruption of biorhythms in homeostatic and natural ecosystem <ul style="list-style-type: none"> – Endocrine disruptors or modulators – Assessment of endocrine disruptor activity – Sources of endocrine disruptors – Xenobiotics – Environmental pollutants altering endocrine secretions 	1
4	Concepts in hormone function <ul style="list-style-type: none"> – Morphological functions Biological functions <ul style="list-style-type: none"> – Physiological functions – Molecular functions 	1
5	Mechanism of hormone synthesis of <ul style="list-style-type: none"> – Protein hormones – Steroid hormones – Eicosanoids – Thyroid hormones – Monoamines 	1
6	Release and transport in blood <ul style="list-style-type: none"> Mechanisms for regulating release <ul style="list-style-type: none"> – In response to Trophic hormone – In response to Nervous stimuli (environmental cues) – In response to levels of various metabolites 	

S. No.	Topic	No. of Lectures
	Transport	
	– Carrier proteins	
	– Half life	
	– Control of hormone release	
	– Pulsatile release	
	– Sustained release	
	– Feed back mechanism	1
7	Mechanisms of hormone action	
	Extracellular receptors	
	– G protein coupled receptors	
	– Catalytic receptors	
	Intracellular receptors	
	– cytoplasmic	
	– intranuclear	
	Target cell interactions	
	– Upregulation	
	– Down regulation	2
8	Genomic approaches in endocrinology.	
	– Use of transgeneic animals	
	– Knockout animals	
	– Proteomics	
	– Two dimensional gel electrophoresis	
	– X ray crystallography	
	– Tomography	
	– MRI	2
9	Animal models to study endocrine disorder	
	– Whole animal model	
	– Isolated organs or tissues	
	– <i>In vitro</i> models	2
10	Hypothalamic, hypophyseal hormones	
	– Structure	
	– function relationship of pituitary and hypothalamus	
	Anterior pituitary hormones	
	Growth hormone	
	– structure, production, biological functions, disorders of growth hormone production	
	Prolactin	
	– structure, production, biological	
	– functions, disorders of growth hormone production	
	ACTH	
	– structure, production, biological	
	– functions	
	FSH	
	– structure, production, biological functions	
	LH	
	– structure, production, biological functions	
	Posterior pituitary hormones	
	Oxytocin	
	– structure, production, biological functions	
	Vasopressin	
	– structure, production, biological functions	



S. No.	Topic	No. of Lectures
	Hypothalamic releasing and release inhibiting hormones	
	– Growth hormone inhibiting hormone	
	– Gonadotropin releasing hormone	2
11.	Thyroid hormones	
	– Transport	
	– Receptors	
	– Metabolism	
	– Metabolic effects	
	– Effect on growth, development, fertility and milk production	2
12.	Adrenal hormones	
	• Structure of adrenal and synthesis of cortical hormones	
	• Physiological roles of	
	– Glucocorticoids	
	– Mineralocorticoids	
	• Physiological role of medullary hormones	2
13.	Pineal gland and its role in production.	
	• Melatonin	
	• Photoperiodism	
	• Seasonal breeding	
	• Manipulation of breeding cycle	
	– Implants	
	– Sustained release bolus	1
14.	Endocrine control of carbohydrate homeostasis	
	– Insulin	
	– Glucagon	
	– Epinephrine	
	– Growth hormone	
	– Glucocorticoids	
	– Thyroxine	2
15.	Endocrine control of calcium homeostasis	
	– Parathyroid hormone	
	– Calcitonin	
	– Calcitriol (Vitamin D3)	
	– Estrogens/ Androgens	
	– Glucocorticoids	
	– Thyroid hormones	
	– Insulin like growth factors	2
16.	Hormonal regulation of gastro-intestinal activity	
	– Gastrin	
	– Secretin	
	– Gastrin releasing peptide	
	– Cholecystokinin	
	– Gastric inhibitory peptide	
	– others	1
17.	Prostaglandins-Synthesis, types, release and mode of action	1
18.	Hormones in fertility regulation	
	• Manipulation of reproduction	
	• Regulation and manipulation of oestrous cycle	
	• Use of hormone agonists to control fertility	
	• Detection and synchronization of oestrus	
	• Strategies for synchronizing oestrus	
	• Prostaglandin F _{2α} based systems	
	• Progesterin and other hormones based systems	
	• Superovulation and embryo transfer	



S. No.	Topic	No. of Lectures
	<ul style="list-style-type: none"> • <i>In-vitro</i> production of embryos • Recognition and maintenance of pregnancy • Induction of abortion/ parturition • Advancing cyclicity in seasonal breeders, and puberty in animals • Immunological manipulation of reproduction 	3
19.	Hormones in production augmentation <ul style="list-style-type: none"> • Somatotrophin • Adipokines • Leptin • Anabolic steroids and Analogues –mechanism of action delivery systems and safety aspects • β Adrenergic Agonists –mechanism of action delivery systems and safety aspects • Dietary supplements <ul style="list-style-type: none"> – chromium, PUFA and CLA • Regulation of feed intake <ul style="list-style-type: none"> – Orexigenic hypothalamic neurohormones – Anorexigenic hypothalamic neuropeptides – Hormonal regulation of mammary gland development and milk secretion 	2
20	Avian endocrinology <ul style="list-style-type: none"> – Reproductive hormones – Hormonal manipulation of egg production – Control of broodiness in poultry – Manipulation of moulting 	2
	Total	32

I. Course Title : Instrumentation and Research Techniques in Veterinary Physiology

II. Course Code : VPY 610

III. Credit Hours : 0+2

IV. Aim of the course

Training in various techniques for application in research in Animal Physiology

V. Suggested Reading

- *Hawk's Physiological Chemistry*. Oser BL Tata McGraw-Hill. 1976.
- *Varley's Practical Clinical Biochemistry* Alan H Gowenlock
- *Handbook of Radioimmunoassay*. Abraham GE Marcel Dekker. 1977.
- *Electrocardiograms: A Systematic Method of Reading Them* Armstrong ML. 1978
- *Rumen Microbiology*, Burk A Dehority 2003 Nottingham University Press

S. No.	Topic	No. of Lectures
1.	Design and types of research laboratory	1
2.	Maintenance of research equipments	1
3.	Imparting knowledge about preparation of various solutions	1
4.	Basic principles and concepts of pH	1
5.	Determination of pH of various solutions and biological samples	1
6.	Basic principles and concepts of ECG	1
7.	Recording of ECG in animals	1



S. No.	Topic	No. of Lectures
8.	Basic principles and concepts of physiograph and its accessories for <i>in-vitro</i> live tissue experiments	1
9.	Recording of blood pressure by physiograph and sphygmomanometer	1
10.	Recording of pulse rate by physiograph	1
11.	Recording of respiratory volumes by spirometer	1
12.	Neuro muscular experimental physiology using physiograph	1
13.	Physical and chemical principles of chromatography	1
14.	Extraction of active compounds from biological samples	1
15.	Protein separation and isolation methods – basic concepts	1
16.	Methods of protein determination	1
17.	Electrophoresis	1
18.	Thin layer chromatography	1
19.	Gas liquid chromatography	1
20.	Basic concepts of mineral estimation	1
21.	Flame photometry	1
22.	Laws of colorimetry	1
23.	Spectrophotometry	1
24.	Organ bath – Applications in experimental physiology	1
25.	Experiments using organ bath	1
26.	Enumeration of ruminal microflora	1
27.	Estimation of VFA	1
28.	Estimation of ammonia nitrogen	1
29.	Estimation of body water	1
30.	<i>In-vitro</i> rumen studies	1
31.	ELISA for estimation of various hormones	1
32.	RIA for estimation of various hormones	1
	Total	32

I. Course Title : Physiology of Wild Life

II. Course Code : VPY 611

III. Credit Hours : 1+0

IV. Aim of the course

To impart the knowledge on physiology of wild animals. The course content refers to wild animals related to Indian forests restricted to small and large animals. This course does not cover insects and other species for which veterinarian are not usually called for.

V. Theory

Unit I

Overview of Indian forests – Identification of sex in wild animals and birds - Blood collection methods in wild animals – Hematology - Common clinical biochemical estimations.

Unit II

Body temperature measurement techniques – Measurement of stress - Measuring senescence.



Unit III

Reproduction management in wild animals - Understanding sound mechanics and communication methods – Ethology of wild animals - Government policies for wild life protection.

VI. Suggested Reading

Standard text books and Government policies pertaining to wild life.

S. No.	Topic	No. of Lectures
Theory		
1.	Animal Species Overview of Indian forests.	1
2.	How to identify the sex of wild animals and birds.	1
3.	Collection of Clinical materials for laboratory examination; methods	1
4.	Haematology	1
5.	Common clinical biochemical estimations.	1
6.	Methods of measuring body temperature of wild animals	1
7.	Measuring capture and immobilization stress in wildlife	1
8.	Measuring senescence in wild animal populations	1
9.	Reproduction management in wild animals	2
10.	Understanding sound mechanics and communication methods	1
11.	Wild animal ethology	2
12.	Government policies for wild life protection (respective state)	1
13.	Lecture by wildlife vet or conservationist	2
	Total	16



Course Title with Credit Load

Ph.D. in Veterinary Physiology

Course Code	Course Title	Credit Hours
RPE 700	Research and Publication Ethics*	1+1
VPY 701	Applied physiology of body fluids and electrolytes	2+1
VPY 702	Physiology of animal behaviour	2+0
VPY 703	Recent trends in ruminant digestion	2+1
VPY 704	Recent trends in neuroendocrinology	2+1
VPY 705	Myophysiology and kinesiology	2+0
VPY 706	Avian physiology	2+1
VPY 707	Physiology of lactation	2+1
VPY 708	Recent trends in environmental physiology and growth	2+1
VPY 709	Cellular and molecular physiology	2+0
VPY 710	Recent trends in immuno-physiology	2+1
VPY 711	Physiology of stress	2+0
VPY 712	Recent trends in reproductive physiology	2+1
VPY 713	Doctorate Seminar-I	1+0
VPY 714	Doctorate Seminar-II	1+0
VPY 715	Doctorate Research	0+75

*Compulsory Major course for Doctorate programme. The other 10 credits can be registered from remaining 700 Series courses listed above.

Suggested list of specified Minor subjects (Departments)

Major Subject	Minor subjects (Departments)*
Veterinary Physiology	Animal Nutrition, Biochemistry, Gynaecology and Obstetrics, Animal Genetics and Breeding, Biotechnology, Surgery and Radiology, Livestock Production Management, Pharmacology and Toxicology, Anatomy, Medicine, poultry science, pathology.

*The Minor courses may be taken from any number of disciplines/ departments listed against major discipline limiting to credits prescribed as decided by the Chairman of Advisory Committee of the student.

Minor courses may also be taken from the disciplines/ departments other than those listed above on the recommendations of advisory committee, if essentially required as per the research problem with the concurrence of Head of the Department and Concerned Authorities.



Course Contents

Ph.D. in Veterinary Physiology

- I. Course Title** : Applied Physiology of Body Fluids and Electrolytes
II. Course Code : VPY 701
III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge regarding physiology of body fluids and electrolytes in relation to homeostasis.

V. Theory

Unit I

Volume and composition of body fluids, Exchange of water and electrolytes between body compartments and transport mechanisms, Blood and external environment. Osmolarity and osmolality of body fluids.

Unit II

Regulation of volume and osmolarity of extracellular fluid. Regulation of pH and acid base balance. Formation and composition of cerebrospinal fluid and lymph.

Unit III

Clinical implications of change in electrolytes and body fluids. Functional consideration of plasma volume and its composition. Diuresis and endocrine control of renal functions.

Unit IV

Clinical feature in fluid and electrolyte imbalances, clinicopathological indicators of fluid and electrolyte imbalances. Physiological basis of fluid therapy.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Body fluid compartments-Extracellular and Intracellular fluid compartment (ECF and ICF), Volume of ECF and ICF. Composition of various body fluids	1
2.	Total Body water, Water requirement, daily intake and loss of water from the body	1
3.	Different transport mechanisms for exchange of water and electrolytes- Active and passive transport, filtration, diffusion and osmosis	1
4.	Exchange of nutrients and other substances between blood and interstitial fluid. Capillary pressure, interstitial fluid pressure, exchange of fluids through capillary membrane	1
5.	Principles of osmosis and osmotic pressure, osmotic equilibrium between ICF and ECF, Tonicity of body fluids	1
6.	Composition of synovial fluid and peritoneal fluid	1



S. No.	Topic	No. of Lectures/ Practicals
7.	Osmolarity and Osmolality of ICF and ECF, regulation of volume and osmolarity of ECF	1
8.	Contribution of different molecules viz glucose, sodium and urea towards osmolarity of ECF	1
9.	pH of different body fluids, factors affecting pH of body fluids, Physiology of acid base balance, buffer systems of ICF and ECF	1
10.	Different types of Acidosis and Alkalosis, their etiology and compensation	1
11.	Evaluation of acid–base status- Siggaard–Andersen alignment nomogram, Anion gap, base excess and deficit	1
12.	Role of Respiratory system and Kidneys in maintenance of Acid base balance	1
13.	Formation and composition of Cerebrospinal fluid and lymph	1
14.	Clinical disorders resulting into loss of electrolytes from body fluids.	1
15.	Changes in plasma volume and its composition under different clinical conditions-vomition and diarrhoea	1
16.	hypovolemia and hypovolemia, Implications of hypovolemic and hemorrhagic shock	1
17.	Dehydration - its types and causes. Water intoxication	1
18.	Role of kidneys in regulation of water balance. Renin-angiotensin system	1
19.	Role of kidneys in formation and excretion of concentrated and diluted urine	1
20.	Hormonal regulation of important electrolytes in plasma	1
21.	Role of Hormones in renal regulation of water and electrolytes	1
22.	Diuresis and pressure natriuresis, polyuria and oligouria	1
23.	Clinical considerations in fluid and electrolyte imbalances	1
24.	Clinicopathological indicators of fluid and electrolyte imbalance	1
25.	Clinical Physiology of Dehydration – Signs, symptoms, evaluation of intensity of dehydration	1
26.	Clinical Physiology of vomition and diarrhoea- Signs and symptoms	1
27.	Clinical Physiology of edema Signs and symptoms, causes and prevention	1
28.	Role of serum sodium, hyponatremia, hypernatremia; Role of serum potassium, hypokalemia, hyperkalemia	1
29.	Role of serum chloride, hypochloremia and hyperchloremia, bicarbonate ions	1
30.	Principle and indications of fluid therapy	1
31.	Types of solution used for fluid therapy, role of their components and their use in different clinical conditions	1
32.	Effect of adding different saline, glucose solutions to ECF-isotonic, hypertonic and hypotonic solutions	1
	Total	32
Practical		
1.	Estimation of pH of different body fluids and evaluation of acid base status.	1
2.	Determination of sodium in serum sample of farm animals (by flame photometry/ colorimetric method)	1
3.	Determination of potassium in serum sample of farm animals (by flame photometry/ colorimetric method)	1
4.	Determination of chloride in serum sample of farm animals (by flame photometry/ colorimetric method)	1



S. No.	Topic	No. of Lectures/ Practicals
5.	Determination of bicarbonate in serum sample of farm animals	1
6.	Determination of Calcium in serum sample of farm animals	1
7.	Determination of Magnesium in serum sample of farm animals	1
8.	Determination of phosphate in serum sample of farm animals	1
9.	Determination of total body water (simulated demonstration)	1
10.	Determination of blood volume (simulated demonstration)	1
11.	Determination of plasma volume (simulated demonstration)	1
12.	Determination of Interstitial Fluid Volume (simulated demonstration)	1
13.	Estimation of osmolarity and osmolality of urine of farm animals	1
14.	Estimation of osmolarity and osmolality of milk	1
15.	Estimation of osmolarity and osmolality of blood of farm animals	1
16.	Evaluation of dehydration in animal and choosing the fluid type, its volume and rate for fluid therapy	1
	Total	16

I. Course Title : Physiology of Animal Behaviour

II. Course Code : VPY 702

III. Credit Hours : 2+0

IV. Aim of the course

To acquaint the students about physiology of animal behaviour in different species of domestic animals.

V. Theory

Unit I

Introduction to animal ethology. Neurophysiological basis of animal behaviour.

Unit II

Behaviour in relation to changes in the environment. Feeding, Grazing, Stall feeding and rumination behaviour.

Unit III

Sexual behaviour in female and male animals. Maternal behaviour. Milk let down.

Unit IV

Social behaviour, Communication in animals, Animal temperament. Responses of dogs and horses to training.

S. No.	Topic	No. of Lectures
Theory		
1.	Introduction to ethology and its importance in Veterinary Science.	1
2.	Ethology-definition and its importance in animal welfare	1
3.	Types of animal behaviour	2
4.	Behavioural Ecology, evolutionary basis for animal behavior	2
5.	Ecological pressures, ontogeny and phylogeny of behaviour	1
6.	Physiological concept of behaviour, neuro-endocrine integration for behavioural manifestation	2
7.	The concept of instinct, Habituation, imprinting, reinforcement, conditioning, reasoning and intelligence. Temperament scoring	2



S. No.	Topic	No. of Lectures
8.	Ingestive/ feeding behaviour in ruminants: Prehension, grazing behaviour in cattle, sheep and goats, rumination behaviour	2
9.	Ingestive behaviour in dogs	1
10.	Ingestive behaviour in swine	1
11.	Special feeding patterns; Abnormal feeding behaviour	2
12.	Precopulatory behavior (Searching, Courtship, Sexual arousal, Erection, Penile protrusion): Species differentiation	1
13.	Copulatory behaviour (Mounting, intromission and ejaculation): Species differentiation	2
14.	Post copulatory behaviour (Dismounting and refractory period)	1
15.	Manifestation of behavioural estrus, estrus intensity scoring	1
16.	Role of pheromon in sexual behaviour manifestation	1
17.	Abnormal sexual behavioural pattern	1
18.	Maternal behaviour: Formation of bond between mother and fetus, concept of critical period, vocalization	1
19.	Maternal behaviour in different species, abnormal maternal behaviour	1
20.	Milking behaviour: Milking temperament, milk let down reflex and the factors affecting milking behaviour	1
21.	Social behaviour: Dominance, Social hierarchy	1
22.	Agonistic (combat or aggressive) behaviour, Gregarious, Peck order in chicken	1
23.	Communicating behaviour: Attraction, Repulsion and Submission	1
24.	Mode of communication (visual, auditory, chemical) in different species.	1
25.	Responses of dogs and horses to training	1
	Total	32

I. Course Title : Advances in Ruminant Digestion

II. Course Code : VPY 703

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge about advances in digestion of ruminant animals.

V. Theory

Unit I

Introduction to rumen bacteria, protozoa and fungi. Development and natural fluctuation in rumen microbial population. Salivary secretion and its regulation.

Unit II

Microbial ecology and physiology of feed degradation within the rumen. Metabolism of nitrogen containing compounds.

Unit III

Degradation of carbohydrate, fat and protein by rumen microbes, Microbe- microbe interaction. Protected nutrients and other feed additives.

Unit IV

Genetics and biotechnology of rumen microbes, rumen anaerobic fungi, their role and interaction with other rumen microbes. Probiotics supplementation, etc. Rumen flow rate and rumen volume.



S. No.	Topic	No. of Lectures
Theory		
1.	Functional development of ruminant stomach	1
2.	Microbial ecosystem of fermentative digestion	1
3.	Fluctuation in rumen microbial population	1
4.	Substrates for fermentative digestion	1
5.	Salivary secretion and its regulation	1
6.	Role of saliva on fermentative digestion	1
7.	Rumen motility and its regulation	1
8.	Rumen bacteria	2
9.	Rumen protozoa – its importance and its interaction with other group	2
10.	Anerobic fungi	1
11.	Polysaccharide degradation by rumen microbes	2
12.	Metabolism of nitrogen containing compounds	1
13.	Lipid metabolism in rumen	1
14.	Rumen metabolites and their assimilation	1
15.	Microbe-microbe interaction	1
16.	Comparative efficiency of rumen function in different species.	2
17.	Protected nutrients	1
18.	Digestive disorders of rumen	1
19.	Nutritional toxicity and strategy to address it	1
20.	Stoichiometry of fermentative digestion	1
21.	Approaches to modification of ruminal fermentation	2
22.	Modifiers of ruminal microbial activity	1
23.	Biological models of rumen function	2
24.	Rumen simulation technique	2
25.	Rumen flow rate and rumen volume	1
	Total	32
Practical		
1.	Reticulo-ruminal motility	1
2.	Total volatile fatty acids and their fractions	2
3.	Culture of rumen bacteria	3
4.	Protozoal counting	1
5.	Culture of rumen fungi	3
6.	Demonstration of effect of defaunation	2
7.	Flow rates of ruminal contents	2
8.	Artificial rumen techniques	2
	Total	16

I. Course Title : Advances in Neuro-endocrinology

II. Course Code : VPY 704

III. Credit Hours : 2+1

IV. Aim of the course

To acquaint the students about advances in neuro-endocrinology of domestic animals.

V. Theory

Unit I

Neuroendocrine integrating mechanism. Structure of hypothalamus, pituitary gland, limbic and other neural pathways and endocrine functions.

Unit II

Neural control of oxytocin, adrenocorticotrophic hormone, aldosterone, thyrotropic hormone, growth hormone, gonadotrophins, Hypothalamic releasing factors and the neuro-vascular link between brain and anterior pituitary.

Unit III

Role of afferent impulses from genitals and other regions in reproductive system. Influence of hormones on brain activity.

Unit IV

Effects of drugs on neuro-endocrine system. Neuro-endocrine mechanisms in birds. Interaction of nervous, endocrine and immune system in animal production and reproduction.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	Evolution and theory of hormones	1
2	Development of endocrine glands	1
3	Neuroendocrine integrating mechanism	1
4	Homeostatic regulation by hormones; Feedback regulation of hormones	1
5	Biorhythms, manipulation and disruption of biorhythms in homeostatic and natural ecosystem	1
6	Hormones and adaptation to environment	1
7	Endocrine methodologies in study of bioregulation	1
8	Animal models and alternate uses of animal model in endocrine studies	1
9	Methods of hormonal assays - Radioimmunoassay, Immunoreometric assay, Radioceptors assay, enzyme linked immunosorbent assay, chemi-luminescence assay	2
10	Hormone secretion, transport and clearance	1
11	Cellular receptors for hormone; Hormones and target cells	1
12	Genomic and non genomic effects of hormones	1
13	Second messenger system; Receptor signal transduction; Hormone receptor interaction – protein and peptide hormones; Hormone receptor interaction – steroid and other hormones	2
14	Half-life of hormones, pattern of hormone release;	1
15	Types and family of hormones	1
16	Hormones regulating growth	1
17	Hormones regulating energy metabolism	1
18	Hormones regulating digestion	1
19	Hormones regulating calcium and phosphorus	1
20	Hormones regulating electrolytes – Na and K	1
21	Hormones regulating hyper and hypoglycemia	1
22	Hormones regulating blood volume and blood pressure	1
23	Alleviation of stress by hormones	1
24	Endocrine role of pineal gland	1
25	Hormones and behavior	1
26	Endocrine pathophysiology	2
27	Avian endocrinology	1
28	Synthetic hormones	1
29	Application of nanotechnology in endocrine studies	1
	Total	32



S. No.	Topic	No. of Lectures/ Practicals
Practical		
1.	Extraction of hormones	1
2.	Immunohistochemistry of hormones	2
3.	Radio-immuno assay of hormones	3
4.	Enzyme linked immunosorbent assay of hormones	2
5.	Bioassay of hormones	2
6.	Induction of atherosclerosis	1
7.	Induction of hypoglycemia in laboratory models by allaxon and streptozotocin	2
8.	Induction of hyperglycemia in laboratory models by administration of epinephrine and glucagon, etc.	1
9.	<i>In-vitro</i> effects of certain hormones such as adrenaline, histamine and acetyl choline on excised intestine	1
10.	Hormone assay in fecal samples	1
Total		16

I. Course Title : Myophysiology and Kinesiology

II. Course Code : VPY 705

III. Credit Hours : 2+0

IV. Aim of the course

To impart knowledge to the students about myophysiology and kinesiology.

V. Theory

Unit I

Morphology of muscle; Chemical composition of muscle; Electrical phenomena and ion influxes; Muscle contraction and irritability; Neuromuscular transmission; Excitation contraction coupling; Mechanical properties of skeletal muscle; Types of chemical muscle fibres; Coordination among muscles.

Unit II

Thermal properties of muscles; Chemical correlates of contraction.

Unit III

Molecular basis of muscular contraction of skeletal muscle; Energetics of Muscle Contraction; Electromyogram; Pathophysiology of muscles; Myocardium – electrical properties; Myocardium – mechanical properties; Pacemaker tissue; Endurance of muscle.

Unit IV

Lever systems of body joints; Synovial fluid formation and its physiology; Principles of Kinesiology and its application in work physiology.

S. No.	Topic	No. of Lectures
1.	Morphology of muscle	1
2.	Chemical composition of muscle	1
3.	Electrical phenomena and ion influxes	2
4.	Muscle contraction and irritability.	2



S. No.	Topic	No. of Lectures
5.	Neuromuscular transmission	2
6.	Excitation contraction coupling	2
7.	Mechanical properties of skeletal muscle	1
8.	Types of chemical muscle fibres	1
9.	Coordination among muscles.	1
10.	Thermal properties of muscles.	1
11.	Chemical correlates of contraction.	1
12.	Molecular basis of muscular contraction of skeletal muscle	2
13.	Energetics of Muscle Contraction	2
14.	Electromyogram	1
15.	Pathophysiology of muscles	1
16.	Myocardium – electrical properties	2
17.	Myocardium – mechanical properties	2
18.	Pacemaker tissue	1
19.	Endurance of muscle	1
20.	Lever systems of body joints,	2
21.	Synovial fluid formation and its physiology.	1
22.	Principles of Kinesiology and its application in work physiology	2
	Total	32

I. Course Title : Avian Physiology

II. Course Code : VPY 706

III. Credit Hours : 2 + 1

IV. Aim of the course

To teach physiology of birds.

Unit I

Digestive and urinary system.

Unit II

Blood, cardiovascular and respiratory system.

Unit III

Reproductive and endocrine system.

Unit IV

Nervous system and musculo-skeletal system.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Digestive system Comparative Functional Anatomy of the Digestive Tract -Gastrointestinal Function	1
2.	Food Intake Regulation GI Motility, Neural and Hormonal Control of Motility	1
3.	Secretions and Digestion	1
4.	Absorption - Carbohydrates, Amino Acids and Peptides, Fatty Acids and Bile Acids, Volatile Fatty Acids	1
5.	Urinary system Functional anatomy of The Kidneys- Intake of Water and Solutes	1



S. No.	Topic	No. of Lectures/ Practicals
6.	Formation of Urine- Osmoregulation	1
7.	Postrenal Modification of Ureteral urine	1
8.	Salt Glands - Evaporative Water Loss	1
9.	Blood, Cardiovascular Blood -Components – Effects of Altitude	1
10.	Gross Structure and Function	1
11.	General Circulatory Hemodynamics	1
12.	Control of the Cardiovascular System	1
13.	Integrative Neural Control	1
14.	Respiratory system Anatomy of the Avian Respiratory System-Air Sacs	1
15.	Ventilatory Reflexes -Respiratory System Volumes	1
16.	Gas Exchange -Ventilation and Respiratory Mechanics	1
17.	Basic Principles of Oxygen Transport - Cross-Current Gas Exchange	1
18.	High-Altitude Flight -Control of Breathing	1
19.	Reproductive system Anatomy of the Female Reproductive Breeding and Ovulation–Oviposition Cycles	1
20.	Ovarian Hormones Hormonal and Physiologic Factors Affecting Ovulation	1
21.	Effect of Light on the Ovary and Ovulation PhotorefractorinessMolt	1
22.	Incubation Physiology	1
23.	Male Reproductive Tract Anatomy Hormonal Control of Testicular Function, Spermatogenesis Extragonadal Sperm Transport and Maturation	1
24.	Endocrine system. Synthesis, Release of Hormones and functions of endocrine glands	1
25.	Hypothalamus and Pituitary Hormones	1
26.	Pancreatic and Adrenal hormones	1
27.	Secretions of Thyroid gland, parathyroid gland	1
28.	Nervous system and musculo-skeletal system Sensory Physiology - Uniqueness of avian brain	1
29.	Functional Organization of the Spinal Cord	1
30.	The Autonomic Nervous System of Avian Species	1
31.	Skeletal MuscleMuscle Fiber Types, Electrical Properties of Muscle Fibers -Contractile Properties	1
32.	Neurotransmission, Smooth muscle	1
	Total	32
Practical		
1.	Collection of blood from the birds and blood processing.	1
2.	Study of blood cells RBC count	1
3.	WBC count	1
4.	DLC	1
5.	Thrombocyte count	1
6.	Haemoglobin concentration	1
7.	Packed cell volume (haematocrit)	1
8.	Erythrocyte sedimentation rate	1
9.	Determination of feed passage rate in birds	1
10.	Enzymatic profile under various physiological states of birds	1
11.	Collection of semen and its evaluation	1
12.	Demonstration of cold shock resistant of avian spermatozoa and sperm stimulatory and inhibitory agents	1
13.	Determination of glucose and calcium in blood	1
14.	Determination of uric acid and urea in blood	1
15.	Electrophoretic separation of plasma proteins and egg proteins	1
16.	Localization of different endocrine glands	1
	Total	16



- I. Course Title : Physiology of Lactation**
II. Course Code : VPY 707
III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge on physiology of lactation in dairy animals.

Unit I

Functional anatomy, histology and cytology of mammary gland in domestic animals.

Unit II

Development of mammary gland, Hormonal control of mammogenesis.

Unit III

Process of lactation, Initiation of milk secretion, Hormonal control of lactation. Biochemical and histological changes in mammary gland during lactation. Mechanism of galactopoiesis.

Unit IV

Neural control of lactation, Milk let down, Milk ejection and inhibition of milk ejection. Induced lactation. Composition of milk in animals.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to the mammary gland and milk production	1
2.	Mammary gland anatomy - macrostructure	1
3.	Mammary gland anatomy - microstructure	1
4.	Mammary gland anatomy – blood supply, nerve supply and lymphatic network	1
5.	Comparative anatomy and physiology of mammary gland of different domestic animals	1
6.	Basic histology of parenchyma and cellular organization of the mammary epithelial cell	1
7.	Mammary growth and development I: fetal through puberty	1
8.	Mammary growth and development II: Post-puberty through involution	2
9.	Hormonal control of mammogenesis	1
10.	Lactogenesis	1
11.	Lactation	2
12.	Biochemical changes in mammary gland during lactation	1
13.	Histological changes in mammary gland during lactation	1
14.	Galactopoiesis	1
15.	Neuro endocrine control of lactation	1
16.	Milk letdown and its inhibition	1
17.	Factors affecting milk yield	1
18.	Dry period – importance, different strategies and beliefs	1
19.	Mammary involution	1
20.	Milk properties and composition	1
21.	Colostrum	1
22.	Milk carbohydrate synthesis and secretion	1
23.	Milk protein synthesis and secretion	1
24.	Milk lipids synthesis and secretion	1
25.	Mammary gland immunology	1



S. No.	Topic	No. of Lectures/ Practicals
26.	Other important milk components	1
27.	Contaminants and pollutants in milk	2
28.	Manipulation of milk production	1
29.	Diseases associated with mammary gland	1
	Total	32
Practical		
1.	External structure of cow's udder	1
2.	Internal structure of cow's udder	2
3.	Histological examination of udder in cows	1
4.	Milk letdown response in dairy animals	2
5.	Composition of colostrum	1
6.	Composition of milk during different phases of lactation	2
7.	Artificial induction of lactation	3
8.	Estimation of lactogenic hormones	4
	Total	16

I. Course Title : Advances in Ecosystem, Environmental Physiology and Growth

II. Course Code : VPY 708

III. Credit Hours : 2+1

IV. Aim of the course

To teach physiology of growth process in animals and effect of environmental factors on homeostasis of animals.

V. Theory

Unit I

Ecology of farm animals, Biological rhythms, Mammalian circadian rhythms, their regulation. Components of physical environment, Biometeorology and principles of thermoregulation in mammals and birds.

Unit II

Physiological response of farm animals to heat and cold. Effect of various climatic components on health and production (growth and egg production), reproduction and climatic adaptation.

Unit III

Concept and definitions of cellular, prenatal and postnatal growth - Patterns in animals.

Unit IV

Factors affecting growth - Nutrition, Hormones, Vitamins, Antibiotics, Environment. Ageing and senescence. Growth anomalies.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	Ecology and its scope in livestock productivity;	1
2	Disciplines of ecology; fundamental principles of ecology	1



S. No.	Topic	No. of Lectures/ Practicals
3	Biosphere and biodiversity	1
4	Ecosystem and Components of Ecosystem; Types of Species Found in Ecosystems; Principal Ways Species Interact	2
5	Adaptation, Acclimation and Acclimatization	1
6	Temperature Regulation - <i>Thermoregulators and Thermoconformer</i>	1
7	Principles of Heat gains and losses in animals	1
8	Warm-blooded versus cold-blooded animals and its relevance to survival	1
9	Heat production in birds and mammals	
10	Hibernation, Estivation and Daily Torpor; Cold Habitation	1
11	Body Temperature of Homeotherms - concept of core temperature measurements -Rectal Temperature of different animal species; Diurnal Variations	1
12	Physiological responses to heat in animals and birds	1
13	Temperature regulation in birds	1
14	Bioclimatology with respect to livestock and poultry farming	1
15	Surface temperature of earth- its measurements	1
16	earth's atmosphere-Geographic Belts, Composition of the Atmosphere	1
17	Climatic elements- components – measurements	2
18	Cold stress, Heat stress- impact on animal health and production	2
19	Adaptation to atmospheric pressure differences [altitude]- physiological changes and phenotypic characters;	1
20	Physiology of growth and its measurements	1
21	Periods of growth- prenatal and postnatal	2
22	Pattern of growth	1
23	Factors affecting growth	1
24	Recent concepts in manipulation of growth	1
25	Growth promoters	2
26	Ethical issues in use of growth promoters	2
27	Growth anomalies	1
28	Ageing and senescence	1
	Total	32
Practical		
1	Atmosphere definition- understanding the globe	1
2	Temperature Recording in animal house, poultry house, and laboratory	1
3	Calculation of RH	1
4	Calculation of THI	1
5	Calculation of Heat Loading index	1
6	Measurement of sweating rate in cattle	2
7	Stress assessment- different methods and indicators	2
8	Weather forecast models followed in India	1
9	Date analysis of rain and temperature for 20 years in the respective region	2
10	Assessing impact of different shades and houses on milk production in the college farms	1
11	Measurements of growth rate and chart of crossbred calves, native breed calf, etc.	1
12	Visit to meteorology stations	1
13	Purpose and role Satellites of ISRO related to the course (invited lecture)	1
	Total	16



- I. Course Title : Cellular and Molecular Physiology**
II. Course Code : PHY 709
III. Credit Hours : 2+0

IV. Aim of the course

To impart knowledge about cellular and molecular physiology.

V. Theory

Unit I

Cell membrane, Organelles and their functions. DNA synthesis and replication.

Unit II

Physiology of cell signaling. Basic classification and characterization of membrane receptors. Intracellular/ nuclear receptors.

Unit III

Major signaling pathways: SPs associated with second messengers; Cell signaling and apoptosis.

Unit IV

Cell cycle and Checkpoints in Cell Cycle Regulation. Regulators of the Cell cycle, cyclin-dependent kinases (CDKs) Signaling defects. Modern methods to study signaling.

S. No. Topic	No. of Lectures
Theory	
1. Cell and its organelles – structure and function, difference between prokaryotic and eukaryotic cell	2
2. Structural organization of biomembranes	1
3. Transport of molecules through cell membrane	1
4. Membrane proteins and their functions	1
5. Cell adhesion molecules and their functions	1
6. Transmembrane signalling pathways	2
7. Cell signaling and apoptosis	1
8. Modern methods to study signaling	1
9. Cell cycle-stages, mitosis and meiosis and regulatory molecules	3
10. Organization of eukaryotic and prokaryotic genome	3
11. DNA replication in prokaryotes and eukaryotes	4
12. Transcription in prokaryotes and eukaryotes	2
13. Translation in prokaryotes and eukaryotes	2
14. Techniques in molecular biology – PCR, DNA sequencing, DNA micro-array, DNA finger printing in situ hybridization	4
15. Recombinant DNA technology and its applications	2
16. Gene silencing by RNA interface technology	2
Total	32

- I. Course Title : Advances in Immuno Physiology**
II. Course Code : VPY 710
III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge regarding physiology of immune system.

V. Theory

Unit I

Introduction, History, Body defense, Organs of immune system, Ontogeny and phylogeny of immune system, Vertical transmission of immunity in animals.

Unit II

Immunoglobulins – Basic structure and functions, Hematopoiesis, T-cell and B-cell-evolution, Development and their functions, Cytokines-sources and actions, MHC, genetic organization of immunoglobulin, MHC and complement system.

Unit III

Immune-endocrine interactions, Immune-reproduction, Ageing, Stress and other physiological functions, Immune modulation.

Unit IV

Hypersensitivity, diseases related to immune system, dysfunction, autoimmune disorders and their genesis, immunodeficiency.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Types of immunity	1
2.	Host cell receptors of innate immunity	1
3.	Passive immunity.	1
4.	Acute phase reactant proteins (APRs) – positive APRs and negative APRs	1
5.	Significance of CRPs	1
6.	Antigen	1
7.	Factors influencing immunogenicity of antigens	1
8.	Heterophile antigens	1
9.	Antibody	1
10.	Functions of immunoglobulin	1
11.	Isotypes	1
12.	Hybridomas	1
13.	Monoclonal antibodies (mAB)	1
14.	Antigen antibody reaction	1
15.	Neutralisation	1
16.	Western blotting technique	1
17.	Complement pathways	1
18.	Leucocytopoiesis	1
19.	Central lymphoid organs I	1
20.	Central lymphoid organs II	1
21.	Characteristics and functions of different T and B lymphocytes	1
22.	NK cells	1
23.	Major histocompatibility	1
24.	Cytokines: interleukins, interferons, TNF, CSF	1
25.	Antigen presenting cells	1
26.	Cell mediated immunity	1
27.	Humoral/ Ab mediated immunity	1
28.	Immediate type	1
29.	Hypersensitivity type III – mechanism	1
30.	Autoimmunity	1



S. No.	Topic	No. of Lectures/ Practicals
31.	Immunological tolerance	1
32.	Transplant immunology	1
	Total	32
Practical		
1.	Isolation of lymphocytes from blood by density gradient centrifugation	1
2.	Determination of live and dead lymphocytes in the separated sample	1
3.	Estimation of CRP in serum by immunoturbidimetric assay	1
4.	Hyperimmuneseum production	1
5.	Haemagglutination test	1
6.	Haemagglutination inhibition assay	1
7.	Immunoprecipitation test	1
8.	Complement fixation test	1
9.	ELISA methodology	1
10.	ELISA diagnostic test	1
11.	RIA methodology	1
12.	RIA diagnostic test	1
13.	Antibody-dependent cell-mediated cytotoxicity methodology	1
14.	Immunofluorescence- Immunohistochemistry	1
15.	Western blotting methodology	1
	Total	15

I. Course Title : Physiology of Stress

II. Course Code : VPY 711

III. Credit Hours : 2+0

IV. Aim of the course

To understand impact of various stress factors on the physiology of animals.

V. Theory

Unit I

Definition of stress, Various types of stresses, Their effect on animal production and reproduction.

Unit II

Physico-chemical changes of blood composition due to exercise and work. Energy utilization and requirement of muscles during work and exercise.

Unit III

Capacity of work under field and controlled laboratory conditions, Factors that regulate it.

Unit IV

Effect of various stresses on endocrine status of animals, Endurances in animals.

Unit V

Energy partitioning in lactating animals under stress, Physiological basis of ameliorative measures to combat stress in lactating animals.



S. No.	Topic	No. of Lectures
Theory		
1.	Definition of Stress, distress and eustress - Concept of Stressors – types of stressors – Acute and chronic stress - Broad measures of stress in animals – Behavioral, Physiological and molecular measures of stress	1
2.	Neuroendocrinology of stress response - sympathetic-adrenal-medullary (SAM) pathway - the hypothalamic-pituitary-adrenal (HPA) axis	1
3.	Effect of stress on musculoskeletal system – Exercise and Draft associated stress - Physiological assessment and indices for evaluating work load – concept of acceptable work load.	1
4.	Effects of stress on reproduction (including birds) – pregnancy, prenatal growth, lactation and Egg production	1
5.	Effect of stress on lactation - Energy partitioning in lactating animals under stress - Physiological basis of strategies to combat stress in lactating animals	1
6.	Effect of stress on immune system – altered cellular responses and cytokine production patterns and their consequences	1
7.	Effect of Stress on learning and memory – Areas of brain associated with stress induced alterations in learning and memory	1
8.	Environmental characteristics affecting animals – Role of Temperature, Humidity, wind, Rainfall and solar radiation on animals	1
9.	Concept of Homeothermy and Thermal stress in animals – Thermoneutral and Thermocomfort Zone – Upper and lower critical temperatures	1
10.	Thermal exchanges between animal and environment – Conduction, Convection, Radiation and Evaporation	1
11.	Physical and biological measures of thermal stress – Temperature Humidity Index (THI), The Livestock Weather Safety Index (LWSI), A wind chill index (WCI), Comprehensive climate index (CCI), Tunica Dartos Index (TDI), Infra-red thermography (IRT) based measures	1
12.	Effect of other environmental stressors like Solar UV radiation, high altitude, pollution related stressors	1
13.	Concept of Adaptation, Acclimatization, Acclimation - Types and levels of Adaptation	1
14.	Morphological, Anatomical Adaptation of Animals and Birds to various kinds of environments – Theories associated with such adaptations	1
15.	Physiological adaptations to heat stress – circulatory, respiratory, endocrine adjustments – Panting and Sweating in animals –	1
16.	Physiological adaptations to cold stress – circulatory, respiratory, endocrine adjustments – Thermogenesis in cold – Tissues associated with thermogenesis	1
17.	Cellular and Molecular adaptations to thermal stress – Heat shock response – Chaperones and their role in thermotolerance	1
18.	Behavioral adaptations to thermal stress in Animals and Birds – Individual and Group adaptation behaviors	1
19.	Special adaptations to Extreme environments like Deserts, polar regions – Estivation, hibernation and torpor	1
20.	Physiology of thermal reception and processing – Central and peripheral thermo receptors – Fever, Hyperthermia and Hypothermia	1
21.	Overview of all thermal adaptation features in Farm animals including camel and donkeys, Yak	1
22.	Special thermal adaptation features in birds – Thermal adaptation during flight	1



S. No.	Topic	No. of Lectures
23.	Measures of thermotolerance in animals – Rhoads, Gaala’s, Benezra’s, Iberian heat tolerance indices and cooling efficiency test of Dowling	1
24.	Adaptation of animals to High Altitude Stress – Pulmonary circulation changes adjustments in blood–O ₂ affinity with change in altitude	1
25.	Concept of Global warming and climate change – Approaches to alleviate the adverse effects of climate change induced heat stress.	1
26.	Concept of redox biology, oxidative eustress and oxidative distress– History of oxidative stress concept	1
27.	Kinds and forms of Oxidative stress – Classification of oxidative stress (Basal, low intensity, intermediate intensity and high intensity)	1
28.	Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS) – Different types of ROS and RNS– Sources of ROS and RNS generation – Oxidative and Nitrosative damage	1
29.	Concept of Redox signaling – Role of redox signaling in physiological and pathological processes	1
30.	Measuring Reactive Oxygen Species – Direct and indirect assays measuring ROS including chemiluminescence and electron spin resonance	1
31.	Antioxidant defense and their mechanism of cytoprotective actions – Enzymatic and non-enzymatic antioxidants in the body	1
32.	Dietary antioxidants in livestock and poultry production including synthetic and herbal antioxidants	1
	Total	32

I. Course Title : Advances in Reproductive Physiology

II. Course Code : VPY 712

III. Credit Hours : 2+1

IV. Aim of the course

To understand recent developments in physiology of reproduction in domestic animals.

V. Theory

Unit I

Estrus synchronization, Superovulation and Embryo transfer in farm animals.

Unit II

Seminal plasma proteins; Sexing of spermatozoa; Cryopreservation of semen.

Unit III

Collection and grading of oocytes; IVM, IVF and IVC; Cryopreservation of embryos; sexing of embryos; Micromanipulation of gametes and embryos.

Unit IV

Transgenic animals; applications of stem cells and nano technology in reproduction.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Estrus synchronization in farm animals (Cattle, Buffalo, Sheep and Goat)	3
2.	Superovulation and Embryo transfer in farm animals(Cattle, Buffalo, Sheep and Goat)	3



S. No.	Topic	No. of Lectures/ Practicals
3.	Collection of Semen in farm animals	1
4.	Seminal plasma proteins and their importance in determining male fertility	2
5.	Sexing of spermatozoa	1
6.	Cryopreservation of semen in farm animals	1
7.	Collection of oocytes from live animals and slaughter house specimens	1
8.	Grading of oocytes	1
9.	<i>In-vitro</i> maturation of oocytes	2
10.	<i>In-vitro</i> fertilization of oocytes	2
11.	<i>In-vitro</i> culture of embryos	1
12.	Cryopreservation of embryos in farm animals	2
13.	Sexing of embryos	2
14.	Micromanipulation of gametes and embryos (Intracytoplasmic sperm injection and somatic cell nuclear transfer) and their applications	3
15.	Transgenic animal production and its importance	2
16.	Stem cell production and its clinical applications	3
17.	Nanotechnology and its use in farm animal breeding and reproduction	2
	Total	32
Practical		
1.	Semen analysis – Fructolytic index, zona free ovum test, Acrosomal integrity test	2
2.	Synchronization and superovulation protocols.	1
3.	Ovum pick up from superovulated animals	1
4.	Collection of oocytes from slaughter house derived ovaries, grading and evaluation	1
5.	Capacitation of spermatozoa	1
6.	<i>In-vitro</i> fertilization, <i>In-vitro</i> embryo production	1
7.	Collection of embryos using non-surgical procedures, Transferring embryos using non- surgical procedures.	2
8.	Oocyte/ Embryo/ ovarian/ testicular tissue freezing protocols.	1
9.	Demonstration on Intracytoplasmic sperm injection	1
10.	Micromanipulation of early embryos.	2
11.	Isolation and identification of embryonic stem cells	3
	Total	16

Note: The course teachers shall conduct the above practicals by utilizing facilities from semen/ IVF lab in the university/ college, if not available in the department.

List of Journals

- *Acta Endocrinologica*
- *Advances in Clinical Chemistry*
- *Advances in Reproductive Physiology*
- *Advances in Veterinary Sciences*
- *American Journal of Clinical Nutrition*
- *American Journal of Physiology*
- *American Journal of Veterinary Research*
- *Animal Nutrition and Feed Technology*
- *Animal Reproduction Science*
- *Animal Sciences*
- *Annual Review of Physiology*
- *Buffalo Journal*



- *Domestic Animal Endocrinology*
- *Indian Journal of Animal Reproduction*
- *Indian Journal of Animal Nutrition*
- *Indian Journal of Animal Physiology*
- *Indian Journal of Animal Research*
- *Indian Journal of Animal Science*
- *Indian Veterinary Journal*
- *Journal of Endocrinology*
- *Journal of Physiology*
- *Journal of Reproduction and Fertility*
- *Neuroendocrinology*

e-Resources

- <http://intl-joe>, endocrinology-journals.org (Journal of Endocrinology)
- <http://intl-ajpcon.physiology.org> (American Journal of Physiology)
- <http://arjournals.annualreviews.org> (Annual Review of Physiology)
- www.jneurosci.org (Journal of Neuroscience)
- www3.interscience.wiley.com (Journal of Physiology and Animal Nutrition)
- <http://jp.physioc.org>. (Journal of Physiology)

I. Course Title : Research and Publication Ethics

II. Course Code : RPE 700

III. Credit Hours : 1+1

IV. Overview

This course has total 6 units focusing on basics of philosophy of science and ethics, Research integrity, Publication ethics. Hands-on-sessions are designed to identify research misconduct and predatory publications. Indexing and citation databases, open access publications, Research metrics (citations, h-index, Impact Factor, etc.) and plagiarism tools will be introduced in this course.

V. Pedagogy

- Class room teaching, Guest lectures, Group discussions and practical sessions.

VI. Evaluation

- Continuous assessment will be done through tutorials, assignments, quizzes, and group discussions. Weightage will be given for active participation. Final written examination will be conducted at the end of the course.

VII. Course Structure

- The course comprises of six modules listed in table below. Each module has 4-5 units.

VIII. Theory

RPE 01: Philosophy and Ethics

- Introduction to philosophy: definition, nature and scope, concept, branches
- Ethics: definition, moral philosophy, nature of moral judgements and reactions

RPE 02: Scientific Conduct

- Ethics with respect to science and research
- Intellectual honesty and research integrity
- Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
- Redundant publications: duplicate and overlapping publications, salami slicing
- Selective reporting and misrepresentation of data

RPE 03: Publication Ethics

- Publication ethics: definition, introduction and importance
- Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc.
- Conflicts of interest
- Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
- Violation of publication ethics, authorship and contributorship
- Identification of publication misconduct, complaints and appeals
- Predatory publishers and journals

IX. Practice

RPE 4: Open Access Publishing

- Open access publications and initiatives
- SHERPA/ RoMEO online resource to check publisher copyright and self-archiving policies
- Software tool to identify predatory publications developed by SPPU
- Journal finder/ journal suggestion tools, viz., JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.

RPE 05: Publication Misconduct

A. Group Discussions

- Subject specific ethical issues, FFP, authorship
- Conflicts of interest
- Complaints and appeals: examples and fraud from India and abroad

B. Software tools

- Use of plagiarism software like Turnitin, Urkund and other open source software tools

RPE 06: Databases And Research Metrics

A. Databases

- Indexing databases
- Citation databases: Web of Science, Scopus, etc.

B. Research Metrics

- Impact Factor of journal as per Journal Citation Report, SNIP, SIR, IPP, Cite Score
- Metrics: h-index, g index, i10 index, altmetrics

Common Courses

I. Course Title : Technical Writing and Communications Skills

II. Course Code : PGS 601

III. Credit Hours : 0+1

IV. Aim of the course

- To equip the students/ scholars with skills to write dissertations, research papers, etc.
- To equip the students/ scholars with skills to communicate and articulate in English (verbal as well as writing).

V. Theory

Scientific Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations, etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article. Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers. Plagiarism – importance in scientific writing.

VI. Practicals

- Exercises on Various forms of scientific writings - theses, technical papers, reviews, manuals
- Writing of abstracts, summaries, précis, citations
- Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion)
- Editing and proof-reading
- Writing of a review article
- Communication Skills
- Exercises on plagiarism

VII. Suggested Reading

- Abhishek Sethi J and Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.
- Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
- Collins' Cobuild English Dictionary. 1995. Harper Collins.
- Gordon HM and Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart and Winston.
- Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed.

Oxford University Press.

- James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
- Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
- Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
- Richard WS. 1969. *Technical Writing*. Barnes and Noble.
- Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*.
- Wren PC and Martin H. 2006. *High School English Grammar and Composition*. S. Chand and Co.

I. Course Title : Agricultural Research, Research Ethics and Rural Development Programmes

II. Course Code : PGS 602

III. Credit Hours : 1+0

IV. Aim of the course

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

V. Theory

Unit I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), Partnership with NARS, Role as a partner in the global agricultural research system, Strengthening capacities at national and regional levels; International fellowships for scientific mobility.

Unit II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

Unit III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

VI. Suggested Reading

- Bhalla GS and Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
- Punia MS. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.
- Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.
- Singh K. 1998. *Rural Development - Principles Policies and Management*. Sage Publ.



- I. Course Title : Basic Concepts in Laboratory Techniques**
II. Course Code : PGS 603
III. Credit Hours : 0+1

IV. Aim of the course

To acquaint the students about the basics of commonly used techniques in laboratory.

V. Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

VI. Suggested Reading

- Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.
- Gabb MH and Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

- I. Course Title : Intellectual Property and its Management in Agriculture**
II. Course Code : PGS 604
III. Credit Hours : 1+0

IV. Aim of the course

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

V. Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, Geographical indications, Designs and layout, Trade secrets and Traditional knowledge, Trademarks, protection of plant varieties and farmers' rights and bio- diversity protection; Protectable subject matters, Protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

VI. Suggested Reading

- Erbisch FH and Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
- Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.
- *Intellectual Property Rights: Key to New Wealth Generation*. 2001. NRDC and Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. *Technology Generation and IPR Issues*. Academic Foundation.
- Rothschild M and Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.
- Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.
- The Indian Acts - *Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.*

I. Course Title : Library and Information Services

II. Course Code : PGS 605

III. Credit Hours : 0+1

IV. Aim of the course

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines, etc.) of information search.

V. Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/ Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

ANNEXURE I

List of BSMA Committee Members for Basic Veterinary Sciences

(Veterinary Anatomy, Veterinary Biochemistry, Veterinary Biotechnology,
Veterinary Extension Education, Veterinary Physiology)

(Constituted by ICAR vide Office order No. F. No. Edn 7/6/2017- EQR dated 4-4-2018)

Name	Address	Specialization.
Dr T.S. Chandrasekhara Rao Chairman	Dean, Faculty of Veterinary Science Sri Venkateswara Veterinary University Tirupati	Veterinary Anatomy
Dr Nirmal Sangwan Member	Director, Human Resource Development LUVAS, Hisar	Veterinary Biochemistry
Dr Taru Sharma Member	Principal Scientist and Head-cum-Director Centre of Advanced Faculty Training in Veterinary Physiology, Division of Physiology and Climatology, ICAR-IVRI, Izatnagar	Veterinary Physiology
Dr Sachinandan De Member	Principal Scientist, Animal Biotechnology Centre, ICAR-NDRI, Karnal	Veterinary Biotechnology
Dr P. Selvaraj Member	Professor, Dept. of Veterinary Physiology Veterinary College and Research Institute, Namakkal	Veterinary Physiology
Dr M. Parthiban Member	Professor and Head, Dept. of Animal Biotechnology Madras Veterinary College, Chennai	Veterinary Biotechnology
Dr Naresh Kumar Member	Professor, Dept. of Vety. Physiology and Biochemistry, Khalsa College of Veterinary and Animal Sciences, Amritsar	Veterinary Biochemistry



Name	Address	Specialization.
Dr S.C. Dubal Member	Professor of Anatomy College of Veterinary Science, Anand	Veterinary Anatomy
Dr D. Thammi Raju Member	Principal Scientist, ICAR, NAARM, Hyderabad	Veterinary Extension
Dr B.P. Singh Convener	Principal Scientist, Division of Veterinary Extension. ICAR-IVRI, Izatnagar	Veterinary Extension

Restructured and Revised
Syllabi of Post-graduate Programmes
Vol. 3

Veterinary Clinical Subjects

- Animal Reproduction Gynaecology and Obstetrics
- Veterinary Surgery and Radiology
- Veterinary Medicine

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Acknowledgements

Veterinary Clinical Subjects are considered as 'Mirror' of Veterinary College. Presently, worldover the ecosystem of Veterinary Clinical Subjects is being dominated by technology driven management and treatment of different clinical entities. Under each discipline of clinical subjects, i.e. Medicine, Surgery and Gynaecology, there is need to introduce specialised courses. This will allow each discipline to grow and render treatment of animals with improved protocols at field level. Further, the spectrum of treatment by private practitioners has widened. All this increases responsibility of University Teaching Hospitals to evolve affordable and state-of-the-art treatment protocols with continuous veterinary education programmes.

Amidst limitations and as per the guidelines of ICAR, restructuring of PG Syllabi in Veterinary Clinical Subjects is undertaken, after deliberations held during the meetings and workshops. The contribution of all Stakeholders including Heads of Department of Veterinary Clinical Subjects is duly acknowledged. BSMA Committee Members for Veterinary Clinical Subjects joins us in conveying special thanks to Hon'ble Vice Chancellors of Kamdhenu University, RAJUVAS and MAFSU for permission to organise meetings/workshops. The cooperation rendered by Deans of Veterinary Colleges at CVAS, Udaipur, BVC, Mumbai and their team is appreciable. Dr G.S. Khandekar from BVC, Mumbai deserves special mention for his efforts.

A scope for refinement exists, which can be undertaken at University level, within the prescribed guidelines of ICAR.

Happy teaching of Clinical Subjects !

Dr D. B. Patil
Convener

Dr Jit Singh
Chairman

ICAR-BSMA Committee for
Veterinary Clinical Subjects

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Veterinary Clinical Subjects

– Animal Reproduction Gynaecology and Obstetrics

Preamble

(Animal Reproduction, Gynaecology and Obstetrics)

At Masters' level, BSMA committee members thoroughly examined the existing course contents and deleted those portions which were of repetitive nature and non-pertinent. Also, the titles of many existing courses have suitably been modified. Some of the new chapters, both in theory as well as practical courses, viz., Role of pineal gland, endogenous opioids and neuropeptides in reproduction, Negative energy balance w.r.t. infertility, its prevention and amelioration, White side test, Endometrial cytology, Transition cow, Onset of postpartum ovarian activity, Caesarean section, Anaesthesia for caesarean section, Ovariohysterectomy, Seminiferous epithelial cycle, Spermatogonial wave, Mechanism of sperm motility, Influence of seminal plasma proteins in modulating fertility, Heat stress and its effect on sperm production, Screening of the breeding bulls to be selected for semen collection, Biosecurity measures in semen production and controlling microbial load, Quality assurance for quality semen production, Instrumentation in semen laboratory, MSP for semen production, Sexed semen production, sexing of embryos, *in-vitro* culture of granulosa cells, cumulus cells, luteal cells and oviductal cells, Recovery of bovine oocytes from abattoir ovaries and live animals, Principles and application of PCR technique in animal reproduction, etc., were suitably added in the different chapters of existing courses. Eight new courses, viz., Canine and feline reproduction, Caprine and ovine reproduction, Equine reproduction, Camel reproduction, Elephant reproduction, Wild and zoo animal reproduction, Porcine reproduction and Ultrasonography in animal reproduction has been introduced at masters level. These new courses will be helpful in introducing new insights to the students. This will increase the wide coverage of area specific courses essentially required with respect to regional prospective of the country. These new courses will also be helpful in enhancing the competency of students in a global prospective.

At doctoral level, different existing courses were examined thoroughly and chapters of repetitive nature were deleted from the course contents. Also, the titles of four existing courses have suitably been modified. Some of the new chapters, viz., Assessment of neonatal viability, Care of the newborn, Care of the postpartum dam, Seminiferous epithelial cycle, Theory of sperm motility and ultrastructure of sperm. Sperm passage in female reproductive tract; capacitation and acrosome reaction, Karyotyping to identify sperm defect and DNA mapping for parentage, Collection of preputial washings and semen for bacterial load and venereal pathogens, Cryopreservation of embryos, Intracytoplasmic sperm injection (ICSI), Gene expression in oocyte and embryo, identification of cellular organelles of Gamete, Semen sorting for production of sexed semen, Contribution of gonads and accessory sex glands to semen ejaculate. Factors affecting semen production. Morphology of sperm and their defects. Biochemical composition of semen, Metabolism of sperm. Role of seminal plasma proteins. Species variation in seminal characteristics, Commercial extenders used for bovine semen, Microbial contamination of semen and measures for its prevention, Quality control and quality assurance of semen, Antisperm antibodies, Flow cytometric assessment of sperm quality, Sperm vitrification, Freeze drying of sperm and sperm encapsulation, *in-vitro* tests for sperm function, i.e. BCMPT, HOST, etc., Physical and enzymatic changes in semen following cryopreservation, Tests to assess acrosomal integrity, mitochondrial activity, DNA



damage, binding assays, etc. Fluorescent probe based assessment of sperm quality. Comet assay, Sperm chromatin structure assay, TUNEL assay, etc. were added in different units of revised courses of both in theory and practical portions. The revised courses will be helpful in introducing new insights and improve competency in the students in a global context.



Course Title with Credit Load

M.V.Sc. in Animal Reproduction Gynaecology and Obstetrics

Course Code	Course Title	Credit Hours
VGO 501	General Gynaecology*	2+1
VGO 502	Female Infertility in Farm Animals*	2+1
VGO 503	Veterinary Obstetrics*	2+1
VGO 504	Andrology and Male Infertility*	2+1
VGO 505	Semen Preservation and Artificial Insemination	2+1
VGO 506	Basics of Reproductive Biotechnology*	2+1
VGO 507	Clinical Practice-I*	0+3
VGO 508	Clinical Practice-II*	0+3
VGO 509	Canine and Feline Reproduction	2+1
VGO 510	Caprine and Ovine Reproduction	2+1
VGO 511	Equine Reproduction	2+1
VGO 512	Camel Reproduction	2+1
VGO 513	Elephant Reproduction	2+1
VGO 514	Wild and Zoo Animal Reproduction	2+1
VGO 515	Porcine Reproduction	2+1
VGO 516	Ultrasonography In Animal Reproduction	1+2
VGO 590	Special Problem	0+1
VGO 591	Master's Seminar	1+0
VGO 599	Master's Research	30

*Core Courses

Course Contents

M.V.Sc. in Animal Reproduction Gynaecology and Obstetrics

I. Course Title : General Gynaecology

II. Course Code : VGO 501

III. Credit Hours : 2+1

IV. Aim of the course

To understand the basics of physiology of female reproduction and its hormonal regulation/ manipulation/ control.

V. Theory

Unit I

Functional anatomy, puberty and sexual maturity, Role of hypothalamic-pituitary-gonadal axis in attainment of puberty and sexual maturity, Endocrine regulation of estrous cycle. Role of pineal gland, endogenous opioids and neuropeptides in reproduction.

Unit II

Folliculogenesis, Oogenesis and ovulation and associated endocrine pattern, manipulation of follicular waves, Synchronization of estrus and ovulation and induction of ovarian activity.

Unit III

Gamete transport, Fertilization, Implantation and maternal recognition of pregnancy.

Unit IV

Embryonic and fetal development, Placentation, Fetal circulation and gestation, position of fetus in the uterus, age characteristics of fetus.

Unit V

Pregnancy diagnosis: Clinical, Ultrasonographic, Endocrinological and other diagnostic laboratory tests.

Unit VI

Lactation and artificial induction of lactation.

VI. Practical

Clinical examination of female genitalia. Biometry of female genital organs. Rectal and vaginal examination to diagnose cyclic phases of estrous cycle. Fern pattern of cervical mucus and exfoliated vaginal cytology. Pregnancy diagnosis in large and small animals by various methods. Estimation of age of the fetus. Use of ultrasound/RIA/ ELISA in gynaecology. Synchronization of estrus and ovulation in farm animals.

VII. Suggested Reading

- Perry T Cupps. 2009. *Reproduction in Domestic Animals*. Academic Press.
- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- Mauricio Pineda and Michael P Dooley. 2008. *McDonald's Veterinary Endocrinology* and Wiley-Blackwell.



- David Noakes, Timothy Parkinson and Gary England 2018. *Veterinary Reproduction and Obstetrics*. Saunders Ltd.
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.

I. Course Title : Female Infertility in Farm Animals

II. Course Code : VGO 502

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge and training in diagnosis and treatment of infertility in female domestic animals.

V. Theory

Unit I

Introduction to infertility, classification, economic impact. Anatomical causes of infertility, congenital and hereditary causes and acquired defects.

Unit II

Nutritional causes of infertility. Importance of body condition score. Negative energy balance, its prevention and amelioration.

Unit III

Managemental and environmental causes of infertility. Out of season breeding.

Unit IV

Infectious causes of female infertility, Specific and non-specific infections; It's diagnosis, treatment, prevention and control.

Unit V

Ovarian dysfunction; Anoestrus, Cystic ovarian degeneration, Anovulation, Delayed ovulation and luteal insufficiency; causes, diagnosis and treatment.

Unit VI

Repeat breeding; its causes, diagnosis and treatment.

Unit VII

Early embryonic death (EED); it's causes, Diagnosis and therapeutic management.

Unit VIII

Abortion; causes, diagnosis and prevention of abortion.

Unit IX

Interactions in immunological mechanisms and infertility.

VI. Practical

Record keeping, herd fertility assessment and management, diagnosis and treatment of infertility in female animals, use of uterine swabs for bacterial and fungal culture, histo-pathological evaluation of uterine biopsy, white side test, endometrial cytology and hormone assay. Use of ultrasonography in diagnosis of infertility. Immuno- diagnostic techniques.

VII. Suggested Reading

- Laing JA. 1979. *Fertility and Infertility in Domestic Animals*. English Language Book Soc. and Bailliere Tindall.



- Morrow DA. 1986. *Current Therapy in Theriogenology*. WB Saunders.
- David Noakes. Timothy Parkinson and Gary England 2018. *Veterinary Reproduction and Obstetrics*. Saunders Ltd.
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.

I. Course Title : Veterinary Obstetrics

II. Course Code : VGO 503

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge and training on problems of pregnancy and parturition and their management in domestic animals.

V. Theory

Unit I

Parturition; stages of parturition, Mechanism of initiation of parturition, Hormonal profiles associated with parturition, Transition cow, Onset of postpartum ovarian activity.

Unit II

Principles of handling of dystocia, Obstetrical procedures: Mutations, Fetotomy, caesarean section. Obstetrical anaesthesia and analgesia, epidural anesthesia.

Unit III

Fetal and maternal dystocia; causes, diagnosis and management.

Unit IV

Uterine torsion; causes, diagnosis and its correction. Caesarean section, anaesthesia for caesarean section, ovariohysterectomy.

Unit V

Diseases and accidents during gestation and around parturition.

Unit VI

Etiology, diagnosis and treatment of ante-partum and post-partum uterine and vaginal prolapse.

Unit VII

Induction of parturition and elective termination of pregnancy.

Unit VIII

Involution of uterus following normal and abnormal parturition.

Unit IX

Care of dam and the newborn.

VI. Practical

Pelvimetry of different species of farm animals. Diagnosis and correction of abnormal fetal presentation, position and posture in phantom box. Epidural anesthesia, episiotomy, ovariohysterectomy and caesarean operation. Management of incomplete cervical dilation. Fetotomy operations. Detorsion of uterus. Management of cervico-vaginal and uterine prolapse. Handling of clinical cases of dystocia.



VII. Suggested Reading

- David Noakes, Timothy Parkinson and Gary England 2018. *Veterinary Reproduction and Obstetrics*. Saunders Ltd.
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.
- Sloss V and Dufty JH. 1980. *Handbook of Bovine Obstetrics*. Williams and Wilkins.

I. Course Title : Andrology and Male Infertility

II. Course Code : VGO 504

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge and training about male reproduction and treatment of male infertility in domestic animals.

V. Theory

Unit I

Structure and function of reproductive tract of male.

Unit II

Sexual behavior and examination of bulls for breeding soundness.

Unit III

Spermatogenesis, Seminiferous epithelial cycle, Spermatogonial wave, Structure of spermatozoa, Semen and its composition. Mechanism of sperm motility.

Unit IV

Diseases transmitted through semen. Factors affecting semen quality, semen culture, tests for assessment of sperm motility, sperm survival and fertilizing capacity of spermatozoa.

Unit V

Causes of infertility; hereditary, congenital, infectious, nutritional and hormonal. Pathological and functional disturbances of epididymis, vas deferens and accessory sex glands.

Unit VI

Impotentia coeundi and impotentia generandi. Testicular hypoplasia and degeneration; causes and affect on semen and fertility. Coital injuries and vices of male animals.

Unit VII

Influence of seminal plasma proteins in modulating fertility. Heat stress and its effect on sperm production.

Unit VIII

Screening of the breeding bulls to be selected for semen collection.

VI. Practical

General and rectal examination for biometrics of male genitalia and accessory sex glands. Breeding soundness evaluation of male animals. Semen evaluation for sperm abnormalities, fertility and determination of other biochemical constituents of seminal plasma, Microbiological load of semen. Examination, diagnosis and treatment of infertile male animals.

VII. Suggested Reading

- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- Mann T and Lutwak-Mann C. 1981. *Male Reproductive Function and Semen*. Springer-Verlag.
- Morrow DA. 1986. *Current Therapy in Theriogenology*. WB Saunders.
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.
- Salisbury GW, VanDemark NL and Lodge JR. 1978. *Physiology of Reproduction and Artificial Insemination of Cattle*. WH Freeman and Co.

I. Course Title : Semen Preservation and Artificial Insemination

II. Course Code : VGO 505

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge and training about collection, evaluation and preservation of semen and artificial insemination in domestic animals.

V. Theory

Unit I

History of artificial insemination. Methods of semen collection.

Unit II

Semen evaluation; macroscopic, microscopic, biochemical and microbiological tests.

Unit III

Semen preservation. Extenders for preservation of semen at different temperatures. Semen additives for enhancement of motility and fertilizing capacity of spermatozoa. Dilution of semen.

Unit IV

Cryopreservation of semen. Effect of cryopreservation on spermatozoa, semen quality and fertility. Liquid Nitrogen (LN₂) cylinders; its handling, care and maintenance.

Unit V

Thawing protocols of frozen semen. Factors affecting post-thaw semen quality.

Unit VI

Ideal protocol for AI in different species of animals. Factors affecting success of AI.

Unit VII

Biosecurity and biosafety guidelines for frozen semen stations, semen processing laboratories and quarantine stations. Minimum standards and standard operating procedures for artificial insemination, Quality testing of straws and sheath for use in artificial insemination.

VI. Practical

Instrumentation in semen laboratory, Minimum standards of protocols and Standard operating procedures for semen production, Computer assisted semen analysis (CASA), Collection and evaluation of semen. Preparation of extenders. Preservation of semen; room temperature, refrigeration and cryopreservation. Handling and evaluation of processed semen. Practice of AI techniques.



VII. Suggested Reading

- Hafez ESE and B Hafez 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- Enos Johnson Perry 2013. *Artificial Insemination of Farm Animals*. Jodhpur: Axis Books (India).
- Salisbury GW, VanDemark NL and Lodge JR. 1978. *Physiology of Reproduction and Artificial Insemination of Cattle*. WH Freeman and Co.

I. Course Title : Basics of Reproductive Biotechnology

II. Course Code : VGO 506

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge and training on biotechniques in animal reproduction.

V. Theory

Unit I

Embryo transfer technology: selection of donors and recipients.

Unit II

Synchronization, super-ovulation, surgical and non-surgical collection of embryos and evaluation of embryos.

Unit III

Cryopreservation of embryos, transfer of embryos to donors. Sexed semen production, sexing of embryos. Guidelines for export and import of bovine germplasm. Guidelines and standards regarding embryo production.

Unit IV

In-vitro culture of granulosa cells, cumulus cells, luteal cells and oviductal cells. Recovery of bovine oocytes; from abattoir ovaries and live animals, *in-vitro* fertilization, *in-vitro* maturation, micromanipulation of embryos.

Unit V

Immuno-neutralization of hormones. Immunomodulation of fertility.

VI. Practical

Synchronization of estrus in donors and recipients, superovulation, surgical and non-surgical collection and transfer of embryos. Collection of oocytes from slaughter house genitalia. *In-vitro* fertilization, *in-vitro* maturation and cryopreservation of embryos. Sexing of embryos.

VII. Suggested Reading

- Ian Gordon. 2017. *Reproductive Technologies in Farm Animals*. Wallingford, Oxfordshire CABI.
- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- B Singh, SK Gautam and MS Chauhan. 2012. *Textbook of Animal Biotechnology*, Pearson Education.
- Heiner Niemann, Christine Wrenzycki. 2018. *Animal Biotechnology 1: Reproductive Biotechnologies*. Springer.
- Heiner Niemann, Christine Wrenzycki. 2018. *Animal Biotechnology 2*. Springer International Publishing AG.
- Troy L Ott, Zhihua Jiang. 2010. *Reproductive Genomics in Domestic Animals*. John Wiley.



- Marcelo Marcondes Seneda, Katia Cristina Silva-Santos LS Rafagnin Marinho. 2016. *Biotechnology of Animal Reproduction*, Nova Science Pub. Inc; UK Ed.
- Tacia Gomes Bergstein-Galan. 2018. *Reproduction Biotechnology in farm animals*. Avid Science.

- I. Course Title** : **Clinical Practice-I**
II. Course Code : **VGO 507**
III. Credit Hours : **0+3**

IV. Aim of the course

Hands-on training on diagnosis and treatment of reproductive disorders in animals at VCC.

V. Practical

Clinical examination of animals affected with reproductive disorders, Use of diagnostic techniques for diagnosis and institution of required therapy. Acquaintance with different equipment used for handling reproductive disorders, Client management, Public relations, Code of conduct, Database management, Maintenance of case records.

VI. Suggested Reading

- Morrow DA. 1986. *Current Therapy in Theriogenology*. WB Saunders.
- Zemjanis R 1970. *Diagnostic and Therapeutic Techniques in Animal Reproduction*. Williams and Wilkins; Second Edition.

- I. Course Title** : **Clinical Practice-II**
II. Course Code : **VGO 508**
III. Credit Hours : **0+3**

IV. Aim of the course

Hands-on training on diagnosis and treatment of reproductive disorders in animals at VCC.

V. Practical

Clinical examination of animals affected with reproductive disorders, use of diagnostic techniques for diagnosis and institution of required therapy. Acquaintance with different equipment used for handling reproductive disorders, Client management, Public relations, Code of conduct, Database management, Maintenance of case records.

VI. Suggested Reading

- Morrow DA. 1986. *Current Therapy in Theriogenology*. WB Saunders.
- Zemjanis R. 1970. *Diagnostic and Therapeutic Techniques in Animal Reproduction*. Williams and Wilkins; Second Edition.

- I. Course Title** : **Canine and Feline Reproduction**
II. Course Code : **VGO 509**
III. Credit Hours : **2+1**

IV. Aim of the course

To impart knowledge and training about reproduction in canine and feline.



V. Theory

Unit I

Development of reproductive system. Anatomy of male and female reproductive system. Canine and feline estrous cycle, endocrinology of estrous cycle.

Unit II

Breeding management, pregnancy, pregnancy diagnosis; clinical, ultrasonographic, endocrinological and other diagnostic laboratory tests.

Unit III

Parturition, fetal and maternal dystocia; causes, diagnosis and management. Induction of parturition and caesarean section, periparturient disorders.

Unit IV

Medical termination of pregnancy in dogs and cats, management of pseudopregnancy, pyometra and its management. Infertility and its management in dogs and cats.

Unit V

Postpartum care of dam and lactation. Neonatal care.

Unit VI

Population control in dogs; surgical and non surgical methods.

Unit VII

Reproductive physiology of male dogs, semen collection techniques, semen evaluation, freezing of semen, artificial insemination techniques, male reproductive disorders and its management.

VI. Practical

Exfoliative vaginal cytology, determination of ovulation time, demonstration of semen collection and artificial insemination, predicting time of parturition using hormonal assay, management of dystocia using clinical cases, castration, ovariohysterectomy, caesarean section, surgical procedure related to reproductive disorders in both male and female dogs and cats.

VII. Suggested Reading

- Edward C Feldman, Richard William Nelson. 2003. *Canine and Feline Endocrinology and Reproduction*. Elsevier Health Sciences, Saunders.
- Shirley Dianne Johnston, Margaret V Root Kustritz, Patricia Schultz Olson. 2001. *Canine and Feline Theriogenology*. Saunders Publ.
- Margaret V, Root Kustritz. 2009. *Clinical Canine and Feline Reproduction: Evidence-Based Answers*. John Wiley and Sons.
- Phyllis A. Holst MS. 2010. *Canine Reproduction: The Breeder's Guide 3rd Edition*. DOGWISE.
- Cheryl Lopate. 2012. *Management of Pregnant and Neonatal Dogs, Cats, and Exotic Pets*. John Wiley and Sons.
- Jovi R Otite. 2015. *Reproduction in the Dog a Tropical Approach*. Xlibris Corporation.

I. Course Title : Caprine and Ovine Reproduction

II. Course Code : VGO 510

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge and training about reproduction in sheep and goat.



V. Theory

Unit I

Caprine and ovine estrous cycle, endocrinology of estrous cycle, Seasonal breeding activity in sheep and goat, Artificial control of oestrus in sheep and goat.

Unit II

Breeding management, methods for advancing sheep breeding season, Induction of multiple births in sheep. Artificial insemination, pregnancy and parturition, Dystocia and its management.

Unit III

Reproductive disorders and its management.

Unit IV

Reproductive physiology of males, semen collection techniques, semen evaluation, freezing of semen, male reproductive disorders and its management.

VI. Practical

Demonstration of semen collection and artificial insemination, management of dystocia using clinical cases, castration, ovariohysterectomy, caesarean section, surgical procedure related to reproductive disorders in both male and females.

VII. Suggested Reading

- Mauricio Pineda and Michael P Dooley. 2008. *McDonald's Veterinary Endocrinology and Reproduction*. Wiley-Blackwell.
- Lindsay DR and Pearce DT. 2011. *Reproduction in Sheep*, Cambridge University Press, Cambridge, London.
- Selected articles from journals.

I. Course Title : Equine Reproduction

II. Course Code : VGO 511

III. Credit Hours : 2+1

IV. Aim of the course

To encompass the fundamentals of equine reproductive anatomy and physiology. This will help in understanding the care and management of the breeding stallion and the broodmare.

V. Theory

Unit I

Anatomy and physiology of the mare and stallion.

Unit II

Manipulation of estrus in the mare, estrous cycle, broodmare management, Use of ultrasound in breeding management.

Unit III

Infertility and its management.

Unit IV

Pregnancy diagnosis and management of the pregnant mare. Fetal development, abortion, induced parturition and dystocia.



Unit V

Neonatal management and common neonatal diseases, orphan foal management, foal management during the first six months.

Unit VII

Semen collection, semen preservation, artificial insemination and embryo transfer.

VI. Practical

Visit of equine/ stud farm, overall management of an equine breeding program, handling the cases of reproductive disorders, artificial insemination, semen collection, semen preservation, breeding record keeping and analysis.

VII. Suggested Reading

- Mauricio Pineda and Michael P Dooley. 2008. *McDonald's Veterinary Endocrinology and Reproduction*. Wiley-Blackwell.
- McKinnon, Squires, Vaala and verner. 2011. *Equine Reproduction* (2nd Ed). Wiley- Blackwell.
- Juan Samper, Jonathan Pyocock and Angus McKinnon. 2007. *Current Therapy in Equine Reproduction*. Saunders.
- Steven Brinsko Terry Blanchard Dickson Varner James Schumacher Charles Love. 2010. *Manual of Equine Reproduction* (3rd Ed). CV Mosby.
- John Dascanio and Patrick McCue. 2014. *Equine Reproductive procedures*. John Wiley and Sons, Inc.
- Selected articles from journals.

I. Course Title : Camel Reproduction

II. Course Code : VGO 512

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge and training about reproduction in camels.

V. Theory

Unit I

Male reproductive organs, male reproductive physiology and sexual behavior, puberty and sexual maturity, seasonal changes, copulation, semen collection and its characteristics.

Unit II

Female reproductive organs, female reproductive physiology and sexual behavior, oestrous cycle, external signs of oestrus, pregnancy and foetal development, pregnancy diagnosis and parturition.

Unit III

Age of sexual maturity, breeding season, conception rate, calving interval, reproductive longevity.

Unit IV

Early embryonic mortality, reproductive problems in the female, reproductive problems in the male.

Unit V

Artificial insemination, nutrition and reproduction, embryo transfer in camel.

VI. Practical

Management of dystocia in clinical cases, castration, ovariohysterectomy, caesarean section, surgical procedure related to reproductive disorders in both male and females.

VII. Suggested Reading

- H Merkt, D Rath, B Musa, MA El-Naggar. 1990. *Reproduction in Camels*. FAO.
- Muhammad Jamshed Khan. 2011. *Equine and Camel Production: An Approach towards Better Management*. LAP LAMBERT Academic Pub.
- Selected articles from journals.

I. Course Title : Elephant Reproduction

II. Course Code : VGO 513

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge and training about reproduction in elephant.

V. Theory

Unit I

General introduction, *Elephas maximus*, domestic and wild elephants.

Unit II

Male genital system, Accessory sex glands, Hormonal control and semenology.

Unit III

Female reproductive system, Ovaries, fallopian tubes, Uterus, vagina and external genitalia. Oestrous cycle, Hormonal regulation of estrous cycle, Mating behaviour and act of copulation.

Unit IV

Pregnancy, Gestation length and parturition. Neonatal care of elephant calves.

Unit V

Musth in elephants, behavioral patterns, pre-musth, violent- musth and post-musth phases, controlling elephants in musth using drugs/ hormones, anti androgens. Artificial insemination and cryopreservation of gametes.

VI. Practical

Management of dystocia in clinical cases, surgical procedure related to reproductive disorders in both male and females.

VII. Suggested Reading

- Brown JL, Paris S, Prado-Oviedo NA, Meehan CL, Hogan JN, Morfeld KA and Carlstead KA. 2016. *Reproductive Health Assessment of Female Elephants in North American Zoos and Association of Husbandry Practices with Reproductive Dysfunction in African Elephants (Loxodonta africana)*. PLOS ONE | DOI:10.1371/journal.pone.014573.
- Ortolani A, Leong K, Graham L, Savage A. 2005. *Behavioral indices of estrus in a group of captive African Elephants (Loxodonta africana)*. Zoo Biol. 24:311-329.
- Rasmussen LE, Schmidt MJ, Henneous R, Groves D, Daves GD. Jr. 1982. *Asian bull elephants: flehmen-like responses to extractable components in female elephant estrous urine*. Science. 217: 159-162.
- Sukumar R. 2006. *A brief review of the status, distribution and biology of wild Asian elephants Elephas maximus*. Int. Zoo Yb. 40: 1-8.
- Thitaram C. 2009. *Elephant reproduction: Improvement of breeding efficiency and development*



of a breeding strategy. Ph.D. Thesis, Utrecht University, The Netherlands

- Vidya TNC and Sukumar R. 2005. *Social and reproductive behaviour in elephants*. *Current sci.* **89**: 1200-1207.
- Selected articles from journals.

I. Course Title : Wild and Zoo Animal Reproduction

II. Course Code : VGO 514

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge and training about reproduction in Wild and zoo animals.

V. Theory

Unit I

Introduction to reproduction, Pattern of estrous cycle, Optimal breeding time with emphasis on tiger, deer, monkey and crocodile.

Unit II

Gestational length, parturition and pregnancy diagnosis.

Unit III

Sexual behavior and major reproductive disorders in wild and zoo animals, contraception techniques for deer.

VI. Practical

Management of dystocia in clinical cases, castration, observation of estrus behavior, pregnancy diagnosis, surgical procedure related to reproductive disorders in both male and females.

VII. Suggested Reading

- GR Smith, JP Hearn and Wellcome Trust (London, England). 1988. *Reproduction and disease in captive and wild animals*, New York: Oxford University Press.
- Ian Gordon. 1997. *Controlled reproduction in horses, deer and camelids*. CAB International.
- Mauricio Pineda and Michael P Dooley. 2008. *McDonald's Veterinary Endocrinology and Reproduction*. Wiley-Blackwell.
- Paul A Rees. 2011. *An Introduction to Zoo Biology and Management*. Wiley-Blackwell.
- R Eric Miller, Murray E Fowler. 2014. *Fowler's Zoo and Wild Animal Medicine*. Saunders.
- Selected articles from journals.

I. Course Title : Porcine Reproduction

II. Course Code : VGO 515

III. Credit Hours : 2+1

IV. Aim of the course

To acquire knowledge about the fundamentals of reproductive anatomy, physiology and advances in fertility management in swine.

V. Theory

Unit I

Anatomy and physiology of boar and sow.

Unit II

Oestrus cycle in sow, manipulation of oestrus cycle, methods for detection of oestrus,

endocrinology of pregnancy and parturition.

Unit III

Infertility in sow and its management.

Unit IV

Pregnancy diagnosis and management of pregnant sow.

Unit V

Fetal development, abortion, induced parturition, dystocia, stages of parturition and mastitis-metritis complex in sow.

Unit VI

Neonatal management and common neonatal diseases, care of piglets.

Unit VII

Breeding boar selection and management, semen collection, semen preservation, natural service, artificial insemination, embryo transfer and IVF.

VI. Practical

Visit of swine farm, breeding management in sows, handling the cases of reproductive disorders, caesarean section, castration, sexual behaviour, vaginal cytology, pregnancy diagnosis, dystocia, semen collection, semen preservation, artificial insemination, embryo transfer and record keeping.

VII. Suggested Reading

- Colin T Whittemore, Ilias Kyriazakis. 2008. *Whittemore's Science and Practice of Pig Production*. John Wiley and Sons Press.
- *Control of Pig Reproduction*. Proceedings of the Eighth International Conference on Pig Reproduction, Alberta, Canada, June 2009 by Heriberto Rodríguez Martínez, Jeff L Vallet, Adam J Ziecik, Nottingham University Press. 2009.
- DJA Cole, GR Foxcroft, Butterworth-Heinemann. 2013. *Control of Pig Reproduction*. Technology and Engineering Press.
- Mauricio Pineda and Michael P Dooley. 2008. *McDonald's Veterinary Endocrinology and Reproduction*. Wiley-Blackwell.
- *Pig Reproduction: Problems, Practices and Principles*. Proceedings of a Conference Held at Christ Church, Oxford University, 16-18 December, 1998.
- Sergi Bonet, Isabel Casas, William V Holt, Marc Yeste. 2013. *Boar Reproduction: Fundamentals and New Biotechnological Trends*. Springer Science and Business Media.
- Selected articles from journals.

I. Course Title : Ultrasonography in Animal Reproduction

II. Course Code : VGO 516

III. Credit Hours : 1+2

IV. Aim of the course

To impart knowledge and training about application of ultrasonography in diagnosis of conditions associated with animal reproduction.

V. Theory

Unit I

Basic principle of ultrasonography, physics of ultrasonography, A-mode, B-mode and M-mode ultrasonography, artifacts, principle of Doppler ultrasonography.



Unit II

Trans-abdominal ultrasonography, transrectal ultrasonography, follicular dynamics and luteal characteristics in large and small ruminants, luteal blood flow studies.

Unit III

Use of ultrasonography in pregnancy diagnosis, infertility management, uterine involution, luteal cyst and follicular cyst, blood flow studies in uterine and foetal arteries. Determination of gestational age in small animals by measuring gestational sac diameter, crown rump length and body diameter. Detection of foetal resorption and mummification. Prediction of parturition time, fetal viability by detecting fetal heart rate, foetal number and sex determination.

Unit IV

Testicular and male accessory sex gland ultrasonography.

VI. Practical

Use of ultrasonography in different stages of reproductive cycle. Use of ultrasonography in diagnosis of clinical cases associated with reproductive disorders in both male and females.

VII. Suggested Reading

- MAM Taverne and AH Willemsse. 1989. *Diagnostic ultrasound and animal reproduction*. Dordrecht; Boston: Kluwer Academic.
- J Ginther. 1998. *Ultrasonic imaging and animal reproduction*. Cross Plains, Wis.: Equiservices Pub.
- Selected articles from journals.

I. Course Title : Special Problem

II. Course Code : VGO 590

III. Credit Hours : 0+1

IV. Aim of the course

To expose students to research techniques related to sub discipline of the subject and submission of written project with references.

V. Practical

Student will carry out research on allotted project and submit the project report.

VGO 591 Master's Seminar 1+0

VGO 599 Master's Research 30

Course Outline: Lecture wise

VGO 501: General Gynaecology (2+1)

Theory Lectures

1. Functional anatomy reproductive organs, puberty and sexual maturity in farm animals.
2. Endocrine regulation of estrous cycle in farm animals.
3. Role of hypothalamic-pituitary-gonadal axis in attainment of puberty.
4. Role of pineal gland, endogenous opioids and neuropeptides in reproduction.
5. Folliculogenesis, follicular waves and its manipulation, oogenesis and ovulation.
6. Synchronization of estrus and ovulation in farm animals.
7. Artificial induction of ovarian activity.
8. Transport of gametes in the reproductive tract, fertilization and implantation.
9. Maternal recognition of pregnancy in farm animals.
10. Embryonic and fetal development during gestation.
11. Placentation and fetal circulation.
12. Gestational changes in the fetus w.r.t. to position in the uterus, age, etc.
13. Pregnancy diagnosis in farm animals. Pregnancy diagnosis using clinical method.
14. Pregnancy diagnosis using endocrinological and other diagnostic laboratory methods.
15. Pregnancy diagnosis using ultrasonographic method.
16. Lactation and artificial induction of lactation in cattle and buffaloes.

Practicals

1. Clinical examination of female genitalia.
2. Biometry of female genital organs using slaughter house specimen.
3. Rectal and vaginal examination to diagnose cyclic phases of estrous cycle.
4. Fern pattern of cervical mucus and exfoliated vaginal cytology.
5. Pregnancy diagnosis in large and small animals by various methods.
6. Estimation of age of the fetus.
7. Pregnancy diagnosis using Ultrasonography method.
8. Pregnancy diagnosis using endocrinological method.
9. Synchronization of estrus and ovulation in farm animals.

VGO 502: Female Infertility In Farm Animals (2+1)

Theory Lectures

1. Infertility, its classification and economic impact.
2. Anatomical, congenital/ hereditary and acquired causes of infertility.
3. Nutritional causes of infertility.
4. Importance of body condition score. Negative energy balance, its prevention and amelioration.
5. Managerial and environmental causes of infertility.
6. Out of season breeding.
7. Infectious causes of female infertility, specific and non-specific infections; it's diagnosis, treatment, prevention and control.



8. Anoestrus; causes, diagnosis and treatment.
9. Cystic ovarian degeneration; causes, diagnosis and treatment.
10. Anovulation and delayed ovulation; causes, diagnosis and treatment.
11. Luteal insufficiency; causes, diagnosis and treatment.
12. Repeat breeding; its causes, diagnosis and treatment.
13. Early embryonic death (EED); its causes, diagnosis and therapeutic management.
14. Abortion; Infectious and non infectious causes of abortion.
15. Diagnosis and prevention of abortion.
16. Immunological mechanisms leading to infertility.

Practicals

1. Record keeping w.r.t. herd fertility assessment and management.
2. Diagnosis and treatment of infertility in female animals.
3. Uterine swabbing for bacterial and fungal culture.
4. Histo-pathological evaluation of uterine biopsy.
5. White side test, endometrial cytology and hormone assay.
6. Use of ultrasonography in diagnosis of infertility.
7. Immuno- diagnostic techniques.

VOG 503: Veterinary Obstetrics (2+1)

Theory Lectures

1. Parturition; stages of parturition.
2. Mechanism of initiation of parturition, hormonal profiles associated with parturition.
3. Transition cow, onset of postpartum ovarian activity.
4. Dystocia and principles of handling of dystocia.
5. Obstetrical procedures: mutations, fetotomy, caesarean section.
6. Obstetrical anesthesia and analgesia, epidural anesthesia.
7. Fetal dystocia; causes, diagnosis and management.
8. Maternal dystocia; causes, diagnosis and management.
9. Uterine torsion; causes, diagnosis and its correction.
10. Caesarean section and ovariohysterectomy.
11. Diseases and accidents during gestation
12. Diseases and accidents around parturition.
13. Etiology, diagnosis and treatment of ante-partum vagino-cervical prolapse.
14. Etiology, diagnosis and treatment of post-partum uterine and vaginal prolapse.
15. Induction of parturition and elective termination of pregnancy.
16. Involution of uterus following normal and abnormal parturition.
17. Care of dam and the newborn.

Practicals

1. Pelvimetry of different species of farm animals.
2. Diagnosis and correction of abnormal fetal presentation, position and posture in phantom box.
3. Epidural anesthesia, episiotomy, ovariohysterectomy.
4. Caesarean operation.
5. Management of incomplete cervical dilation.
6. Fetotomy operations.
7. Detorsion of uterus.
8. Management of cervico-vaginal and uterine prolapse.
9. Handling of clinical cases of dystocia.

VGO 504: Andrology and Male Infertility (2+1)

Theory Lectures

1. Structure and function of reproductive tract of male.
2. Sexual behavior in males.
3. Examination of bulls for breeding soundness.
4. Spermatogenesis, seminiferous epithelial cycle and spermatogonial wave.
5. Structure of spermatozoa, semen and its composition.
6. Mechanism of sperm motility.
7. Diseases transmitted through semen.
8. Factors affecting semen quality.
9. Tests for assessment of sperm motility, sperm survival and fertilizing capacity of spermatozoa.
10. Causes of male infertility; hereditary, congenital, infectious, nutritional and hormonal.
11. Pathological and functional disturbances of epididymis, vas deferens and accessory sex glands.
12. Impotentia cocundi and impotentia generandi.
13. Testicular hypoplasia and degeneration; causes and affect on semen and fertility.
14. Coital injuries and vices of male animals.
15. Influence of seminal plasma proteins in modulating fertility.
16. Heat stress and its effect on sperm production.
17. Screening of the breeding bulls to be selected for semen collection.

Practicals

1. General and per-rectal examination for biometrics of male genitalia and accessory sex glands.
2. Breeding soundness evaluation of male animals.
3. Semen evaluation for sperm abnormalities, fertility.
4. Determination of biochemical constituents of seminal plasma.
5. Microbiological load assessment of semen.
6. Examination, diagnosis and treatment of infertile male animals.

VGO 505: Semen Preservation and Artificial Insemination (2+1)

Theory Lectures

1. History of artificial insemination.
2. Methods of semen collection.
3. Semen evaluation; macroscopic and microscopic examination.
4. Biochemical and microbiological tests of semen.
5. Semen dilution and preservation.
6. Extenders for preservation of semen at different temperatures.
7. Semen additives for enhancement of motility and fertilizing capacity of spermatozoa.
8. Cryopreservation of semen.
9. Effect of cryopreservation on spermatozoa, semen quality and fertility.
10. Liquid Nitrogen (LN₂) cylinders; its handling, care and maintenance.
11. Thawing protocols of frozen semen.
12. Factors affecting post-thaw semen quality.
13. Ideal protocol for AI in different species of animals. Factors affecting success of AI.
14. Biosecurity and biosafety guidelines for frozen semen stations, semen processing laboratories and quarantine stations.



15. Minimum standards and standard operating procedures for artificial insemination.
16. Quality testing of straws and sheath for use in artificial insemination.

Practicals

1. Instrumentation in semen laboratory.
2. Minimum standards of protocols of semen laboratory.
3. Standard operating procedures for semen production.
4. Computer assisted semen analysis.
5. Collection and evaluation of semen for its quality.
6. Preparation of semen extenders.
7. Preservation of semen; room temperature, refrigeration and cryopreservation.
8. Handling and evaluation of processed semen.
9. Practice of AI techniques.

VGO 506: Basics of Reproductive Biotechnology (2+1)

Theory Lectures

1. Embryo transfer technology: selection of donors and recipients.
2. Synchronization of estrus in donors and recipients.
3. Super-ovulation, surgical and non-surgical collection of embryos.
4. Evaluation and cryopreservation of embryos.
5. Transfer of embryos to donors.
6. Sexed semen production.
7. Sexing of embryos.
8. Guidelines for export and import of bovine germplasm.
9. Guidelines and standards regarding embryo production.
10. *In-vitro* culture of granulosa cells, cumulus cells, luteal cells and oviductal cells.
11. Recovery of bovine oocytes; from abattoir ovaries and live animals.
12. *In-vitro* maturation, *in-vitro* fertilization and micromanipulation of embryos.
13. Immuno-neutralization and immunomodulation of fertility.

Practicals

1. Synchronization of estrus in donors and recipients.
2. Superovulation, surgical and non-surgical collection and transfer of embryos.
3. Collection of oocytes from slaughter house genitalia.
4. *In-vitro* maturation and *in-vitro* fertilization of embryos.
5. Sexing of embryos.

VGO 509: Canine and Feline Reproduction (2+1)

Theory Lectures

1. Development of reproductive system. Anatomy of male and female reproductive system.
2. Canine and feline estrous cycle, endocrinology of estrous cycle.
3. Breeding management.
4. Pregnancy and pregnancy diagnosis; clinical method of pregnancy diagnosis.
5. Ultrasonographic, endocrinological and other diagnostic laboratory tests of pregnancy diagnosis.
6. Parturition and periparturient disorders in dogs and cats.
7. Dystocia; fetal and maternal causes, diagnosis and management.
8. Induction of parturition and caesarean section.
9. Medical termination of pregnancy in dogs and cats.



10. Management of pseudopregnancy and pyometra.
11. Infertility and its management in dogs and cats.
12. Postpartum care of dam and lactation. Neonatal care.
13. Population control in dogs; surgical and non surgical methods.
14. Reproductive physiology of male dogs.
15. Semen collection techniques and semen evaluation.
16. Freezing of semen and artificial insemination techniques.
17. Male reproductive disorders and its management.

Practicals

1. Exfoliative vaginal cytology.
2. Determination of ovulation time.
3. Demonstration of semen collection and artificial insemination.
4. Predicting time of parturition using hormonal assay.
5. Management of dystocia in clinical cases.
6. Castration, ovariohysterectomy and caesarean section.
7. Surgical procedure related to reproductive disorders in both male and female dogs and cats.

VGO 510: Caprine and Ovine Reproduction (2+1)

Theory Lectures

1. Caprine and ovine estrous cycle.
2. Endocrinology of estrous cycle.
3. Seasonal breeding activity in sheep and goat.
4. Artificial control of oestrus in sheep and goat.
5. Breeding management.
6. Methods for advancing sheep breeding season, induction of multiple births in sheep.
7. Artificial insemination.
8. Pregnancy and parturition.
9. Dystocia and its management.
10. Reproductive disorders and its management.
11. Reproductive physiology of males.
12. Semen collection techniques and semen evaluation.
13. Freezing of semen.
14. Male reproductive disorders and its management.

Practicals

1. Demonstration of semen collection.
2. Demonstration of artificial insemination.
3. Management of dystocia in clinical cases.
4. Castration.
5. Ovariohysterectomy and caesarean section.
6. Surgical procedure related to reproductive disorders in both male and females.

VGO 511: Equine Reproduction (2+1)

Theory Lectures

1. Reproductive anatomy and physiology of Mare.
2. Reproductive anatomy and physiology Stallion.
3. Estrous cycle, manipulation of estrus in Mare.
4. Broodmare management.



5. Use of ultrasound in breeding management.
6. Infertility in Mare and it's management.
7. Pregnancy diagnosis.
8. Management of the pregnant mare.
9. Fetal development.
10. Abortion.
11. Parturition, induced parturition.
12. Management of dystocia.
13. Neonatal management.
14. Common neonatal diseases, orphan foal management.
15. Foal management during the first six months.
16. Semen collection.
17. Semen preservation.
18. Artificial insemination.
19. Embryo transfer.

Practicals

1. Visit of equine/ stud farm.
2. Overall management of an equine breeding program.
3. Handling the cases of reproductive disorders.
4. Artificial insemination.
5. Semen collection.
6. Semen preservation.
7. Breeding record keeping and analysis.

VGO 512: Camel Reproduction (2+1)

Theory Lectures

1. Male reproductive organs, male reproductive physiology.
2. Sexual behavior, puberty and sexual maturity.
3. Seasonal changes and copulation.
4. Semen collection and it's characteristics.
5. Female reproductive organs, female reproductive physiology.
6. Sexual behavior, oestrous cycle, signs of oestrus.
7. Pregnancy and foetal development.
8. Pregnancy diagnosis.
9. Parturition.
10. Age of sexual maturity, breeding season.
11. Conception rate, calving interval, reproductive longevity.
12. Early embryonic mortality, reproductive problems in the female.
13. Reproductive problems in the male.
14. Artificial insemination.
15. Nutrition and reproduction.
16. Embryo transfer in camel.

Practicals

1. Management of dystocia in clinical cases.
2. Castration and ovariohysterectomy.
3. Caesarean section.
4. Surgical procedure related to reproductive disorders in both male and females.

**VGO 513: Elephant Reproduction (2+1)****Theory Lectures**

1. General introduction, *Elephas maximus*, domestic and wild elephants.
2. Male genital system, accessory sex glands.
3. Spermatogenesis and hormonal control.
4. Semen characteristics.
5. Female reproductive system, ovaries, fallopian tubes, uterus, vagina and external genitalia.
6. Oestrous cycle, hormonal regulation of estrous cycle.
7. Mating behaviour and act of copulation.
8. Pregnancy, gestation length.
9. Parturition.
10. Neonatal care of elephant calves.
11. Musth in elephants, behavioural patterns, pre-musth, violent- musth and post-musth phases.
12. Controlling elephants in musth using drugs/ hormones, anti androgens.
13. Artificial insemination.
14. Cryopreservation of gametes.

Practicals

1. Management of dystocia in clinical cases.
2. Surgical procedure related to reproductive disorders in both male and females.

VGO 514: Wild and Zoo Animal Reproduction (2+1)**Theory Lectures**

1. Introduction to reproduction in wild animals.
2. Pattern of estrous cycle in tiger, deer, monkey and crocodile.
3. Optimal breeding time with emphasis on tiger, deer, monkey and crocodile.
4. Gestational length and pregnancy diagnosis in wild and zoo animals.
5. Parturition in wild and zoo animals.
6. Sexual behavior in wild and zoo animals.
7. Major reproductive disorders in wild and zoo animals.
8. Contraception techniques for deer.

Practicals

1. Management of dystocia in clinical cases.
2. Castration in wild and zoo animals.
3. Observation of estrus behavior.
4. Pregnancy diagnosis.
5. Surgical procedure related to reproductive disorders in both male and females.

VGO 515: Porcine Reproduction (2+1)**Theory Lectures**

1. Anatomy and physiology of Boar
2. Anatomy and physiology of Sow.
3. Oestrus cycle, manipulation of oestrus cycle in sow.
4. Methods for detection of oestrus.
5. Endocrinology of pregnancy.
6. Endocrinology of parturition.



7. Infertility in sow and its management.
8. Pregnancy diagnosis and management of pregnant sow.
9. Fetal development.
10. Abortion and induced parturition.
11. Parturition and its stages.
12. Dystocia in Sow.
13. Mastitis-metritis complex in sow.
14. Neonatal management and common neonatal diseases, care of piglets.
15. Breeding boar selection and management.
16. Semen collection and preservation.
17. Natural service and artificial insemination.
18. Embryo transfer and IVF.

Practicals

1. Visit and record keeping of swine farm.
2. Breeding management in sows.
3. Handling the cases of reproductive disorders.
4. Caesarean section and castration.
5. Sexual behaviour and vaginal cytology.
6. Pregnancy diagnosis in Sow.
7. Semen collection, semen preservation and artificial insemination.
8. Embryo transfer in Sow.

VGO 516: Ultrasonography in Animal Reproduction (1+2)

Theory Lectures

1. Basic principle of ultrasonography, physics of ultrasonography, A-mode, B-mode and M-mode Ultrasonography. Artifacts and principle of Doppler ultrasonography.
2. Trans-abdominal and transrectal ultrasonography.
3. Follicular dynamics and luteal characteristics in large and small ruminants, luteal blood flow studies.
4. Use of ultrasonography in pregnancy diagnosis and infertility management.
5. Studies on uterine involution, luteal cyst and follicular cyst, blood flow studies in uterine and foetal arteries ultrasonography.
6. Determination of gestational age in small animals by measuring gestational sac diameter, crown rump length and body diameter. Detection of foetal resorption and mummification.
7. Prediction of parturition time, fetal viability by detecting fetal heart rate, foetal number and sex determination.
8. Testicular and male accessory sex gland ultrasonography.

Practicals

1. Practicing trans-abdominal and trans-rectal ultrasonography.
2. Use of ultrasonography in follicular dynamics study.
3. Use of ultrasonography in luteal characteristics study.
4. Use of ultrasonography in pregnancy diagnosis.
5. Prediction of parturition time using ultrasonography.
6. Use of ultrasonography in diagnosis of clinical cases associated with reproductive disorders in females.
7. Testicular studies using ultrasonography.
8. Male accessory sex gland studies using ultrasonography



9. Use of ultrasonography in diagnosis of clinical cases associated with reproductive disorders in male.

Minor Courses for M.V.Sc. Degree programme

Courses of any one department/ discipline from the list given below:

- Veterinary Pathology
- Veterinary Pharmacology
- Veterinary Physiology
- Veterinary Biochemistry
- Veterinary Bacteriology
- Veterinary Immunology

Supporting Courses

It could be any subject considered relevant for student's research work. This will be decided by Advisor/ guide concerned.

Common Courses

The following courses (one credit each) will be offered to all students undergoing Master's degree programme.

- Library and Information Services
- Technical Writing and Communications Skills
- Intellectual Property and its management in Agriculture
- Basic Concepts in Laboratory Techniques
- Agricultural Research, Research Ethics and Rural Development Programmes



Course Title with Credit Load

Ph.D. in Animal Reproduction Gynaecology and Obstetrics

Course Code	Course Title	Credit Hours
VGO 601	Advances in Gynaecology and Infertility* Management	2+1
VGO 602	Advances in Veterinary Obstetrics	1+1
VGO 603	Advances in Andrology and Male Infertility*	2+1
VGO 604	Reproductive Biotechnology	1+1
VGO 605	Semenology	1+1
VGO 606	Clinical Practice-I*	0+3
VGO 607	Clinical Practice-II*	0+3
VGO 690	Special Problem	0+2
VGO 691	Doctoral Seminar-I	1+0
VGO 692	Doctoral Seminar-II	1+0
VGO 699	Doctoral Research	75

*Core Courses

Course Contents

Ph.D. in Animal Reproduction Gynaecology and Obstetrics

I. Course Title : Advances in Gynaecology and Infertility Management

II. Course Code : VGO 601

III. Credit Hours : 2+1

IV. Aim of the course

To learn about advances in endocrine, ovarian and uterine functions and effect of nutrition, season and immunological factors on female fertility.

V. Theory

Unit I

Neuro-endocrine control of reproduction, follicular development, ovulation fertilization and implantation. Embryonic and fetal development.

Unit II

Maternal recognition of pregnancy advances in early diagnosis of pregnancy.

Unit III

Embryonic losses, abortion and their prevention.

Unit IV

Seasonal breeders, Synchronization and induction of estrus and ovulation in seasonal breeders, Assisted Reproductive Technology (ART) to increase reproductive efficiency in farm animals.

Unit V

Effect of stress, nutrition and immunological factors on fertility.

Unit VI

Onset of postpartum ovarian activity and factors affecting it.

Unit VI

Diagnostic and therapeutic approaches in infertility; principles of hormone therapy in reproductive disorders, laparoscopy, ultrasonographic diagnosis of ovarian/ uterine dysfunction, reproductive disorders, vaginal and uterine cytology.

VI. Practical

Clinical examination of female animals. Use of ultrasonography in ovarian function (follicular image pattern, follicular dynamics) and in early pregnancy diagnosis and infertility. Utility of uterine culture, uterine cytology and uterine biopsy (histopathological examination) in infertility investigation. Laparoscopy in diagnosis of ovarian and uterine dysfunction. ELISA/ RIA of hormones and interpretation of results. Use of assisted reproductive technology (ART) to enhance reproductive efficiency in farm animals.

VII. Suggested Reading

- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.



- Mauricio Pineda and Michael P Dooley. 2008. *McDonald's Veterinary Endocrinology* and Wiley-Blackwell.
- David Noakes, Timothy Parkinson and Gary England. 2018. *Veterinary Reproduction and Obstetrics*. Saunders Ltd.
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.
- Morrow DA. 1986. *Current Therapy in Theriogenology*. WB Saunders.
- Selected articles from journals.

I. Course Title : Advances in Veterinary Obstetrics

II. Course Code : VGO 602

III. Credit Hours : 1+1

IV. Aim of the course

To learn current developments in diagnosis and management of dystocia, accidents of gestation and peri-parturient disorders in domestic animals.

V. Theory

Unit I

Conceptus and its development. Factors influencing gestation period and birth weight.

Unit II

Anomalies of conceptus, teratogens and effect of stress on conceptus development.

Unit III

Mechanism of initiation of parturition. Use of tocolytic drugs.

Unit IV

Induction of parturition and termination of abnormal pregnancies. Obstetrical analgesia and anesthesia.

Unit V

Pre-treatment evaluation of the dam suffering from dystocia. Management of maternal and fetal dystocia, hydrallantois, hydramnion, fetal mummification, fetal maceration, uterine inertia and uterine torsion.

Unit VI

Fetotomy, caesarean section and ovario-hysterectomy. Retention of fetal membranes and management.

Unit VII

Neo-natal physiology and post-natal adaptations. Assessment of neonatal viability, care of the newborn.

Unit VIII

Involution of uterus, post-partum ovarian dysfunction and their manipulation. Care of the postpartum dam.

VI. Practical

Obstetrical operations in fetal dystocia; mutations, fetotomy, cesarean section, ovario-hysterectomy; induction of parturition, obstetrical analgesia and anaesthesia.

VII. Suggested Reading

- David Noakes, Timothy Parkinson and Gary England. 2018. *Veterinary Reproduction and Obstetrics*. Saunders Ltd.
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.
- Sloss V and Dufty JH. 1980. *Handbook of Bovine Obstetrics*. Williams and Wilkins.
- Selected articles from journals.

I. Course Title : Advances in Andrology and Male Infertility

II. Course Code : VGO 603

III. Credit Hours : 2+1

IV. Aim of the course

To learn advances in male reproduction and treatment of male infertility in domestic animals.

V. Theory

Unit I

Spermatogenesis, Spermatogenic waves, Sperm passage in male genitalia, biochemical milieu of male genitalia. Correlation between motility and fertilizing capacity of spermatozoa. Seminiferous epithelial cycle, Theory of sperm motility and ultrastructure of sperm. Sperm passage in female reproductive tract; capacitation and acrosome reaction.

Unit II

Separation of motile and immotile spermatozoa.

Unit III

Sperm plasma membrane and its permeability and binding properties: acrosome and lysosomal enzymes, sperm nucleus and nuclear proteins. Mitochondria and their role in sperm metabolism. Flagellum and the mechanochemical basis of motility and cyclic nucleotides.

Unit IV

Biochemistry of seminal plasma and accessory sex gland secretions. Electrolytes, proteins, Enzymes and amino acids in seminal plasma. Fructose and other sugars, Lipids, Cholesterol, Steroid hormones and Prostaglandins in seminal plasma.

Unit V

Fructolysis index. Aerobic and anaerobic metabolism of spermatozoa.

Unit VI

Markers of fertility in males, sperm chromatin structure assay, Anti-sperm antibodies. Karyotyping to identify sperm defect and DNA mapping for parentage.

VI. Practical

Breeding soundness evaluation of bulls, biochemical tests of semen for evaluation of fertility, semen culture for diagnosis of venereal diseases, diagnosis and treatment of genital pathological condition. Computer assisted semen analysis (CASA), Semen evaluation for assessment of fertilizing capacity of spermatozoa: cervical mucus penetration test, sperm capacitation test, hypo osmotic swelling test and zona free



hamster egg penetration test. Anti-sperm antibody assay. Collection of preputial washings and semen for bacterial load and venereal pathogens.

VII. Suggested Reading

- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- Enos Johnson Perry. 2013. *Artificial Insemination of Farm Animals*. Jodhpur: Axis Books (India).
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.
- Selected articles from journals.

I. Course Title : Reproductive Biotechnology

II. Course Code : VGO 604

III. Credit Hours : 1+1

IV. Aim of the course

To learn advances and recent developments in biotechnology in reproduction for the production of desired elite animals.

V. Theory

Unit I

Micromanipulation, Intracytoplasmic Sperm Injection (ICSI), Sexing of embryos.

Unit II

Stem cell biotechnology, Semen sorting for production of sexed semen.

Unit III

Cloning, Biopharming, Transgenic Animals and Chimeras.

Unit IV

Transgenic animals and chimeras. Gene expression in oocyte and embryo, Identification of cellular organelles of Gamete.

Unit V

Principle and application of PCR technique in animal reproduction.

VI. Practical

Micromanipulation of embryos, Sexing of embryos, Stem cell production.

VII. Suggested Reading

- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- B Singh, SK Gautam and MS Chauhan. 2012. *Textbook of Animal Biotechnology*, Pearson Education.
- Heiner Niemann, Christine Wrenzycki. 2018. *Animal Biotechnology 1: Reproductive Biotechnologies*. Springer.
- Heiner Niemann, Christine Wrenzycki. 2018. *Animal Biotechnology 2*. Springer International Publishing AG.
- Ian Gordon. 2017. *Reproductive Technologies in Farm Animals*. Wallingford, Oxfordshire CABI.
- Troy L Ott, Zhihua Jiang. 2010. *Reproductive Genomics in Domestic Animals*. John Wiley.
- Marcelo Marcondes Seneda, Katia Cristina Silva-Santos, LS Rafagnin Marinho. 2016. *Biotechnology of Animal Reproduction*, Nova Science Pub. Inc; UK Ed.
- Tacia Gomes Bergstein-Galan. 2018. *Reproduction Biotechnology in farm animals*. Avid Science.
- Selected articles from journals.



- I. Course Title** : Semenology
II. Course Code : VGO 605
III. Credit Hours : 1+1

IV. Aim of the course

To learn advances in processing and cryopreservation of semen and insemination techniques to obtain high fertility.

V. Theory

Unit I

Contribution of gonads and accessory sex glands to semen ejaculate. Factors affecting semen production. Morphology of sperm and their defects. Biochemical composition of semen.

Unit II

Metabolism of sperm. Role of seminal plasma proteins. Species variation in seminal characteristics. Factors affecting motility and fertilizing capacity of spermatozoa.

Unit III

Use of semen additives and activators. Sperm cryodamage, Commercial extenders used for bovine semen. Microbial contamination of semen and measures for its prevention. Transmission of venereal diseases through semen and their prevention.

Unit IV

Thawing protocols for frozen semen. Post-thaw evaluation of motility and fertilizing capacity of spermatozoa. Quality control and quality assurance of semen, antisperm antibodies. Flow cytometric assessment of sperm quality.

Unit V

Sperm vitrification, freeze drying of sperm and sperm encapsulation.

Unit VI

Criteria for gradation of semen stations.

VI. Practical

Semen evaluation. Estimation of bacterial load and enzymes in semen. Morphological defects of sperm. *In-vitro* tests for sperm function i.e. BCMPT, HOST, etc. Physical and enzymatic changes in semen following cryopreservation. Tests to assess acrosomal integrity, Mitochondrial activity, DNA damage, binding assays, etc. Fluorescent probe based assessment of sperm quality. Comet assay, Sperm chromatin structure assay, TUNEL assay.

VII. Suggested Reading

- Salisbury GW, VanDemark NL and Lodge JR. 1978. *Physiology of Reproduction and Artificial Insemination of Cattle*. WH Freeman and Co.
- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- Selected articles from journals.

- I. Course Title** : Clinical Practice-I
II. Course Code : VGO 606
III. Credit Hours : 0+3

IV. Aim of the course

Hands-on training on diagnosis and treatment of reproductive disorders in animals



V. Practical

Clinical examination of animals affected with reproductive disorders, use of diagnostic techniques for diagnosis and institution of required therapy. Acquaintance with different equipment used for handling reproductive disorders, client management, public relations, code of conduct, database management, Maintenance of case records.

VI. Suggested Reading

- Morrow DA. 1986. *Current Therapy in Theriogenology*. WB Saunders.
- Zemjanis R. 1970. *Diagnostic and Therapeutic Techniques in Animal Reproduction*. Williams and Wilkins; Second Edition.
- Selected articles from journals.

I. Course Title : Clinical Practice-II

II. Course Code : VGO 607

III. Credit Hours : 0+3

IV. Aim of the course

Hands-on training on diagnosis and treatment of reproductive disorders in animals.

V. Practical

Clinical examination of animals affected with reproductive disorders, use of diagnostic techniques for diagnosis and institution of required therapy. Acquaintance with different equipment used for handling reproductive disorders, client management, public relations, code of conduct, database management, Maintenance of case records.

VI. Suggested Reading

- Morrow DA. 1986. *Current Therapy in Theriogenology*. WB Saunders.
- Zemjanis R. 1970. *Diagnostic and Therapeutic Techniques in Animal Reproduction*. Williams and Wilkins; Second Edition.
- Selected articles from journals.

I. Course Code : VGO 690

II. Course Title : Special Problem

III. Credit Hours : 0+2

V. Aim of the course

To expose students to research techniques related to sub discipline of the subject and submission of written project with references.

VI. Practical

Student will carry out research on allotted project and submit the project report.

VGO 691 DOCTORAL SEMINAR-I 1+0

VGO 692 DOCTORAL SEMINAR-II 1+0

VGO 699 DOCTORAL RESEARCH75



Course Outline: Lecture wise

VGO 601: Advances in Gynaecology and Infertility Management (2+1)

Theory Lectures

1. Neuro-endocrine control of reproduction.
2. Follicular development.
3. Ovulation, fertilization and implantation.
4. Embryonic and fetal development.
5. Maternal recognition of pregnancy.
6. Advances in early diagnosis of pregnancy.
7. Embryonic losses, abortion and their prevention.
8. Seasonal breeders, synchronization and induction of estrus and ovulation in seasonal breeders.
9. Assisted reproductive technology (ART) to increase reproductive efficiency in farm animals.
10. Effect of stress and nutritional factors on fertility.
11. Effect of immunological factors on fertility.
12. Onset of postpartum ovarian activity and factors affecting it.
13. Diagnostic and therapeutic approaches in infertility.
14. Principles of hormone therapy in reproductive disorders.
15. Laparoscopy.
16. Ultrasonographic diagnosis of ovarian/ uterine dysfunction.
17. Vaginal and uterine cytology.

Practicals

1. Clinical examination of female animals for reproductive soundness.
2. Use of ultrasonography in ovarian function (follicular image pattern, follicular dynamics).
3. Use of ultrasonography in early pregnancy diagnosis.
4. Use of ultrasonography in infertility management.
5. Uterine culture, uterine cytology and uterine biopsy (histopathological examination) in infertility investigation.
6. Laparoscopy in diagnosis of ovarian and uterine dysfunction.
7. Use of ELISA/ RIA in reproductive parameters study and interpretation of results.
8. Use of Assisted reproductive technology (ART) to enhance reproductive efficiency in farm animals.

VGO 602: Advances in Veterinary Obstetrics (1+1)

Theory Lectures

1. Conceptus and its development.
2. Factors influencing gestation period and birth weight.
3. Anomalies of conceptus, teratogens and effect of stress on conceptus development.
4. Mechanism of initiation of parturition. Use of tocolytic drugs.



5. Induction of parturition and termination of abnormal pregnancies.
6. Pre-treatment evaluation of the dam suffering from dystocia. Obstetrical analgesia and anaesthesia.
7. Management of maternal and fetal dystocia, hydrallantois, hydramnion, fetal mummification, fetal maceration, uterine inertia and uterine torsion.
8. Fetotomy, caesarean section and ovario-hysterectomy.
9. Retention of fetal membranes and management.
10. Neo-natal physiology and post-natal adaptations. Assessment of neonatal viability, care of the newborn.
11. Involution of uterus, post-partum ovarian dysfunction and their manipulation. Care of the postpartum dam.

Practicals

1. Performing obstetrical operations.
2. Performing obstetrical mutations.
3. Fetotomy.
4. Caesarean section and ovario-hysterectomy.
5. Induction of parturition.
6. Obstetrical analgesia and anaesthesia.

VGO 603: Advances in Andrology and Male Infertility (2+1)

Theory Lectures

1. Spermatogenesis and spermatogenic waves.
2. Sperm passage in male genitalia, biochemical milieu of male genitalia.
3. Correlation between motility and fertilizing capacity of spermatozoa.
4. Seminiferous epithelial cycle, theory of sperm motility and ultrastructure of sperm.
5. Sperm passage in female reproductive tract; capacitation and acrosome reaction.
6. Separation of motile and immotile spermatozoa.
7. Sperm plasma membrane and its permeability and binding properties: acrosome and lysosomal enzymes, sperm nucleus and nuclear proteins.
8. Mitochondria and their role in sperm metabolism.
9. Flagellum and the mechanochemical basis of motility and cyclic nucleotides.
10. Biochemistry of seminal plasma and accessory sex gland secretions.
11. Electrolytes, proteins, enzymes and amino acids in seminal plasma. Fructose and other sugars, lipids, cholesterol, steroid hormones and prostaglandins in seminal plasma.
12. Fructolysis index. Aerobic and anaerobic metabolism of spermatozoa.
13. Markers of fertility in males.
14. Sperm chromatin structure assay.
15. Anti-sperm antibodies.
16. Karyotyping to identify sperm defect and DNA mapping for parentage.

Practicals

1. Breeding soundness evaluation of bulls.
2. Biochemical tests of semen for evaluation of fertility.
3. Semen culture for diagnosis of venereal diseases.
4. Diagnosis and treatment of genital pathological condition.
5. Studies on sperm motility using Computer assisted semen analysis (CASA).
6. Cervical mucus penetration test, sperm capacitation test and hypo-osmotic swelling test.



7. Zona free hamster egg penetration test.
8. Anti-sperm antibody assay.
9. Collection of preputial washings and semen for bacterial load and venereal pathogens.

VGO 604: Reproductive Biotechnology (1+1)

Theory Lectures

1. Micromanipulation and Intracytoplasmic sperm injection (ICSI).
2. Sexing of embryos.
3. Stem cell biotechnology.
4. Semen sorting for production of sexed semen.
5. Cloning and biopharming.
6. Transgenic animals and chimeras.
7. Gene expression in oocyte and embryo, identification of cellular organelles of Gamete.
8. Principle and application of PCR technique in animal reproduction.

Practicals

1. Micromanipulation of embryos.
2. Sexing of embryos.
3. Stem cell production.

VGO 605: Semenology (1+1)

Theory Lectures

1. Contribution of gonads and accessory sex glands to semen ejaculate. Factors affecting semen production.
2. Morphology of sperm and their defects. Biochemical composition of semen.
3. Metabolism of sperm. Role of seminal plasma proteins. Species variation in seminal characteristics.
4. Factors affecting motility and fertilizing capacity of spermatozoa. Commercial extenders used for bovine semen.
5. Use of semen additives and activators. Sperm cryodamage.
6. Microbial contamination of semen and measures for its prevention. Transmission of venereal diseases through semen and their prevention.
7. Thawing protocols for frozen semen. Post-thaw evaluation of motility and fertilizing capacity of spermatozoa.
8. Quality control and quality assurance of semen.
9. Antisperm antibodies assay.
10. Flow cytometric assessment of sperm quality.
11. Sperm vitrification, freeze drying of sperm and sperm encapsulation.
12. Criteria for gradation of semen stations.

Practicals

1. Semen evaluation for its quality.
2. Estimation of bacterial load in semen.
3. Estimation of enzymes in the semen.
4. *In-vitro* tests for sperm function i.e. BCMPT, HOST, etc.
5. Tests to assess acrosomal integrity, mitochondrial activity and DNA damage.
6. Tests to assess binding assays.
7. Fluorescent probe based assessment of sperm quality.
8. Comet assay, Sperm chromatin structure assay, TUNEL assay.



Minor Courses for Ph.D. Degree programme

Courses of any one department/ discipline from the list given below:

- Veterinary Pathology
- Veterinary Pharmacology
- Veterinary Physiology
- Veterinary Biochemistry
- Veterinary Bacteriology
- Veterinary Immunology

Supporting Courses

It could be any subject considered relevant for student's research work. This will be decided by Advisor/ guide concerned.

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Veterinary Clinical Subjects

– Veterinary Surgery and Radiology

Preamble

(Veterinary Surgery and Radiology)

The subjects under surgical discipline have undergone sea change, except for 'Tenets of Halstead', since the introduction of 'Key Hole' surgery and newer imaging techniques. In fact, the technological advancements demand creation of two separate disciplines - Surgery and Imaging. Further, to start with there is need of separate speciality courses involving Imaging, Orthopaedics, Anaesthesia and Ophthalmology. Scope also exists for addition of Avian Surgery, etc. However, in view of BSMA guidelines, efforts have been made to tune the Syllabus as per the existing infrastructure catering futuristic societal needs and to remain relevant and purposeful.

To encourage clinical practice in the veterinary clinics, courses on clinical practice, each at M.V.Sc. and Ph.D. level have been made mandatory. To focus on learning of research methodology, scientific thinking, planning and experimentation, a course on special problems has been introduced.

The new and restructured postgraduate curricula and syllabi in Surgery and Radiology contains several innovative and practically applicable courses. Credit hours for Clinical Practice have been increased from 0+3 to 0+4, as maximum time of the postgraduate scholars of clinical disciplines is spent in clinics. Small animal anaesthesia (2+1) and Large animal anaesthesia (2+1) courses are merged together and a new course on Veterinary Anaesthesia and Analgesia (2+1) is proposed. Small Animal Soft Tissue Surgery (2+1) and Large Animal Soft Tissue Surgery (2+1) courses are merged together and a new course Soft Tissue Surgery (2+1) is proposed. As per the advances in Ophthalmology and Dentistry, Veterinary Ophthalmology and Dentistry (1+1) is bifurcated into two separate courses, Veterinary Ophthalmology (1+1) and Veterinary Dentistry and Oral Surgery (1+1) to give more emphasis in two different distinct subjects.

New Courses were added to M.V.Sc. degree programme to gain thorough knowledge in areas like Anaesthesia of zoo, wild, exotic and laboratory animals (1+1), Urogenital Surgery (1+1), Cardiovascular Surgery (1+1). Clinical Case Conference (0+1) was added to encourage the students to do thorough case study of a single patient. In few states of India, certain species of animals are more prevalent, hence, we have developed species specific courses for those dealing with majority of cases in that particular region. Thus two new courses, viz., Camel surgery (1+1) and Elephant surgery (1+1) are added.

At Ph.D. level, courses on experimental surgical techniques in animals (1+1) is deleted in view of new CPCEA guidelines of unnecessary experimentation on animals to be discouraged and new methods be designed for teaching. Few new courses in Ph.D. degree programme were added, viz., Advances in orthopaedics (2+1), Reconstructive and regenerative surgery (1+1), Cardiovascular surgery (1+1), Special problems in diagnostic imaging (0+2), Advances in soft tissue surgery (2+1), Advances in veterinary ophthalmology (1+1), Veterinary surgical oncology (1+1), Clinical case conference (0+1), Advances in radiology (2+1) and Advances in diagnostic imaging techniques (2+1). These new courses are designed in such a way to keep pace with the development of new technologies and recent advances in these areas.



Under existing clinical ecosystem, the implementation of the new and restructured postgraduate course curricula is expected to build clinical knowledge and skill portfolio of the students so as to enhance their employability and marketability as multi-service providers with hands on skills and comprehensive knowledge of the entire subject after Masters degree. The doctorates should, in turn, prove as specialists, in the field of their specialization.



Course Title with Credit Load

M.V.Sc. in Veterinary Surgery and Radiology

Course Code	Course Title	Credit Hours
VSR 501	Clinical Practice-I*	0+3
VSR 502	Clinical Practice-II*	0+3
VSR 503	Principles of Surgery*	2+1
VSR 504	Anaesthesia And Analgesia*	2+1
VSR 505	Diagnostic Imaging Techniques*	2+1
VSR 506	Soft Tissue Surgery	2+1
VSR 507	Orthopaedic Surgery*	2+1
VSR 508	Anaesthesia of Zoo, Wild, Exotic and Laboratory Animals	1+1
VSR 509	Urogenital Surgery	1+1
VSR 510	Ophthalmology	1+1
VSR 511	Dentistry and Oral Surgery	1+1
VSR 512	Camel Surgery	1+1
VSR 513	Elephant Surgery	1+1
VSR 587	Clinical Case Conference	0+1
VSR 588	Special Problem in Radiology	0+2
VSR 589	Special Problem in Anaesthesia	0+2
VSR 590	Special Problem in Surgery	0+2
VSR 591	Masters Seminar	1+0
VSR 599	Masters Research	0+30

*Core Courses

Course Contents

M.V.Sc. in Veterinary Surgery and Radiology

- I. Course Title** : Clinical Practice-I
II. Course Code : VSR 501
III. Credit Hours : 0+3

IV. Aim of the course

To learn techniques and procedures in anaesthesia, diagnostic imaging techniques and surgery

V. Practical

Basic requirements and designing surgical and general veterinary hospital, Developing different proformas required in hospital facility, Assessing surgical patients and documentation, Preparation of surgical team and duties of team members, Surgical suite maintenance and sterilization, Acquaintance with different equipment like inhalant anaesthesia machine, Radiography systems, Ultrasonography, Endoscopy, Electro-surgery, Cryosurgery and physiotherapy equipment, Client management, Public relations, code of conduct, Management of surgical affections, Hospital database management, Attending surgical cases, Disaster management.

- I. Course Code** : VSR 502
II. Course Title : Clinical Practice-II
III. Credit Hours : 0+3

IV. Aim of the course

To learn techniques and procedures in anaesthesia, diagnostic imaging techniques and surgery

V. Practical

Application of different equipment like inhalant anaesthesia machine, Computerized radiography system, Ultrasonography, Electro-surgery, Cryosurgery, Physiotherapy and endoscopy and Physiotherapy equipment, Client management and Counselling, public relations, Code of conduct, Management of surgical affections, Hospital management, Database management, Attending surgical cases, Disaster management.

- I. Course Title** : Principles of Surgery
II. Course Code : VSR 503
III. Credit Hours : 2+1

IV. Aim of the course

To learn basic and advance principles and standards of practice in veterinary surgery

V. Theory

Unit I

Classification of wounds, wound healing, mechanism of wound repair, local and



systemic factors affecting wound healing, current concepts of inflammation and management, thermal, electrical and chemical injuries and their management.

Unit II

Asepsis, sterilization and disinfection and principles and practice of antimicrobial therapy in surgical patients.

Unit III

Shock, classification, pathophysiology, diagnosis, treatment and monitoring, surgical stress and its systemic effects, haemorrhage and haemostasis, acid-base balance, fluid therapy and blood transfusion, metabolism of the surgical patient.

Unit IV

Principles and clinical applications of laser surgery, cryosurgery, electrosurgery, physiotherapy.

Unit V

Minimally invasive surgical procedures which includes laparoscopy and endoscopy, principles of microscopic surgery-vessel and nerve anastomosis, application of computers in surgery.

VI. Practical

Identification and handling of surgical instruments, preparation of surgical pack, surgical team and surgical patients, surgical facilities and equipment, introduction to clinical skill laboratory, practice of different suturing patterns and repair of different wounds, using drains, bandages and bandaging techniques, monitoring of traumatized surgical patient, operation theatre conduct.

I. Course Title : Anaesthesia And Analgesia

II. Course Code : VSR 504

III. Credit Hours : 2+1

IV. Aim of the course

To gain the basic and practical knowledge of principals of companion and farm animals anaesthesia and pain management

V. Theory

Unit I

Introduction and history of anaesthesia, General consideration for anaesthesia in animals, Properties of ideal anaesthetic agent, Types of anaesthesia, Anaesthetic triad, Preanaesthetic evaluation of patient and selection of anaesthesia.

Unit II

Preanaesthetic medication (anticholinergics, sedatives, tranquilizers, alpha-2 agonist, narcotics), Muscle relaxants and neuromuscular blocking agents.

Unit III

General anaesthetics and factors affecting their uptake, Distribution and metabolism; Injectable anaesthetic agents (properties, dosage and usage); Combinations of injectable agents and neuroleptanalgesia, Inhalation anaesthetic agents (properties, methods of administration, dosage and usages), Inhalation anaesthesia equipment and breathing circuits, artificial ventilation.

**Unit IV**

Post-operative care of the surgical patient, operating room emergencies, cardio-pulmonary arrest and resuscitation, monitoring of anaesthetic recovery.

Unit V

Local anaesthetics, their mechanisms, local and regional nerve blocks, spinal analgesia, intravenous regional anaesthesia, peri-operative and post-operative pain and its management.

VI. Practical

Inhalation anaesthesia equipment, circuits and vaporizers, artificial ventilation, use of various pre-anaesthetic and anaesthetic agents in small and large animals, anaesthetic triad, balanced anaesthesia, total intravenous anaesthesia, regional and local nerve blocks using local anaesthetics, alpha-2 agonists and their combinations in domestic animals, monitoring of anaesthesia, reversal of sedation and analgesia induced by alpha-2 agonists, practice of anaesthesia in clinical cases; record keeping in anaesthesia and euthanasia.

I. Course Title : Diagnostic Imaging Techniques

II. Course Code : VSR 505

III. Credit Hours : 2+1

IV. Aim of the course

To learn the basic principles and gain practical knowledge of diagnostic imaging techniques and interpretation

V. Theory**Unit I**

Regulations regarding establishment and handling of x-ray units. Requirements for establishment of x-ray units, conventional and digital x-ray machine, x-ray films, Cassettes, screen, x-ray production, Qualities of x-rays, Image formation and dark room procedures, Image plate, Formation of radiograph technique chart, Artifacts and their prevention, Radiographic quality Contrast, Density and details), radiographic accessories, radiographic positioning for different organs/ parts in small and large animals.

Unit II

Plain and contrast radiographic techniques of small and large animals, fluoroscopy/ C-arm, principles of radiographic interpretation,

Unit III

Principles of radiation therapy, medical radioisotope curves, radiation laws and regulations. Radiation hazards and monitoring of radiographic exposure to personnel and protection.

Unit IV

Basic physics of ultrasound waves and image formation, scanning principles of ultrasound, transducers, equipment controls, modes of display, terminology used for echotexture and USG artifacts, application of ultrasound in small and large animals.

Unit V

Doppler techniques echocardiography and its application, introduction to nuclear



imaging techniques, computerized tomography, magnetic resonance imaging, positron emission tomography technique.

VI. Practical

Acquaintance with imaging equipment, computed radiography and digital radiography systems, dark room processing techniques and x-ray film handling, formulation of technique chart with fixed kVp and variable mAs, radiographic artefacts and their prevention, basics of radiographic interpretation of diseases, PACS, radiography positioning of different regions in domestic animals, contrast radiographic techniques, interpretation of radiographs, practice of ultrasonographic imaging and report writing.

I. Course Title : Soft Tissue Surgery

II. Course Code : VSR 506

III. Credit Hours : 2+1

IV. Aim of the course

To learn about soft tissue surgical skills and various surgical affections of different body systems in companion and farm animals

V. Theory

Unit I

Skin, adnexa, integument, appendages, horn, tail, sinus affections of equine and bovine, teat affections, principles of plastic and reconstructive surgery, different types of skin grafts.

Unit II

Surgical approaches/ affections of ear, oral cavity, larynx and pharynx, salivary glands, oesophagus, abdomen, rumen, reticulum, omasum, abomasum, stomach, intestines, rectum, anus, liver and biliary system, pancreas and porto-systemic shunts.

Unit III

Abdominal hernia, diaphragmatic hernia, perineal hernia, ventral, femoral and umbilical hernia, ritcher hernia, hiatal hernia, omental hernia, pre-pubic tendon rupture, use of biological and synthetic grafts for hernia repair, laparoscopic repair of hernia.

Unit IV

Principles of thoracic surgery, Functional anatomy of respiratory system, diseases of upper and lower respiratory system, functional anatomy of cardiovascular system and common affections of heart.

Unit V

Affections of pituitary, adrenals, thyroid, parathyroid glands, Principles of neurosurgery and common surgical affections of nervous system and special sense organs.

Unit VI

Haemolymphatic system, bone marrow, spleen, tonsils, lymph nodes and lymphatics, thymus.



VII. Practical

Practice of various surgical techniques of skin and adnexa, alimentary system, hernias, respiratory system, affections of horn, tail and teat, endoscopy techniques, instrumentation, use of rigid/ flexible endoscopes in companion and farm animals.

I. Course Title : Orthopaedic Surgery

II. Course Code : VSR 507

III. Credit Hours : 2+1

IV. Aim of the course

To learn about various affections of bones, joints, tendons, ligaments and foot and their treatment in companion and farm animals.

V. Theory

Unit I

Bone structure and function, growth, Response to injury, Fractures and luxations, classification of fracture, Fracture healing.

Unit II

Biomechanics of fracture healing, Considerations for selection of fixation techniques, Treatment of fractures of different bones in companion and farm animals, Diseases of bone.

Unit III

Various affections of the joints, ligaments and tendons and their treatment.

Unit IV

Spinal affections and injury to axial skeleton.

Unit V

Conformation of the limb, anatomy of hoof, anatomical, conformational and pathological causes of lameness and allied surgical conditions of fore and hind limbs, rehabilitation of orthopaedic patient.

VI. Practical

Application of Plaster of Paris cast, fiberglass cast, Roberts Jones bandage, modified Schroeder Thomas splint, Coaptation splint, sling application, practice of IM pinning, wiring, bone plating, inter locking nailing, external skeletal fixation, arthrotomy, tenotomy, examination of limbs for lameness, desmotomy, nerve blocks, injections in joints, operations for arthritis, hoof surgery and corrective shoeing.

I. Course Title : Anaesthesia of Zoo, Wild, Exotic and Laboratory Animals

II. Course Code : VSR 508

III. Credit Hours : 1+1

IV. Aim of the course

To learn about basic and practical knowledge of chemical immobilization, sedation and anaesthesia of laboratory animals, exotic, captive and free ranging wild animals.



V. Theory

Unit I

General consideration in chemical restraint of captive and free ranging wild animals, handling of birds with minimum stress, physical examination, blood sampling, crop washes, faecal sampling.

Unit II

Methods of administration of anaesthesia in captive, free ranging animals, birds and laboratory animals.

Unit III

Local and general anaesthesia in exotic species, wild animals, birds, zoo animals and laboratory animals.

Unit IV

Anaesthetic emergencies and complications.

Unit V

Diagnostic interpretation, haematology and biochemistry analysis, avian diagnostic endoscopy

VI. Practical

Familiarization with capture and anaesthetic equipments, local anaesthetic techniques, use of various preanaesthetic and anaesthetic agents in laboratory animals, birds, monitoring of patient during general anaesthesia, familiarization of various diseases in exotic birds like tumours, foreign body, crop stasis, crop tear, crop fistula, toe necrosis, feather cyst, excision of uropygial gland, rhinolith, pharyngostomy, ingluviotomy, ventriculotomy and orthopedic injuries, visits to zoos and wild life sanctuaries for practical on wild and zoo animals.

I. Course Title : Urogenital Surgery

II. Course Code : VSR 509

III. Credit Hours : 1+1

IV. Aim of the course

To learn about various surgical affections of urinary and genital tract and their treatment in companion and farm animals.

V. Theory

Unit I

Surgical anatomy of urinary and reproductive tract in male and female animals, Congenital anomalies of organs of male and female urinary and reproductive system.

Unit II

Principals of urinary tract surgery, Pathophysiology, Diagnosis and surgical management of affections of kidney, ureter, urinary bladder and urethra, Medical dissolution and prevention of Canine uroliths, Feline urologic syndrome, Surgical management of urolithiasis in ruminants and its prevention, management of uroperitoneum and renal failure.

Unit III

Pathogenesis, Clinical symptoms, Diagnosis and surgical management of vaginal

and uterine prolapse, Rectovaginal fistula, Pneumovagina, Vaginal tumours, pyometra, Cysts of Gartner's canal and vestibular glands.

Unit IV

Surgical conditions of penis, Prepuce, Prostate and testicles, Cryptorchidism, Inguinal and scrotal hernia, Affections of teat and udder.

Unit V

Indications, Techniques and postoperative complications of episiotomy, Ovariectomy, ovariectomy and caesarean section, Pyometra and its surgical treatment.

Unit VI

Castration, Vasectomy, Cauda epididymectomy and penile deviation.

VI. Practical

Hands-on-training of techniques of centesis of urinary bladder in companion and farm animals, Different types of catheters used in urogenital surgery, Retrograde catheterization of urethra and urinary bladder, Normograde catheterization of urethra on clinical cases of urinary retention, Pudendal nerve block for penis examination in ruminants, Diagnostic techniques and surgical management of the affections of kidney, Ureters, Urinary bladder, Urethra, Uro-hydropropulsion, Restraint and anaesthesia for urogenital tract surgery, Cystotomy, Tube cystostomy, Nephrotomy, Ureterocolostomy, Urethrotomy, Urethrostomy, Castration, Vasectomy, Penile deviation, Epididymectomy, Amputation of penis, Episiotomy, Ovariectomy, Tubectomy, Caesarean section, Management of phimosis, Paraphimosis, Venereal granuloma, Vaginal and uterine prolapse, Rectovaginal fistula and pneumovagina, Bladder and uterine marsupialization.

I. Course Title : Ophthalmology

II. Course Code : VSR 510

III. Credit Hours : 1+1

IV. Aim of the course

To learn basic principles and gain practical knowledge of diagnosis and treatment of diseases of eye.

V. Theory

Unit I

Anatomy and physiology of eye and its adnexa, Ophthalmic examination and diagnosis, Diagnostic instrumentation, Anaesthesia and surgery.

Unit II

General consideration for eye surgery in companion and farm animals, Therapeutic agents for eye diseases and surgery of eye lids, lacrimal apparatus, naso-lacrimal duct.

Unit III

Diseases of conjunctiva, cornea, sclera, iris, orbit, lens, vitreous and aqueous humor, retina and optic nerve, eye tumours, enucleation, exenteration.

Unit IV

Ocular manifestations of systemic diseases.



Unit V

Neuro-ophthalmology and ocular emergencies

VI. Practical

Ophthalmic instrumentation, examination of the eye and its adnexa, anaesthesia, preparation of patient, suture materials for eye surgery, canthotomy, tarsorrhaphy, keratoplasty, anterior chamber paracentesis, flushing of naso-lacrimal duct, iridectomy, phacoemulsification and implantation of foldable lens, surgical treatment of entropion and ectropion, cherry eye, Schirmer tear test, use of fluorescein dye in corneal ulcer, glaucoma surgery, eye worm removal.

I. Course Title : Dentistry and Oral Surgery

II. Course Code : VSR 511

III. Credit Hours : 1+1

IV. Aim of the course

To learn the basic and practical knowledge of diagnosis and treatment of diseases of teeth and oral cavity.

V. Theory

Unit I

Anatomy, development of teeth (odontogenesis), dentition and ageing of different species.

Unit II

Clinical examination of oral cavity, Dental anesthesia and pain management, Dental radiography.

Unit III

Diseases of oral cavity and teeth, Congenital and developmental anomalies of oral cavity, Abnormal tooth eruption, Irregular wear of teeth in companion and farm animals, occlusion and malocclusion, Mandibular fracture, Malformation of mandible, maxilla (cleft palate).

Unit IV

Acquired diseases of teeth (halitosis, dental caries, fracture of teeth, dental materials and dental radiography), Oronasal fistula, Maxilla and mandibular fractures repair, Orthodontics, Tumors and Other acquired condition of oral cavity.

Unit V

Exodontics, Restorative dentistry, Periodontal disease, Tooth extraction, Gum diseases. Endodontics, Pulpectomy, Root Canal therapy (RCT), Current techniques in dentistry.

VI. Practical

Oral examination, Modified triadian system of tooth numbering in various species, Dental chart for companion and farm animals, Dentistry instrumentation, Dental radiography procedure, Periodontal probing, Scaling/ teeth cleaning, Tooth extraction, Malpractices in equine dentistry, Periodical maintenance of oral hygiene, Corrective procedures, Malocclusion, Treatment strategies congenital malformations of maxilla and mandible, oral surgery.



- I. Course Title** : Camel Surgery
II. Course Code : VSR 512
III. Credit Hours : 1+1

IV. Aim of the course

To learn the basic principles and gain practical knowledge of diagnosis and treatment of surgical diseases of camel.

V. Theory

Unit I

Introduction to special surgical anatomy of important parts, i.e. Mandible, Soft palate, Chest pad, saddle region, Male urinary system, tail, etc., Restraint and positioning for various surgical procedures and radiography of different parts.

Unit II

Use of local anaesthesia, Various nerve blocks and regional anaesthesia used to treat diverse surgical disorders, Preanaesthetics, Tranquilizers, Sedatives and general anaesthetics used for camel surgery.

Unit III

Surgical affections of head and neck region: Laceration and infected wounds of nostril skin, Infection of turbinate, Actinobacillosis, Dental affections, Removal of canines in furious camels, Torticollis, Fracture of mandible and maxilla, Soft palate injuries, Ophthalmic affections, Salivary fistula, Stenson's duct ligation, Oesophageal obstruction.

Unit IV

Surgical affections of thorax and abdominal region: Saddle gall, Hernia, Chest pad wounds and enlargements, Foreign bodies in compartment, Intestinal obstruction, Obstructive urolithiasis, Rupture of urethra, Subcutaneous infiltration of urine, Cystorrhexis.

Unit V

Surgical affections of musculo-skeletal system: diagnosis of lameness in camels, management of long bone and digital fractures, upward fixation of patella, sprains, arthritis.

Unit VI

Sheath abscess, Necrosis of penis, Phimosis, Paraphimosis, Preputial prolapse, Various types of tumours, Gangrene and tumours of udder, Necrosis of tail, Punctured foot, prolapse of digital cushion, Foot injuries, Kumri, Kapali, etc.

VI. Practical

Restraint and anaesthesia (Local, regional, sedation and general anaesthesia), Preparation of sites, Surgical anatomy of important surgical affections, Special instruments used for camel restraining and surgery, Observing and assisting in diverse surgical procedures on clinical cases in camels, Practice of interdental wiring for repair of mandibular fractures in specimen mandibles, Clinical and radiographic diagnosis of lameness, Protection of wounds of chest pad and foot using special bandages, Radiography of different part of camels and postoperative care of diverse surgical affections of camels.



- I. Course Title : Elephant Surgery**
II. Course Code : VSR 513
III. Credit Hours : 1+1
IV. Aim of the course

To learn the basic principles and gain practical knowledge of diagnosis and treatment of surgical diseases of elephant.

V. Theory

Unit I

Basic surgical anatomy of Asian elephants and comparison with other farm animals.

Unit II

Drug administration techniques in captive and wild elephants, Anaesthetic management of captive and wild elephants for various surgical and managerial conditions.

Unit III

Principles of soft tissue surgery in elephants, Cyst, Bursitis, Gall, Haematoma, Abscess, etc.

Unit IV

Management and treatment of fractures and arthritis in elephants.

Unit V

Pedicure, corrective foot care and maintenance of healthy feet of captive elephants housed in different establishments in different seasons.

Unit VI

Hoisting of recumbent elephants, Surgical methods of birth control in elephants, limitations and risks of abdominal surgery in elephants (eg. Caesarian section, Castration, Hernia, etc., Soft tissue surgery like episiotomy, vestibulotomy, etc.)

VI. Practical

Familiarity with clinical examination procedures, Body weight estimation, Signs of health and diseases, Signs of localized lesions, etc., Familiarity with physical and chemical restraint procedures, Drug administrations by various routes-IM, IV, SC, sub-conjunctival, oral, per rectal, etc., foot examination and foot care procedures, visit to elephant camps and attending clinical procedures, surgeries, etc.

- I. Course Title : Clinical Case Conference**
II. Course Code : VSR 587
III. Credit Hours : 0+1
IV. Practical

Present seminar on unusual/ interesting clinical cases done in the semester. Compile them from presentation to follow up and also submit the write up in soft or hard copy.



- I. Course Title** : **Special Problem in Radiology**
II. Course Code : **VSR 588**
III. Credit Hours : **0+2**

IV. Practical

Investigative radiological problems in clinical or experimental models, didactic and interpersonal learning-teaching, problem solving self-learning strategies in problems related to radiology.

- I. Course Title** : **Special Problem in Anaesthesia**
II. Course Code : **VSR 589**
III. Credit Hours : **0+2**

IV. Practical

Investigative anesthetic problems in clinical or experimental models, Didactic and interpersonal learning-teaching, Problem solving self-learning strategies in problems related to anaesthesia.

- I. Course Title** : **Special Problem in Surgery**
II. Course Code : **VSR 690**
III. Credit Hours : **0+2**

IV. Practical

Investigative surgical problems in clinical or experimental models, Didactic and interpersonal learning-teaching, Problem solving self-learning strategies in problems related to surgery.

VSR 591 MASTERS SEMINAR (1+0)
VSR 599 MASTERS RESEARCH (0+30)



Course Outline: Lecture wise

VSR 503: Principles of Surgery (2+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Classification of wounds	1
2.	Wound healing, mechanism of wound repair	2
3.	Local and systemic factors affecting wound healing	1
4.	Current concepts of inflammation and management	1
5.	Thermal, electrical and chemical injuries and their management	3
Unit II		
6.	Asepsis, sterilization and disinfection	1
7.	Principles and practice of antimicrobial therapy in surgical patients	2
Unit III		
8.	Shock, classification, pathophysiology, diagnosis, treatment and monitoring	4
9.	Surgical stress and its systemic effects	1
10.	Haemorrhage and haemostasis	1
11.	Acid-base balance	1
12.	Fluid therapy	2
13.	Blood transfusion	1
14.	Metabolism of the surgical patient	2
Unit IV		
15.	Principles and clinical applications of laser surgery, cryosurgery, electrosurgery, physiotherapy	4
Unit V		
16.	Minimally invasive surgical procedures which includes laproscopy and endoscopy	2
17.	Principles of microscopic surgery-vessel and nerve anastomosis	1
18.	Application of computers in surgery	1
Practical		
1.	Identification and handling of surgical instruments	3
2.	Preparation of surgical pack	1
3.	Preparation of surgical team	1
4.	Preparation of surgical patients	1
5.	Surgical facilities and equipment	2
6.	Introduction to clinical skill laboratory	1
7.	Practice of different suturing patterns	2
8.	Repair of different wounds, using drains, bandages and bandaging techniques	2
9.	Monitoring of traumatized surgical patient	2
10.	Operation theatre conduct	1

**Suggested Reading**

- Fossum TW. (Ed.). 2018. *Small Animal Surgery*. Mosby.
- Slatter DH. 2003. 3rd ed. *Textbook of Small Animal Surgery*. WB Saunders.
- Hendrickson DA and Baird AN. 2013. *Turner and McIlwraiths Techniques in Large Animal Surgery* 4th ed. Wiley Black Well.
- AK Gangwar, Naveen Kumar and Kh. Sangeeta Devi. 2010. *General Animal Surgery and Anesthesiology* (With Theory and Practicals) New India Publishing Agency, New Delhi (ISBN: 9789-38-0235-172).

VSR 504: Anaesthesia and Analgesia (2+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Introduction and history of anaesthesia	1
2.	General consideration for anaesthesia in animals	1
3.	Properties of ideal anaesthetic agent, types of anaesthesia	1
4.	Anaesthetic triad, preanaesthetic evaluation of patient and selection of anaesthesia	1
5.	Preanaesthetic evaluation of patient and selection of anaesthesia	2
Unit II		
6.	Preanaesthetic medication (anticholinergics, sedatives, tranquilizers, alpha-2 agonist, narcotics)	5
7.	Muscle relaxants and neuromuscular blocking agents	1
Unit III		
8.	General anaesthetics and factors affecting their uptake, distribution and metabolism	2
9.	Injectable anaesthetic agents (properties, dosage and usage)	3
10.	Combinations of injectable agents and neuroleptanalgesia	1
11.	Inhalation anaesthetic agents (properties, methods of administration, dosage and usages)	2
12.	Inhalation anaesthesia equipment and breathing circuits	1
13.	Artificial ventilation	1
Unit IV		
14.	Post-operative care of the surgical patient	1
15.	Operating room emergencies	1
16.	Cardio-pulmonary arrest and resuscitation	1
17.	Monitoring of anaesthetic recovery	1
Unit V		
18.	Local anaesthetics, their mechanisms	1
19.	Local and regional nerve blocks	1
20.	Spinal analgesia, intravenous regional anaesthesia	1
21.	Peri-operative and post-operative pain and its management	2
Practical		
1.	Inhalation anaesthesia equipment, circuits and vaporizers	2
2.	Artificial ventilation	1
3.	Use of various pre-anaesthetic and anaesthetic agents in small and large animals	3
4.	Anaesthetic triad	1
5.	Balanced anaesthesia	1



S. No.	Topics	No. of Lectures/ Practicals
6.	Total intravenous anaesthesia	1
7.	Regional and local nerve blocks using local anaesthetics	1
8.	Repair of different wounds, using drains, bandages and bandaging techniques	1
9.	Alpha-2 agonists and their combinations in domestic animals	1
10.	Monitoring of anaesthesia	1
11.	Reversal of sedation and analgesia induced by alpha-2 agonists	1
12.	Practice of anaesthesia in clinical cases	1
13.	Record keeping in anaesthesia and euthanasia	1

Suggested Reading

- AK Gangwar, Naveen Kumar and Kh. Sangeeta Devi. 2010. *General Animal Surgery and Anesthesiology (With Theory and Practicals)* New India Publishing Agency, New Delhi (ISBN: 9789-38-0235-172).
- Clarke KW, Trim CM and Hall LW. 2013. *Veterinary Anaesthesia*. 11th ed. WB Saunders.
- Grim KA, Lamont LA, Tranquilli WJ, Greene SA and Robertson SA. 2015. *Veterinary Anaesthesia and Analgesia*, The 5th ed. Lumb and Jones. Wiley Blackwell.
- Grim KA, Tranquilli WJ and Lamont LA. 2011. *Essentials of Small Animal Anesthesia and Analgesia*. 2nd ed. Wiley Blackwell.
- Paddelford RR. 1999. *Manual of Small Animal Anesthesia*. 2nd ed. WB Saunders.

VSR 505: Diagnostic Imaging Techniques (2+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Regulations regarding establishment and handling of x-ray units, requirements for establishment of x-ray units	1
2.	Conventional and digital X-ray machine	1
3.	X-ray films, cassettes, screen	1
4.	X-ray production, qualities of x-rays	1
5.	Image formation and dark room procedures	1
6.	Image plate, formation of radiograph technique chart, artifacts and their prevention	1
7.	Radiographic quality (Contrast, density and details)	1
8.	Radiographic accessories	1
9.	Radiographic positioning for different organs/ parts in small and large animals	1
Unit II		
10.	Plain and contrast radiographic techniques of small and large animals	3
11.	Fluoroscopy/ C-arm	1
12.	Principles of radiographic interpretation	1
Unit III		
13.	Principles of radiation therapy, medical radioisotope curves, radiation laws and regulations	2
14.	Radiation hazards and monitoring of radiographic exposure to personnel and protection	2
Unit IV		
15.	Basic physics of ultrasound waves and image formation	2



S. No.	Topics	No. of Lectures/ Practicals
16.	Scanning principles of ultrasound	1
17.	Transducers, equipment controls, modes of display	1
18.	Terminology used for echotexture and USG artifacts	4
Unit V		
19.	Doppler techniques echocardiography and its application	2
20.	Introduction to nuclear imaging techniques, computerized tomography, magnetic resonance imaging, positron emission tomography techniques	3
Practical		
1.	Acquaintance with imaging equipment, computed radiography and digital radiography systems	3
2.	Dark room processing techniques and X-ray film handling	1
3.	Formulation of technique chart with fixed kVp and variable mAs	1
4.	Radiographic artefacts and their prevention	1
5.	Basics of radiographic interpretation of diseases	2
6.	Radiography positioning of different regions in domestic animals	1
7.	Contrast radiographic techniques	2
8.	Interpretation of radiographs	2
9.	PACS, Practice of ultrasonographic imaging and report writing	3

Suggested Reading

- AK Gangwar, Kh. Sangeeta Devi and Naveen Kumar. 2015. *Radiography in Veterinary Practice at a glance (Including Diagnostic Imaging techniques)* Astral International Pvt. Limited, New Delhi (ISBN: 978-93-5124-335-9).
- Barr FJ and Gaschen L. 2011. *BSAVA Manual of Canine and Feline Ultrasonography*. British Small Animal Veterinary Association
- Boon JA. 2011. *Veterinary Echocardiography*. 2nd ed. Wiley-Blackwell.
- Bushong SC. 2017. *Radiologic Science for Technologists*. 11th ed. CV Mosby.
- Gillette EL, Thrall DE and Lebel JL. (Eds.). 1977. *Carlson's Veterinary Radiology*. Lea and Febiger.
- Goddard PJ. 1995. *Veterinary Ultrasonography*. CABI.
- Kealy JK, McAllister H and Graham JP. (Eds.). 2011. *Diagnostic Radiology and Ultrasonography of the Dog and Cat*. 5th ed. WB Saunders, Philadelphia.
- Mannion P. 2006. *Diagnostic Ultrasound in Small Animal practice*. Blackwell Science.
- Kirberger RM and McEvoy FJ 2016. *BASAVA Manual of Canine and Feline Musculoskeletal Imaging*. 2nd BASAVA Gloucester.
- Morgan JP. 1972. *Radiology in Veterinary Orthopaedics*. Lea and Febiger.
- Nyland TG and Mattoon JS. 2002. *Small Animal Diagnostic Ultrasound*. WB Saunders.
- Thrall DE. 2017. *Textbook of Veterinary Diagnostic Radiology*. 7th ed. Saunders, Philadelphia.
- Bargai U, Pharr, JW and Morgan JP. 1989. *Bovine Radiology*. Iowa State University Press, Ames.

VSR 506: Soft Tissue Surgery (2+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Skin, adnexa, integument, appendages, horn, tail, sinus affections of equine and bovine	3



S. No.	Topics	No. of Lectures/ Practicals
2.	Principles of plastic and reconstructive surgery, different types of skin grafts	2
	Unit II	
3.	Surgical approaches/ affections of ear	1
4.	Surgical approaches/ affections of oral cavity	1
5.	Surgical approaches/ affections of larynx, pharynx, salivary glands and oesophagus	1
6.	Surgical approaches/ affections of abdomen	1
7.	Surgical approaches/ affections of rumen and reticulum	1
8.	Surgical approaches/ affections of omasum and abomasum	1
9.	Surgical approaches/ affections of stomach, intestines, rectum, anus	3
10.	Surgical approaches/ affections of liver and biliary system, pancreas and porto-systemic shunts	1
	Unit III	
11.	Abdominal hernia	1
12.	Diaphragmatic hernia	1
13.	Perineal hernia, ventral, femoral and umbilical hernia	1
14.	Ritcher hernia, hiatal hernia, omental hernia, pre-pubic tendon rupture	1
15.	Use of biological and synthetic grafts for hernia repair, laparoscopic repair of hernia	1
	Unit IV	
16.	Principles of thoracic surgery, functional anatomy of respiratory system	1
17.	Diseases of upper and lower respiratory system	4
18.	Functional anatomy of cardiovascular system and common affections of heart	3
	Unit V	
19.	Affections of pituitary, adrenals, thyroid, parathyroid glands	1
20.	Principles of neurosurgery and common surgical affections of nervous system and special sense organs	1
	Unit VI	
21.	Haemolymphatic system, bone marrow, spleen, tonsils, lymph nodes and lymphatics, thymus	2
	Practical	
1.	Practice of various surgical techniques of skin and adnexa	2
2.	Practice of various surgical techniques of alimentary system	5
3.	Practice of various surgical techniques of hernias	2
4.	Practice of various surgical techniques of respiratory system	2
5.	Affections of horn, tail and teat	2
6.	Endoscopy techniques, instrumentation, use of rigid/ flexible endoscopes in companion and farm animals	1
7.	Use of rigid/ flexible endoscopes in companion animals	1
8.	Use of rigid/ flexible endoscopes in farm animals	1

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.
- Yool DA. 2012. *Small Animal Soft Tissue Surgery*. CABI.
- Tobia KM. 2010. *Manual of Small Animal Soft Tissue Surgery*. Wiley Black Well.

**VSR 507: Orthopaedic Surgery (2+1)**

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Bone structure and function, growth, response to injury, fractures and luxations	1
2.	Classification of fracture	1
3.	Fracture healing, Biological osteosynthesis	1
Unit II		
4.	Biomechanics of fracture healing	1
5.	Considerations for selection of fixation techniques	1
6.	Current trends in treatment of fractures of different bones in companion and farm animals	4
7.	Diseases of bone	2
Unit III		
8.	Various affections of the joints and their treatment	3
9.	Various affections of the ligaments and tendons and their treatment	3
Unit IV		
10.	Spinal affections and injury to axial skeleton	3
Unit V		
11.	Conformation of the limb	3
12.	Anatomy of hoof	1
13.	Anatomical, conformational and pathological causes of lameness and allied surgical conditions of fore and hind limbs	6
Practical		
1.	Application of Plaster of Paris cast	1
2.	Application of fiberglass cast	1
3.	Application of Roberts Jones bandage	1
4.	Application of modified Schroeder Thomas splint	1
5.	Application of Coaptation splint, sling application	1
6.	Practice of IM pinning, wiring	2
8.	Practice of bone plating	1
9.	Practice of inter locking nailing	1
10.	Practice of external skeletal fixation	1
11.	Practice of arthrotomy	1
12.	Practice of tenotomy	1
13.	Examination of limbs for lameness	1
14.	Desmotomy, nerve blocks, injections in joints	1
15.	Operations for arthritis and hoof surgery	1
16.	Corrective shoeing	1

Suggested Reading

- AK Gangwar, Khangembam Sangeeta Devi, Ajit Kumar Singh and Naveen Kumar (2018) *Veterinary Orthopaedics and Lameness*, Kalyani Publishers, New Delhi (ISBN 978-93-272-8837-7).
- Auer JA. 2006. *Equine Surgery*. WB Saunders.
- Baxter GM. (Ed.). 2011. *Adams and Stashak's Lameness in Horses*. 6th ed. Wiley-Blackwell.
- Decamp CE, Johnston, SA, Dejardin LM and Schaefer SL. 2016. *Handbook of Small Animal Orthopaedics and Fracture Repair*, 5th ed., Elsevier.



- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders.
- Greenough PR. 2007. *Bovine Laminitis and Lameness*. WB Saunders.
- Millis DL and Levine D 2014. *Canine Rehabilitation and Physical Therapy*, 2nd ed., Elsevier.
- Newton CD and Nunamaker DM. (Eds.). 1985. *Textbook of Small Animal Orthopaedics*. JB Lippincott.
- Oehme FW and Prier JE. (Eds.). 1974. *Textbook of Large Animal Surgery*. Williams and Wilkins.
- Tyagi RPS and Singh J. (Eds.). 1993. *Ruminant Surgery*. CBS.
- Weaver AD, Jean GS and Steiner A. 2007. *Bovine Surgery and Lameness*. 2nd ed. Wiley-Blackwell.

VSR 508: Anaesthesia of Zoo, Wild, Exotic and Laboratory Animals (1+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	General consideration in chemical restraint of captive wild animals	1
2.	General consideration in chemical restraint of free ranging wild animals	1
3.	Handling of birds with minimum stress	1
4.	Physical examination, blood sampling, crop washes, faecal sampling	1
Unit II		
5.	Methods of administration of anaesthesia in captive animals	1
6.	Methods of administration of anaesthesia in free ranging animals	1
7.	Methods of administration of anaesthesia in birds	1
8.	Methods of administration of anaesthesia in laboratory animals	1
Unit III		
9.	Local and general anaesthesia in exotic species	1
10.	Local and general anaesthesia in wild animals	1
11.	Local and general anaesthesia in birds	1
12.	Local and general anaesthesia in zoo animals	1
13.	Local and general anaesthesia in laboratory animals	1
Unit IV		
14.	Anaesthetic emergencies and complications	1
Unit V		
15.	Diagnostic interpretation, haematology and biochemistry analysis	2
16.	Avian diagnostic endoscopy	1
Practical		
1.	Familiarization with capture and anaesthetic equipments	1
2.	Local anaesthetic techniques	1
3.	Use of various preanaesthetic and anaesthetic agents in laboratory animals	1
4.	Use of various preanaesthetic and anaesthetic agents in birds	1
5.	Monitoring of patient during general anaesthesia	1
6.	Familiarization of various diseases in exotic birds like tumours, foreign body, crop stasis, crop tear, crop fistula, toe necrosis, feather cyst	2
8.	Excision of uropygial gland	1
9.	Excision of rhinolith	1
10.	Pharyngostomy	1
11.	Ingluviotomy	1
12.	Ventriculotomy	1



S. No.	Topics	No. of Lectures/ Practicals
13.	Orthopedic injuries	2
15.	Visits to zoos for practical on zoo animals	1
16.	Visits to wild life sanctuaries for practical on wild animals	1

Suggested Reading

- Coles BH. 2007. *Essentials of Avian Medicine and Surgery*. 3rd ed. Blackwell Publishing
- Donely B. 2010. *Avian Medicine and Surgery in Practice*. Manson Publishing Ltd.
- Grim KA, Lamont LA, Tranquilli WJ, Greene SA and Robertson SA. 2015. *Veterinary Anaesthesia and Analgesia*. 5th ed. Lumb and Jones. Wiley Blackwell.
- Mader DR. 2005. *Reptile Medicine and Surgery*. 2nd ed. WB Saunders
- Miller RE and Fowler M. 2014. *Fowler's Zoo and Wild Animal Medicine*. 1st ed. Saunders
- Wobeser GA. 2007. *Disease in Wild Animals: Investigation and Management*. 2nd ed. Springer

VSR 509: Urogenital Surgery (1+1)

S. No.	Topics	No. of Lectures/ Practicals
--------	--------	--------------------------------

Theory**Unit I**

- | | | |
|----|---|---|
| 1. | Surgical anatomy of urinary tract in male and female animals | 1 |
| 2. | Surgical anatomy of reproductive tract in male and female animals | 1 |
| 3. | Congenital anomalies of organs of male and female urinary system | 1 |
| 4. | Congenital anomalies of organs of male and female reproductive system | 1 |

Unit II

- | | | |
|-----|---|---|
| 5. | Principels of urinary tract surgery, pathophysiology, diagnosis and surgical management of affections of kidney | 1 |
| 6. | Pathophysiology, diagnosis and surgical management of affections of ureter and urinary bladder | 2 |
| 7. | Medical dissolution and prevention of canine uroliths | 1 |
| 8. | Feline urologic syndrome | 1 |
| 9. | Surgical management of urolithiasis in ruminants and its prevention | 1 |
| 10. | Management of uroperitoneum and renal failure | 1 |

Unit III

- | | | |
|-----|---|---|
| 11. | Pathogenesis, clinical symptoms, diagnosis and surgical management of vaginal and uterine prolapse, rectovaginal fistula, pneumovagina | 1 |
| 12. | Pathogenesis, clinical symptoms, diagnosis and surgical management of vaginal tumours, pyometra, cysts of Gartner's canal and vestibular glands | 1 |

Unit IV

- | | | |
|-----|--|---|
| 13. | Surgical conditions of penis, prepuce, prostate and testicles, cryptorchidism, inguinal and scrotal hernia | 1 |
| 14. | Affections of teat and udder | 1 |

Unit V

- | | | |
|-----|---|---|
| 15. | Indications, techniques and postoperative complications of episiotomy, ovariectomy, ovariohysterectomy and caesarean section, pyometra and its surgical treatment | 1 |
|-----|---|---|

Unit VI

- | | | |
|-----|--|---|
| 16. | Castration, vasectomy, cauda epididymectomy and penile deviation | 1 |
|-----|--|---|



S. No.	Topics	No. of Lectures/ Practicals
Practical		
1.	Hand-on-training of techniques of centesis of urinary bladder in companion and farm animals	1
2.	Different types of catheters used in urogenital surgery, retrograde catheterization of urethra and urinary bladder	1
3.	Normograde catheterization of urethra on clinical cases of urinary retention	1
4.	Pudendal nerve block for penis examination in ruminants	1
5.	Diagnostic techniques and surgical management of the affections of kidney and ureters	2
6.	Uro-hydropropulsion	1
7.	Restraint and anaesthesia for urogenital tract surgery	1
8.	Cystotomy, tube cystostomy	1
9.	Nephrotomy, ureterocolostomy	1
10.	Urethrotomy, urethrostomy	1
11.	Castration, vasectomy, penile deviation, epididymectomy, amputation of penis, episiotomy	1
12.	Ovariohysterectomy, tubectomy	1
13.	Caesarean section	1
14.	Management of phimosis, paraphimosis, venereal granuloma	1
15.	Vaginal and uterine prolapse, rectovaginal fistula and pneumovagina	1
16.	Bladder and uterine marsupialization	1

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.
- Wolfe DF and Moll HD. *Large Animal Urogenital Surgery* 1999. 2nd ed., Williams and Wilkins, Tokyo.
- Yool DA. 2012. *Small Animal Soft Tissue Surgery*. CABI.

VSR 510: Ophthalmology (1+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Anatomy and physiology of eye and its adnexa	1
2.	Ophthalmic examination and diagnosis, diagnostic instrumentation	1
3.	Anaesthesia and surgery	1
Unit II		
4.	General consideration for eye surgery in companion and farm animals	1
5.	Therapeutic agents for eye diseases and surgery of eye lids, lacrimal apparatus, naso-lacrimal duct	1
Unit III		
6.	Diseases of conjunctiva	1
7.	Diseases of cornea, sclera, iris, orbit	1
8.	Diseases of lens	1
9.	Diseases of vitreous and aqueous humor	1



S. No.	Topics	No. of Lectures/ Practicals
10.	Diseases of retina and optic nerve	1
11.	Eye tumours, enucleation, exenteration	1
	Unit IV	
12.	Ocular manifestations of systemic diseases	2
	Unit V	
13.	Neuro-ophthalmology and ocular emergencies	3
	Practical	
1.	Ophthalmic instrumentation	1
2.	Examination of the eye and its adnexa	2
3.	Anaesthesia, preparation of patient, suture materials for eye surgery	1
4.	Canthotomy, tarsorrhaphy	1
5.	Keratoplasty, anterior chamber paracentesis	1
6.	Flushing of naso-lacrimal duct	1
7.	Iridectomy	1
8.	Phacoemulsification and implantation of foldable lens	1
9.	Surgical treatment of entropion	2
10.	Surgical treatment of cherry eye	1
11.	Schirmer tear test	1
12.	Use of fluorescein dye in corneal ulcer	1
13.	Glaucoma surgery	1
14.	Eye worm removal	1

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders
- Gelatt KN. 2014. *Essentials of Veterinary Ophthalmology*. 3rd ed. Wiley Blackwell. US.
- Gilger BC. 2017. *Equine Ophthalmology*, 3rd ed. Wiley Blackwell.
- Maggs DJ, Miller PE and Ofri R. 2017. *Slatter's Fundamentals of Veterinary Ophthalmology*. 6th ed. Saunders.
- Slatter DH 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.

VSR 511: Dentistry and Oral Surgery (1+1)

S. No.	Topics	No. of Lectures/ Practicals
	Theory	
	Unit I	
1.	Anatomy, development of teeth (odontogenesis)	1
2.	Dentition and ageing of different species	1
	Unit II	
3.	Clinical examination of oral cavity, dental anaesthesia and pain management	1
4.	Dental anaesthesia and pain management	1
5.	Dental radiography	1
	Unit III	
6.	Diseases of oral cavity and teeth, congenital and developmental anomalies of oral cavity	1



S. No.	Topics	No. of Lectures/ Practicals
7.	Abnormal tooth eruption, irregular wear of teeth in companion and farm animals, occlusion and malocclusion	1
8.	Mandibular fracture, malformation of mandible, maxilla (cleft palate)	1
Unit IV		
9.	Acquired diseases of teeth (halitosis, dental caries, fracture of teeth, dental materials and dental radiography), oronasal fistula	1
10.	Maxilla and mandibular fractures repair	1
11.	Orthodontics	1
12.	Tumors and other acquired condition of oral cavity	1
Unit V		
13.	Exodontics, restorative dentistry	1
14.	Periodontal disease, tooth extraction, gum diseases	1
15.	Endodontics, pulpectomy, root canal therapy, current techniques in dentistry	2
Practical		
1.	Oral examination	1
2.	Modified triadian system of tooth numbering in various species	1
3.	Dental chart for companion and farm animals	1
4.	Dentistry instrumentation	1
5.	Dental radiography procedure	1
6.	Periodontal probing, scaling/ teeth cleaning	1
7.	Tooth extraction	1
8.	Malpractices in equine dentistry	1
9.	Periodical maintenance of oral hygiene	1
10.	Corrective procedures, malocclusion	1
11.	Treatment strategies congenital malformations of maxilla	2
12.	Oral surgery	4

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders
- Holmstrom SE. 2013. *Veterinary Dentistry - A Team Approach*. 2nd ed. Elsevier.
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.
- Soto JC. 2015. *Visual Atlas of Dental Pathologies in Dogs*. SERVET, Spain.

VSR 512: Camel Surgery (1+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Introduction to special surgical anatomy of important parts, i.e. mandible, soft palate, chest pad, saddle region, male urinary system, tail, etc.	1
2.	Restraint and positioning for various surgical procedures and radiography of different parts	1



S. No.	Topics	No. of Lectures/ Practicals
Unit II		
3.	Use of local anaesthesia, various nerve blocks and regional anaesthesia used to treat diverse surgical disorders	1
4.	Preanaesthetics, tranquilizers, sedatives and general anaesthetics used for camel surgery	1
Unit III		
5.	Surgical affections of head and neck region: laceration and infected wounds of nostril skin, infection of turbinate, actinobacillosis, dental affections	1
6.	Surgical affections of head and neck region: removal of canines in furious camels, torticollis, fracture of mandible and maxilla, soft palate injuries	1
7.	Surgical affections of head and neck region: ophthalmic affections, salivary fistula, Stenson's duct ligation, oesophageal obstruction	1
Unit IV		
8.	Surgical affections of thorax and abdominal region: saddle gall, hernia, chest pad wounds and enlargements	1
9.	Surgical affections of thorax and abdominal region: foreign bodies in compartment, intestinal obstruction	1
10.	Surgical affections of thorax and abdominal region: obstructive urolithiasis, rupture of urethra, subcutaneous infiltration of urine, cystorrhexis	1
Unit V		
11.	Surgical affections of musculo-skeletal system: diagnosis of lameness in camels	1
12.	Surgical affections of musculo-skeletal system: management of long bone and digital fractures	1
13.	Surgical affections of musculo-skeletal system: upward fixation of patella, sprains, arthritis	1
Unit VI		
14.	Sheath abscess, necrosis of penis, phimosis, paraphimosis, preputial prolapse	1
15.	Various types of tumours, gangrene and tumours of udder, necrosis of tail	1
16.	Punctured foot, prolapse of digital cushion, foot injuries, Kumri, Kapali etc	1
Practical		
1.	Restraint and anaesthesia (Local, regional, sedation and general anaesthesia)	2
2.	Preparation of sites	1
3.	Surgical anatomy of important surgical affections	1
4.	Special instruments used for camel restraining and surgery	1
5.	Observing and assisting in diverse surgical procedures on clinical cases in camels	5
6.	Practice of interdental wiring for repair of mandibular fractures in specimen mandibles	1
7.	Clinical and radiographic diagnosis of lameness	2
8.	Protection of wounds of chest pad and foot using special bandages	1
9.	Radiography of different part of camels	1



Suggested Reading

- *Selected Topics on Camelids*, Ed-TK Gahlot, The Camelid Publishers, Bikaner and now marketed by Camel Publishing House, Edition 2000.
- *Medicine and Surgery of Camelids*. Ed-Murray E. Fowler, Wiley-Blackwell, Edition 2010.
- *Advances in Surgery and Diagnostic Imaging of the Dromedary Camel*, Ed- RO Ramadan, King Faisal University, Edition 2016.

VSR 513: Elephant Surgery (1+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Basic surgical anatomy of Asian elephants and comparison with other farm animals	4
Unit II		
2.	Drug administration techniques in captive and wild elephants, anaesthetic management of captive and wild elephants for various surgical and managerial conditions	1
3.	Drug administration techniques in captive and wild elephants, anaesthetic management of captive and wild elephants for various surgical and managerial conditions	1
Unit III		
4.	Principles of soft tissue surgery in elephants, cyst, bursitis, gall, haematoma, abscess, etc.	2
Unit IV		
5.	Management and treatment of fractures and arthritis in elephants	2
Unit V		
6.	Pedicure, corrective foot care and maintenance of healthy feet of captive elephants housed in different establishments in different seasons	2
Unit VI		
7.	Hoisting of recumbent elephants, surgical methods of birth control in elephants	1
8.	Limitations and risks of abdominal surgery in elephants (eg. caesarian section, castration, hernia, etc., soft tissue surgery like episiotomy, vestibulotomy, etc.)	2
Practical		
1.	Familiarity with clinical examination procedures	1
2.	Body weight estimation	1
3.	Signs of health and diseases	1
4.	Signs of localized lesions, etc.	1
5.	Familiarity with physical and chemical restraint procedures	1
6.	Drug administrations by various routes-IM, IV, SC, sub-conjunctival, oral, per rectal, etc.	1
7.	Foot examination and foot care procedures	1
8.	Visit to elephant camps	1
9.	Attending clinical procedures, surgeries etc	7

Suggested Reading

- Fowler ME and Mikota SK. 2006. *Biology, Medicine, and Surgery of Elephants*. Blackwell Publishing

**Minor Courses for M.V.Sc. Degree programme**

Courses of any one department/ discipline from the list given below or as considered relevant by the Advisory Committee from the BSMA approved subjects:

- Veterinary Physiology
- Veterinary Biochemistry
- Veterinary Biotechnology
- Veterinary Anatomy
- Veterinary Medicine
- Veterinary Pathology
- Animal Reproduction, Gynaecology and Obstetrics

Supporting Courses

It could be any subject considered relevant for student's research work. This will be decided by Advisor/ Guide concerned.

Common Courses

The following courses (one credit each) will be offered to all students undergoing Master's degree programme.

- Library and Information Services
- Technical Writing and Communications Skills
- Intellectual Property and its management in Agriculture
- Basic Concepts in Laboratory Techniques
- Agricultural Research, Research Ethics and Rural Development Programmes



Course Title with Credit Load

Ph.D. in Veterinary Surgery and Radiology

Course Code	Course Title	Credit Hours
VSR 601	Clinical Practice-I*	0+2
VSR 602	Clinical Practice-II*	0+2
VSR 603	Clinical Practice-III*	0+2
VSR 604	Cardiovascular Surgery	2+1
VSR 605	Advances in Anaesthesiology	2+1
VSR 606	Advances in Radiology	2+1
VSR 607	Advances in Diagnostic Imaging Techniques	2+1
VSR 608	Advances in Orthopaedics	2+1
VSR 609	Neurosurgery	2+1
VSR 610	Reconstructive and Regenerative Surgery	1+1
VSR 611	Advances in Soft Tissue Surgery	2+1
VSR 612	Advances in Ophthalmology	1+1
VSR 613	Surgical Oncology	1+1
VSR 687	Clinical Case Conference*	0+1
VSR 688	Special Problem in Diagnostic Imaging	0+2
VSR 689	Special Problem in Anaesthesia	0+2
VSR 690	Special Problem in Surgery	0+2
VSR 691	Doctoral Seminar-I	2+0
VSR 692	Doctoral Seminar-II	2+0
VSR 699	Doctoral Research	0+75

*Core Courses

Course Contents

Ph.D. in Veterinary Surgery and Radiology

- I. Course Title** : Clinical Practice-I
II. Course Code : VSR 601
III. Credit Hours : 0+2

IV. Aim of the course

To learn clinical techniques and procedures in anaesthesia, diagnostic imaging and surgery

V. Practical

Application of different equipment like inhalant anaesthesia machine, Computerized or digital radiography system, Ultrasonography, Endoscopy, Electro-surgery, Cryosurgery, Operating microscope, Phacoemulsification and physiotherapy, Client management and counseling, Treating surgical cases using advances techniques, managing surgical facilities, ICU equipment and personnel, Planning and formulating clinical research projects using the clinical data and facilities, Data analysis and writing of clinical case reports and success stories about the clinical achievements.

- I. Course Title** : Clinical Practice-II
II. Course Code : VSR 602
III. Credit Hours : 0+2

IV. Aim of the course

To learn clinical techniques and procedures in anaesthesia, Diagnostic imaging and surgery

V. Practical

Application of different equipment like inhalant anaesthesia machine, Computerized or digital Radiography system, Ultrasonography, Endoscopy, Electro-surgery, Cryosurgery, Operating microscope, Phacoemulsification and physiotherapy, Client management and counseling, Treating surgical cases using advances techniques, managing surgical facilities, ICU equipment and personnel, Planning and formulating clinical research projects using the clinical data and facilities, Data analysis and writing of clinical case reports and success stories about the clinical achievements.

- I. Course Title** : Clinical Practice-III
II. Course Code : VSR 603
III. Credit Hours : 0+2

IV. Aim of the course

To learn clinical techniques and procedures in anaesthesia, Diagnostic imaging and surgery



V. Practical

Application of different equipment like inhalant anaesthesia machine, Computerized or digital radiography system, Ultrasonography, Endoscopy, Electro-surgery, Cryosurgery, Operating microscope, Phacoemulsification and physiotherapy, Client management and counseling, Treating surgical cases using advances techniques, Managing surgical facilities, ICU equipment and personnel, Planning and formulating clinical research projects using the clinical data and facilities, Data analysis and writing of clinical case reports and success stories about the clinical achievements.

- I. Course Title** : Cardiovascular Surgery
II. Course Code : VSR 604
III. Credit Hours : 2+1

IV. Aim of the course

To learn the basic principles and and gain practical knowledge of diagnosis and treatment of diseases of cardiovascular system.

V. Theory

Unit I

Surgical anatomy, Pathophysiology, Systolic and diastolic functions, Heart failure.

Unit II

Physical examination, Electrocardiography, Cardiac catheterization.

Unit III

Special preoperative considerations for patients undergoing cardiovascular surgery, Surgical approaches to thorax, Different techniques of thoracotomy. Special instruments required in cardio-thoracic surgery, Defibrillator, Heart lung machine

Unit IV

Surgical management of congenital cardiac disorders: Malpositioning, Atrial septal defect, Endocardial cushion defect, Tricuspid valve disorder, Ventricular septal defect, Pulmonic stenosis, Teratology of fallot, Eisenmenger's complex, Anomalous pulmonary venous return, Mitral valve abnormalities, Aortic stenosis, Aortic regurgitation, transposition of the great vessels, Aortic pulmonary window, Persistent arteriosus, Patent ductus arteriosus, Coarctation of aorta, Persistent right aortic arch, Pericardial diaphragmatic hernia

Unit V

Acquired cardiac disorders: Mitral regurgitation, Tricuspid regurgitation, Dirofilariasis, Acquired aortic regurgitation, Endocarditis, Heart block, Cardiomyopathy, Pericarditis, Heart tumours, Hypothermia, Extracorporeal circulatory support, Cardiopulmonary bypass, Artificial heart transplant, Post operative management, Basic peripheral vascular procedures arteriotomy, Venotomy, anastomosis, Portocaval shunts and anomalies

VI. Practical

Instrumentation and suture techniques for cardiovascular surgery, Vascular prostheses, Anticoagulants, Surgical approaches to thorax, Different techniques of thoracotomy, Hand-on-training of different techniques of centesis of thoracic cavity



on cadavers, Thoracic drain placement, Demonstration of basic Cardiac procedures, Pericardiocentesis, Pericardiotomy, Cardiac catheterization, and various surgical conditions, Pericardiectomy, on cadaver and clinical cases of constructive pericarditis, Biopsy techniques, Use of IPPV in thoracic surgery.

- I. Course Title** : **Advances in Anaesthesiology**
II. Course Code : **VSR 605**
III. Credit Hours : **2+1**
IV. Aim of the course

To learn advance concepts and techniques of veterinary anaesthesia.

V. Theory

Unit I

Cellular and molecular mechanisms of anaesthesia, Effects of anaesthesia on different systems.

Unit II

Drug interactions with anaesthetics, Pharmacokinetics and pharmacodynamics of anaesthetics, CRI and TCI, Computer assisted anaesthesia.

Unit III

Opioids, alpha-2 agonists and ketamine for epidural anaesthesia, Acupuncture and electroanaesthesia.

Unit IV

Critical care in ICU, Pain transmission and processing, Methods for pain assessment in animals, Multimodal and preemptive analgesia, Techniques and drugs for pain managements.

Unit V

Anaesthesia for selected diseases (cardiovascular dysfunction, pulmonary dysfunction, Neurologic diseases, Renal diseases, Hepatic diseases, Gastrointestinal diseases, Endocrine diseases, Airway diseases).

Unit VI

Anaesthesia for special patients (ocular patients, heart patients, caesarian section patients, trauma patients, neonatal and geriatric patients).

VI. Practical

Various procedures for catheterization of heart and great vessels, Central venous line, Haemodynamic changes and pulmonary function tests during trials of anaesthetics, Electrocardiographic, Encephalographic evaluation of central nervous system activity, Cybernetics, Data acquisition and retrieval, Administration and monitoring of newer anaesthetics combinations.

- I. Course Title** : **Advances in Radiology**
II. Course Code : **VSR 606**
III. Credit Hours : **2+1**
IV. Aim of the course

To learn advance theoretical and practical knowledge in radiology.



V. Theory

Unit I

Biological effects of radiations (alpha, beta, X-ray and gamma rays) in vivo and *in-vitro* cellular response following radiation as an immunosuppressive agent.

Unit II

Different kind of projections and positioning, Contrast material, Different contrast techniques, PACS.

Unit III

Radiography of head and neck region, Radiography of thorax, Lung patterns, Radiography of abdominal and pelvic region

Unit IV

Radiography of limbs for lameness and fracture diagnosis, Application of image intensifiers in veterinary practice, Different types of screens.

Unit V

Computerized radiography (CR), Digital radiography (DR), Contrast CT and contrast MRI, PETCT, Advances in scintigraphy.

Unit VI

Radiation therapy in cancer patients, Biological effects of radiation physics, Physics of radiation, Electromagnetic radiations, Hazards of electromagnetic Radiations and protection and bio-safety.

VI. Practical

Radiographic positioning, Radiation safety measures, Handling radioactive material, Clinical radiological diagnosis at Radiology Unit, Demonstration of advanced radiological techniques.

I. Course Title : Advances in Diagnostic Imaging Techniques

II. Course Code : VSR 607

III. Credit Hours : 2+1

IV. Aim of the course

To learn advance theoretical and practical knowledge of ultrasonography, Diagnostic imaging techniques and their interpretations.

V. Theory

Unit I

Techniques of ultrasonography for diagnosis of different affections of neck, thorax (echocardiography, Doppler techniques), Abdomen and pelvis (Urinary bladder and prostate), Synovial joints, Muscle and tendons, Eye.

Unit II

Interpretation of ultrasonogram of different body organs/ vessels (normal and abnormal), Therapeutic applications of ultrasonography for physiotherapy.

Unit III

Imaging modalities like, MRI, CT scan, Nuclear medicine, Positron emission tomography technique, Single-photon emission computed tomography, etc.

**Unit IV**

Nuclear Scintigraphy-isotopes (natural and man-made); Cyclotron reactor, Half-life, decay pattern, Storage and handling of radioactive material,

Unit V

Methods in the detection of isotopes, Geiger-Muller tubes, Photo-multiplier tube, medical use of isotope, Dosimetry, Nuclear medicine and its use in diagnosis of thyroid, Kidney, bone and liver function studies, Labelling of isotope and biological uses, Detonation and fission products, Image storage and transfer, DICOM, PACS and teleinterpretation.

VI. Practical

Hands-on-practice on different visceral organs collected from slaughter house for ultrasonographic scanning in water tub, dry and wet lab training, Demonstration and practice on different clinical cases reported for ultrasonography, Visit to places with facility of other alternate imaging techniques.

I. Course Title : Advances in Orthopaedics

II. Course Code : VSR 608

III. Credit Hours : 2+1

IV. Aim of the course

To learn advance concepts and techniques of treatment of various affections of bones, joints, tendons, ligaments and foot in companion and farm animals.

V. Theory**Unit I**

Biomechanics of bone, Fracture etiology, Fracture reduction and different fracture fixation techniques like IM pinning, plating, nailing (inter locking nailing) and external skeletal fixation.

Unit II

Types, Properties, Biomechanics and use of different orthopaedic Implants, Bone grafts and their collection, Preservation, Indications and limitations, Bone graft substitutes like ceramics and composites, Their usage and limitations.

Unit III

Principles of osteogenesis, Osteoinduction and Osteoconduction.

Unit IV

Advances in internal fixation and external skeletal fixation techniques in veterinary orthopaedics.

Unit V

Metabolic bone diseases like rickets, osteomalacia, osteodystrophy and secondary hyperparathyroidism, etc. Classification, diagnosis and treatment of arthritis.

Unit VI

Advances in the management of congenital and acquired disorders of joints like traumatic dislocations, luxations and dysplasia. etiopathology and management of equine lameness including Laminitis, Navicular disease, Quitter, Canker and thrush, Sand cracks, Ring bone, Hygromas, Bursitis, Spavin and Splint.



Unit VII

Affections of muscles, tendons and ligaments, joint prosthesis and transplantation.

Unit VIII

Postoperative management of orthopaedic patients including the role of movement restriction, Weight bearing, Nutritional therapy, Physiotherapy and rehabilitation, Introduction to recovery assessment using lameness score, Gait analysis using computerized software.

VI. Practical

Hands on practice for different internal fixation techniques on cadaver, Management of different types of long bone fractures in different species of domestic animals, with special reference to practice of bone plating, Interlocking nailing and external skeletal fixation, Treatment of metabolic bone diseases in growing animals, Correction of antebrachial deformities including osteotomies and limb lengthening procedures, preservation of bone grafts, practice of bone grafting and use of osteoinducers in Clinical situation, Clinical and radiographic evaluation of various joint affections, Reduction and fixation of different joint luxations like coxo-femoral, Patellar, femoro-tibial, hock, scapulo-humeral, elbow and temporomandibular, Techniques of osteotomy, arthrodesis and joint replacement, Repair of tendon and ligament injuries, Diagnosis and treatment of various conditions causing lameness in equines and bovines.

I. Course Title : Neurosurgery

II. Course Code : VSR 609

III. Credit Hours : 2+1

IV. Aim of the course

To learn principles and techniques of treatment of surgical affections of nervous system in animals

V. Theory

Unit I

Nervous system – anatomy, physiology and pathological manifestations.

Unit II

Clinical neurology, Therapeutic Neurectomy, Nerve anastomosis, Pathogenesis of disease of the central nervous system.

Unit III

Diagnostic methods – Electrodiagnostic methods, Neuro radiology.

Unit IV

Fundamentals of neurosurgery, Surgical approaches to brain, Surgical diseases of peripheral nerves, Surgical affections and approaches to the spine, Diseases of the spinal column, Intervertebral disc diseases.

Unit V

Surgical approaches to brain and intracranial surgery.

VI. Practical

Methods for clinical and neurological examination including electro-encephalography,

electromyography and electro-diagnostic testing, Collection of CSF and its evaluation, Techniques of myelography, Vertebral venography, Pneumoventriculography, Cerebral arteriography and cavernous sinus venography, Management of vertebral fractures and luxations with stabilization, Treatment of spinal cord compression, viz., Disc fenestration, Hemilaminectomy, Dorsal laminectomy and ventral slot, Techniques of peripheral nerve anastomosis and reconstruction of peripheral nerves.

I. Course Title : Reconstructive And Regenerative Surgery

II. Course Code : VSR 610

III. Credit Hours : 1+1

IV. Aim of the course

To learn principles and techniques of reconstructive and regenerative surgery.

V. Theory

Unit I

Principles of regenerative medicine, Tissue homeostasis, Tissue and organ transplantation, Histo-compatibility matching, Transplantation immunity and host graft reaction, Immunosuppression

Unit II

Classification, Isolation, Characterization, Storage and application of stem cells, Extracellular matrix, Microenvironment and growth factors for tissue repair and regeneration.

Unit III

Synthetic and biological scaffolds, Preparation of biological scaffold and its role in Tissue regeneration, Whole organ decellularization and its application, Biomimetic scaffolds.

Unit IV

Designing for 3D printing, Bio-fabrication of organ and Tissue substitutes and its applications, Ethical concerns in regenerative medicine, GMP protocols and its applications in regenerative medicine

Unit V

Current techniques in designing and clinical application of biomaterials, Mechanical and functional testing of biomaterials, Biocompatibility testing

VI. Practical

Collection of bone marrow derived stem cells from different species of animals, Growth and differentiation of stem cells in different lineages, Decellularization of different tissues and organs, cell growth on different scaffolds, Clinical application of stem cells

I. Course Title : Advances in Soft Tissue Surgery

II. Course Code : VSR 611

III. Credit Hours : 2+1

IV. Aim of the course

To learn advanced concepts and practical techniques of treatment of soft tissue surgery, laparoscopic and minimally invasive surgery



V. Theory

Unit I

Advances in surgeries of ENT affections of small and large animals, Rhinoscopy-rhinotomy, Tumors of turbinates, Cheiloplasty, Hare lip correction, Salivary duct ligation, Parotid gland ablation, Bullaosteotomy, Buccotomy procedures, Glossophagia, Self suck correction.

Unit II

Upper respiratory tract affection in small and large animals, Barchiocephalic air way syndrome, Laryngeal paralysis, Tracheal collapse, Tracheostomy (temporary/permanent), Chest trauma, Chest tube placement, Thoracocentesis, Pneumectomy, (partial/ unilateral), Heart lung transplant, Thoracic duct ligation, Trans tracheal intubation, Thoracoscopic procedure.

Unit III

Esophageal affections in small and large animals, Dilatation, Diverticulum, PRAA-Mullers surgery, Gastroesophageal intussception, Short bowel syndrome, Colostomy, megacolon, Rectal tube placement, Rectal diverticulum, Gastroscopy techniques

Unit IV

Pyelolithotomy, Lithotripsy, Renal transplantation, Ectopic ureter, Prostatectomy, Urinary incontinence, Penile urethrotomy, Urethroscopic retrieval of urolith, Endoscopic ureter stent placement.

Unit V

Thyroidectomy in cats, Liver lobectomy, Cholelithiasis, Cholecystectomy, Cholecystoduodenostomy, Porto caval shunt, Adrenalectomy.

Unit VI

Skin grafting, Subdermal, Axial skeletal, Omocervical axial pattern flap, Thoracodorsal axial pattern flap, Superficial brachial axial pattern flap, Caudal superficial epigastric axial pattern flap, Cranial superficial epigastric axial pattern flap, Deep circumflex iliac dorsal axial pattern flap, Deep circumflex iliac ventral axial pattern flap, Genicular axial pattern flap, Reverse saphenous conduit flap, Caudal auricular axial pattern flap, Split thickness and full thickness grafts, Reconstructive surgical procedures.

VI. Practical

Endoscopic surgical procedures in small and large animals, Chest tube placement, Rhinoscopy, Thoracoscopy, Bronchoscopy, Gastroscopy, Colonoscopy, Urethrocystoscopy, Laproscopic surgical techniques, Skin flap and grafting techniques, Tracheostomy, Renal graft cystoplasty.

I. Course Title : Advances in Ophthalmology

II. Course Code : VSR 612

III. Credit Hours : 1+1

IV. Aim of the course

To learn advanced concepts and practical techniques in ophthalmology.

V. Theory

Unit I

Embryology of the eye, study of ocular physiology and biochemistry, structure and



function of eye and adenexa, Physiology of vision, Electrophysiology of visual system

Unit II

Advances in diagnosis and diseases of the eye and adnexia.

Unit III

Ocular neoplasia, advances in neuro ophthalmology, Advances in ophthalmic pharmacology, microbiology and nutrition

Unit IV

Advances in ocular imaging, Advances in ocular anaesthesia and analgesia

Unit V

Advances in ocular emergencies, Ophthalmology of exotic species and lab animals, ocular toxicology

Unit VI

Corneal grafting, application of nanotechnology and stem cell therapy in veterinary ophthalmology.

VI. Practical

Exposure to latest ophthalmic instrumentation like phaco, ultrasound, cataract surgery and lens implantation, corneal transplantation.

I. Course Title : Surgical Oncology

II. Course Code : VSR-613

III. Credit Hours : 1+1

IV. Aim of the course

To learn about tumor genesis and treatment in animals.

V. Theory

Unit I

Biology of neoplastic disease: etiology, cellular mechanism, principles of surgical oncology.

Unit II

Diagnosis, classification and clinical staging of tumors and decision making for therapy, metastasis.

Unit III

Surgical management: Surgical excision of tumors, Cytoreductive surgery, Surgery for metastatic disease, Palliative surgery, Evaluation and interpretation of surgical margins.

Unit IV

Clinical signs, Diagnosis and treatment options of tumors of skin, Soft tissues, skeletal system, Head and neck, Gastro-intestinal tract, Respiratory tract, Urinary tract, Genital tract, Mammary gland, Nervous system, Endocrine system, haematopoietic system, the eye and orbit and miscellaneous tumours.

Unit V

Radiation therapy, Chemotherapy, Electrochemotherapy, Cryotherapy and targeted



therapy. Side effects of radio and chemotherapy, Nutritional management of cancer patients, Basics of immunotherapy in cancer management.

VI. Practical

General approaches to the diagnosis of neoplasia: Fine needle aspiration biopsy, needle core biopsy, excisional and incisional biopsy, bone marrow biopsy, lymph node biopsy, percutaneous lung biopsy, bone biopsy, ultrasound/ laparoscope guided biopsy.

I. Course Title : Clinical Case Conference

II. Course Code : VSR 687

III. Credit Hours : 0+1

IV. Practical

Present seminar on unusual/ interesting clinical cases done in the semester. Compile them from presentation to follow up and also submit the write up in soft or hard copy.

I. Course Title : Special Problem in Diagnostic Imaging

II. Course Code : VSR 688

III. Credit Hours : 0+2

IV. Practical

Investigative diagnosing imaging problems in clinical models, didactic and interpersonal learning-teaching, problem solving self-learning strategies in problems related to surgery

I. Course Title : Special Problem in Anaesthesia

II. Course Code : VSR 689

III. Credit Hours : 0+2

IV. Practical

Investigative anaesthetic problems in clinical models, didactic and interpersonal learning-teaching, problem solving self-learning strategies in problems related to anaesthesia

I. Course Title : Special Problem in Surgery

II. Course Code : VSR 690

III. Credit Hours : 0+2

IV. Practical

Investigative surgical problems in clinical models, didactic and interpersonal learning-teaching, problem solving self-learning strategies in problems related to surgery

VSR 691 Doctoral Seminar-I (2+0)

VSR 692 Doctoral Seminar-II (2+0)

VSR 699 Doctoral Research (0+75)



Course Outline: Lecture wise

VSR 604: Cardiovascular Surgery (2+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Surgical anatomy, pathophysiology	1
2.	Systolic and diastolic functions	1
3.	Heart failure	1
Unit II		
4.	Physical examination	1
5.	Electrocardiography	1
6.	Cardiac catheterization	1
Unit III		
7.	Special preoperative considerations for patients undergoing cardiovascular surgery, surgical approaches to thorax	1
8.	Different techniques of thoracotomy	1
9.	Special instruments required in cardio-thoracic surgery, defibrillator, heart lung machine	1
Unit IV		
10.	Surgical management of congenital cardiac disorders: malpositioning, atrial septal defect, endocardial cushion defect	1
11.	Surgical management of congenital cardiac disorders: tricuspid valve disorder, ventricular septal defect	1
12.	Surgical management of congenital cardiac disorders: pulmonic stenosis, teratology of fallot	1
13.	Surgical management of congenital cardiac disorders: eisenmenger's complex, anomalous pulmonary venous return	1
14.	Surgical management of congenital cardiac disorders: mitral valve abnormalities, aortic stenosis, aortic regurgitation	1
15.	Surgical management of congenital cardiac disorders: transposition of the great vessels, aortic pulmonary window, persistent arteriosus	1
16.	Surgical management of congenital cardiac disorders: patent ductus arteriosus, coarctation of aorta, persistent right aortic arch	1
17.	Surgical management of congenital cardiac disorders: pericardial diaphragmatic hernia	1
Unit V		
18.	Acquired cardiac disorders: mitral regurgitation, tricuspid regurgitation	1
19.	Acquired cardiac disorders: dirofilariasis	1
20.	Acquired cardiac disorders: acquired aortic regurgitation, endocarditis	1
21.	Acquired cardiac disorders: heart block	1
22.	Acquired cardiac disorders: cardiomyopathy, pericarditis, heart tumours	1
23.	Acquired cardiac disorders: hypothermia, extracorporeal circulatory support	1



S. No.	Topics	No. of Lectures/ Practicals
24.	Acquired cardiac disorders: cardiopulmonary bypass	1
25.	Acquired cardiac disorders: artificial heart transplant, post operative management	1
26.	Acquired cardiac disorders: basic peripheral vascular procedures arteriotomy, venotomy, anastomosis	1
27.	Acquired cardiac disorders: portocaval shunts and anomalies	1
Practical		
1.	Instrumentation and suture techniques for cardiovascular surgery	2
2.	Vascular prostheses	1
3.	Anticoagulants	1
4.	Surgical approaches to thorax	1
5.	Different techniques of thoracotomy	1
6.	Hand-on-training of techniques of centesis of thoracic cavity on cadavers	1
7.	Hand-on-training of thoracic drain placement	1
8.	Demonstration of pericardiocentesis	1
9.	Demonstration of pericardiotomy	1
10.	Demonstration of cardiac catheterization	1
11.	Demonstration of pericardiectomy on cadaver and clinical cases of constructive pericarditis	1
12.	Demonstration of cardiac biopsy techniques	1
13.	Demonstration of use of IPPV in thoracic surgery	1

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.

VSR 605: Advances in Anaesthesiology (2+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Cellular and molecular mechanisms of anaesthesia	1
2.	Effects of anaesthesia on different systems	3
Unit II		
3.	Drug interactions with anaesthetics	1
4.	Pharmacokinetics and pharmacodynamics of anaesthetics	2
5.	CRI and TCI, computer assisted anaesthesia	1
Unit III		
6.	Opioids, alpha-2 agonists and ketamine for epidural anaesthesia	2
7.	Acupuncture and electroanaesthesia	
Unit IV		
8.	Critical care in ICU	1
9.	Pain transmission and processing, methods for pain assessment in animals	1
10.	Multimodal and preemptive analgesia	1
11.	Techniques and drugs for pain managements	1



S. No.	Topics	No. of Lectures/ Practicals
Unit V		
12.	Anaesthesia for selected diseases (cardiovascular dysfunction)	1
13.	Anaesthesia for selected diseases (pulmonary dysfunction)	1
14.	Anaesthesia for selected diseases (neurologic diseases)	1
15.	Anaesthesia for selected diseases (renal diseases)	1
16.	Anaesthesia for selected diseases (hepatic diseases)	1
17.	Anaesthesia for selected diseases (gastrointestinal diseases)	1
18.	Anaesthesia for selected diseases (endocrine diseases, airway diseases)	1
Unit VI		
19.	Anaesthesia for special patients (ocular patients)	1
20.	Anaesthesia for special patients (heart patients)	1
21.	Anaesthesia for special patients (caesarian section patients)	1
22.	Anaesthesia for special patients (trauma patients)	1
23.	Anaesthesia for special patients (neonatal patients)	1
24.	Anaesthesia for special patients (geriatric patients)	1
Practical		
1.	Various procedures for catheterization of heart and great vessels	2
2.	Central venous line	1
3.	Haemodynamic changes during trials of anaesthetics	2
4.	Electrocardiography	1
5.	Encephalographic evaluation of central nervous system activity	1
6.	Cybernetics	1
7.	Data acquisition and retrieval	1
8.	Administration and monitoring of newer anaesthetics combinations	6

Suggested Reading

- Aronson LR. 2016. *Small Animal Surgical Emergencies*. Wiley Blackwell.
- Clarke KW, Trim CM and Hall LW. 2013. *Veterinary Anaesthesia*. 11th ed. WB Saunders.
- Grim KA, Lamont LA, Tranquilli WJ, Greene SA and Robertson SA. 2015. *Veterinary Anaesthesia and Analgesia*. 5th ed. Lumb and Jones. Wiley Blackwell.
- Grim KA, Tranquilli WJ and Lamont LA. 2011. *Essentials of Small Animal Anesthesia and Analgesia*. 2nd ed. Wiley Blackwell.
- Paddleford RR. 1999. *Manual of Small Animal Anesthesia*. 2nd ed. WB Saunders.

VSR 606: Advances in Radiology (2+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Biological effects of radiations (alpha, beta, X-ray and gamma rays) <i>in vivo</i> and <i>in-vitro</i> cellular response following radiation as an immunosuppressive agent	4
Unit II		
2.	Different kind of projections and positioning, contrast material, different contrast techniques, PACS	4
Unit III		
3.	Radiography of head region	1



S. No.	Topics	No. of Lectures/ Practicals
4.	Radiography of neck region	1
5.	Radiography of thorax	1
6.	Lung patterns	1
7.	Radiography of abdominal region	1
8.	Radiography of pelvic region	1
Unit IV		
9.	Radiography of limbs for lameness and fracture diagnosis	1
10.	Application of image intensifiers in veterinary practice	1
11.	Different types of screens	1
Unit V		
12.	Computerized radiography (CR)	1
13.	Digital radiography (DR)	1
14.	Contrast CT	1
15.	Contrast MRI	1
16.	PETCT	1
17.	Advances in scintigraphy	1
18.	Radiation therapy in cancer patients	1
19.	Biological effects of radiation physics	1
20.	Physics of radiation, electromagnetic radiations	1
21.	Hazards of electromagnetic radiations and protection and bio-safety	2
Practical		
1.	Radiographic positioning	3
2.	Radiation safety measures	1
3.	Handling radioactive material	1
4.	Clinical radiological diagnosis at Radiology Unit	8
5.	Demonstration of advanced radiological techniques	2

Suggested Reading

- Bargai U, Pharr, JW and Morgan JP. 1989. *Bovine Radiology*. Iowa State University Press, Ames.
- Bushong SC. 2017. *Radiologic Science for Technologists*. 11th ed. CV Mosby.
- Gillette EL, Thrall DE and Lebel JL. (Eds.). 1977. *Carlson's Veterinary Radiology*. Lea and Febiger.
- Kealy JK, McAllister H and Graham JP. (Eds.). 2011. *Diagnostic Radiology and Ultrasonography of the Dog and Cat*. 5th ed. WB Saunders, Philadelphia.
- Morgan JP. 1972. *Radiology in Veterinary Orthopaedics*. Lea and Febiger.
- Thrall DE. 2017. *Textbook of Veterinary Diagnostic Radiology*. 7th ed. Saunders, Philadelphia.

VSR 607: Advances in Diagnostic Imaging Techniques (2+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Techniques of ultrasonography for diagnosis of different affections of neck	1
2.	Techniques of ultrasonography for diagnosis of different affections of thorax (echocardiography, Doppler techniques)	3



S. No.	Topics	No. of Lectures/ Practicals
3.	Techniques of ultrasonography for diagnosis of different affections of abdomen and pelvis (Urinary bladder and prostate)	1
4.	Techniques of ultrasonography for diagnosis of different affections of synovial joints	1
5.	Techniques of ultrasonography for diagnosis of different affections of muscle and tendons.	1
6.	Techniques of ultrasonography for diagnosis of different affections of eye.	1
Unit II		
7.	Interpretation of ultrasonogram of different body organs/ vessels (normal and abnormal)	3
8.	Therapeutic applications of ultrasonography for physiotherapy	1
Unit III		
9.	Imaging modalities like, MRI, CT scan, nuclear medicine, positron emission tomography technique, single-photon emission computed tomography etc	4
10.	Nuclear Scintigraphy-isotopes (natural and man-made); cyclotron reactor, half-life, decay pattern, storage and handling of radioactive material	4
Unit IV		
11.	Methods in the detection of isotopes, Geiger-Muller tubes, photo-multiplier tube, medical use of isotope, dosimetry	2
12.	Nuclear medicine and its use in diagnosis of thyroid	1
13.	Nuclear medicine and its use in diagnosis of kidney	1
14.	Nuclear medicine and its use in diagnosis of bone	1
15.	Nuclear medicine and its use in diagnosis of liver function studies	1
16.	Labelling of isotope and biological uses, detonation and fission products, image storage and transfer, DICOM, PACS and teleinterpretation	3
Practical		
1.	Hands-on-practice on different visceral organs collected from slaughter house for ultrasonographic scanning in water tub, dry and wet lab training	6
2.	Demonstration and practice on different clinical cases reported for ultrasonography	7
3.	Visit to places with facility of other alternate imaging techniques	2

Suggested Reading

- Bargai U, Pharr, JW and Morgan JP. 1989. *Bovine Radiology*. Iowa State University Press, Ames.
- Barr FJ and Gaschen L. 2011. *BSAVA Manual of Canine and Feline Ultrasonography*. British Small Animal Veterinary Association.
- Boon JA. 2011. *Veterinary Echocardiography*. 2nd ed. Wiley-Blackwell.
- Bushong SC. 2017. *Radiologic Science for Technologists*. 11th ed. CV Mosby.
- Butler JA, Colles CM, Dyson SJ, Kold SE and Poulos PW. 2017. *Clinical Radiology of the Horse*. 4th ed. Wiley Blackwell.
- Gillette EL, Thrall DE and Lebel JL. (Eds.). 1977. *Carlson's Veterinary Radiology*. Lea and Febiger.
- Goddard PJ. 1995. *Veterinary Ultrasonography*. CABI.



- Kealy JK, McAllister H and Graham JP. (Eds.). 2011. *Diagnostic Radiology and Ultrasonography of the Dog and Cat*. 5th ed. WB Saunders, Philadelphia.
- Mannion P. 2006. *Diagnostic Ultrasound in Small Animal Practice*. Blackwell Science.
- Mantis P. 2016. *Practical Small Animal Ultrasonography Abdomen*. SERVET, Spain.
- Morgan JP@. 1972. *Radiology in Veterinary Orthopaedics*. Lea and Febiger.
- Nyland TG and Mattoon JS. 2002. *Small Animal Diagnostic Ultrasound*. WB Saunders.
- Thrall DE. 2017. *Text book of Veterinary Diagnostic Radiology*. 7th ed. Saunders, Philadelphia.
- Weisse C and Berent A (Eds.) 2015. *Veterinary Image Guided Interventions*. Wiley Blackwell.

VSR 608: Advances in Orthopaedics (2+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Biomechanics of bone, fracture etiology	1
2.	Fracture reduction and different fracture fixation techniques like IM pinning	1
3.	Fracture reduction and different fracture fixation techniques like plating	1
4.	Fracture reduction and different fracture fixation techniques like nailing (inter locking nailing) and external skeletal fixation	1
5.	Fracture reduction and different fracture fixation techniques like external skeletal fixation	1
Unit II		
6.	Types, properties, biomechanics and use of different orthopaedic implants	1
7.	Bone grafts and their collection, preservation, indications and limitations	1
8.	Bone graft substitutes like ceramics and composites, their usage and limitations	1
Unit III		
9.	Principles of osteogenesis, osteoinduction and osteoconduction	2
Unit IV		
10.	Advances in internal fixation techniques in veterinary orthopaedics	2
11.	Advances in internal fixation techniques in veterinary orthopaedics	
12.	Advances in external skeletal fixation techniques in veterinary orthopaedics	2
13.	Metabolic bone diseases like rickets, osteomalacia, osteodystrophy and secondary hyperparathyroidism, etc.	2
14.	Classification, diagnosis and treatment of arthritis.	3
15.	Advances in the management of congenital and acquired disorders of joints like traumatic dislocations, luxations and dysplasia.	2
16.	Etiopathology and management of equine lameness including laminitis, navicular disease, quitter, canker and thrush, sand cracks, ring bone, hygromas, bursitis, spavin and splint.	5
17.	Affections of muscles, tendons and ligaments	1
18.	Joint prosthesis and transplantation	1
Unit V		
19.	Postoperative management of orthopaedic patients including the role of movement restriction, weight bearing, nutritional therapy, physiotherapy and rehabilitation	2
20.	Introduction to recovery assessment using lameness score, gait analysis using computerized software	2



S. No.	Topics	No. of Lectures/ Practicals
Practical		
1.	Hands on practice for different internal fixation techniques on cadaver	4
2.	Management of different types of long bone fractures in different species of domestic animals, with special reference to practice of bone plating	1
3.	Management of different types of long bone fractures in different species of domestic animals, with special reference to practice of interlocking nailing	1
4.	Management of different types of long bone fractures in different species of domestic animals, with special reference to practice of external skeletal fixation	1
5.	Treatment of metabolic bone diseases in growing animals	1
6.	Correction of antebrachial deformities including osteotomies and limb lengthening procedures	1
7.	Preservation of bone grafts	1
8.	Practice of bone grafting and use of osteoinducers in clinical situation	1
9.	Clinical and radiographic evaluation of various joint affections	1
10.	Reduction and fixation of different joint luxations like coxo-femoral, patellar, femoro-tibial, hock, scapulo-humeral, elbow and temporomandibular	1
11.	Techniques of osteotomy, arthrodesis and joint replacement	1
12.	Repair of tendon and ligament injuries	1
13.	Diagnosis and treatment of various conditions causing lameness in equines	1
14.	Diagnosis and treatment of various conditions causing lameness in bovines	1

Suggested Reading

- Auer JA and Stick JA. 2017. *Equine Surgery*. 4th ed. Elsevier Saunders.
- Baxter GM. (Ed.). 2011. *Adams and Stashak's Lameness in Horses*. 6th ed. Wiley-Blackwell
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders.
- Greenough PR. 2007. *Bovine Laminitis and Lameness*. WB Saunders.
- Newton CD and Nunamaber DM. (Eds.). 1985. *Textbook of Small Animal Orthopaedics*. JB Lippincott.
- Oehme FW and Prier JE. (Eds.). 1974. *Textbook of Large Animal Surgery*. Williams and Wilkins.
- Ross MW and Dyson SJ. 2011. *Diagnosis and Management of Lameness in the Horse*. 2nd ed. Elsevier Saunders.
- Tyagi RPS and Singh J. (Eds.). 1993. *Ruminant Surgery*. CBS
- Weaver AD, Jean GS and Steiner A. 2007. *Bovine Surgery and Lameness*. 2nd ed. Wiley-Blackwell.

VSR 609: Neurosurgery (2+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Nervous system – anatomy, physiology and pathological manifestations	5



S. No.	Topics	No. of Lectures/ Practicals
Unit II		
2.	Clinical neurology	1
3.	Therapeutic neurectomy	1
4.	Nerve anastomosis	1
5.	Pathogenesis of disease of the central nervous system	1
Unit III		
6.	Diagnostic methods – electrodiagnostic methods, neuro radiology	4
Unit IV		
7.	Fundamentals of neurosurgery	1
8.	Surgical approaches to brain	1
9.	Surgical diseases of peripheral nerves	1
10.	Surgical approaches to brain and intracranial surgery	1
11.	Surgical affections and approaches to the spine	2
12.	Diseases of the spinal column	1
13.	Intervertebral disc diseases	1
Unit V		
14.	Surgical approaches to brain and intracranial surgery	3
Practical		
1.	Methods for clinical and neurological examination	1
2.	Electro-encephalography	1
3.	Electromyography and electro-diagnostic testing	2
5.	Collection of CSF and its evaluation	2
7.	Techniques of myelography	1
8.	Vertebral venography	1
9.	Pneumoventriculography	1
10.	Cerebral arteriography	1
11.	Cavernus sinus venography	1
12.	Management of vertebral fractures and luxations with stabilization	1
13.	Treatment of spinal cord compression, viz., disc fenestration, hemilaminectomy, dorsal laminectomy and ventral slot	2
15.	Techniques of peripheral nerve anastomosis and reconstruction of peripheral nerves	2

Suggested Reading

- Dewey CW and C da Costa R. 2016. *Practical Guide to Canine and Feline Neurology*, 3rd ed. Wiley Blackwell.
- Lorenz MD, Coastes JR and Kent M. 2011. *Handbook of Veterinary Neurology*, 5th ed. Elsevier.

VSR 610: Reconstructive and Regenerative Surgery (1+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Principles of regenerative medicine, tissue homeostasis	1
2.	Tissue and organ transplantation, histo-compatibility matching	1



S. No.	Topics	No. of Lectures/ Practicals
3.	Transplantation immunity and host graft reaction, immunosuppression	1
	Unit II	
4.	Classification, isolation, characterization, storage and application of stem cells, extracellular matrix,	3
5.	Microenvironment and growth factors for tissue repair and regeneration	1
	Unit III	
6.	Synthetic and biological scaffolds	1
7.	Preparation of biological scaffold and its role in tissue regeneration	1
8.	Whole organ decellularization and its application, biomimetic scaffolds	1
	Unit IV	
9.	Designing for 3D printing, bio-fabrication of organ and tissue substitutes and its applications	1
10.	Ethical concerns in regenerative medicine	1
11.	GMP protocols and its applications in regenerative medicine	1
	Unit V	
12.	Current techniques in designing and clinical application of biomaterials,	2
13.	Mechanical and functional testing of biomaterials	1
14.	Biocompatibility testing	1
	Practical	
1.	Collection of bone marrow derived stem cells from different species of animals	3
2.	Growth and differentiation of stem cells in different lineages	1
3.	Decellularization of different tissues and organs	6
4.	Cell growth on different scaffolds	3
5.	Clinical application of stem cells	3

Suggested Reading

- Bojrab Joseph M, Monnet Eric. 2010. *Mechanisms of Disease in Small Animal Surgery*, 3rd Teton New Media, U.S.
- Griffers D and Hamaide A. (Eds.). 2016. *Complications in Small Animal Surgery*. Wiley Blackwell.
- Theoret C and Schumacher J. 2017. *Equine Wound Management*. Griffon, D and Hamaide A 2016. *Complications in Small Animal Surgery*, Wiley Blackwell.

VSR 611: Advances in Soft Tissue Surgery (2+1)

S. No.	Topics	No. of Lectures/ Practicals
	Theory	
	Unit I	
1.	Advances in surgeries of ENT affections of small and large animals- rhinoscopy, rhinotomy, tumors of turbinates	1
2.	Advances in surgeries of ENT affections of small and large animals- cheiloplasty, hare lip correction, salivary duct ligation, parotid gland abalation	1
3.	Advances in surgeries of ENT affections of small and large animals- bullaostectomy, buccotomy procedures, glossoplagia, self suck correction	1



S. No.	Topics	No. of Lectures/ Practicals
Unit II		
4.	Upper respiratory tract affection in small and large animals- barchiocephalic air way syndrome, laryngeal paralysis	1
5.	Upper respiratory tract affection in small and large animals- tracheal collapse, tracheostomy (temporary/ permanent)	1
6.	Upper respiratory tract affection in small and large animals- chest trauma, chest tube placement, thoracocentesis	1
7.	Upper respiratory tract affection in small and large animals- pneumectomy, (partial/ unilateral), heart lung transplant, thoracic duct ligation	1
8.	Upper respiratory tract affection in small and large animals- thoracic duct ligation, trans tracheal intubation, thoracoscopic procedure	1
Unit III		
9.	Esophageal affections in small and large animals- dilatation, diverticulum, PRAA- Mullers surgery	1
10.	Esophageal affections in small and large animals- gastroesophageal intussception, short bowel syndrome	1
11.	Esophageal affections in small and large animals- colostomy, megacolon, rectal tube placement	1
12.	Esophageal affections in small and large animals- rectal diverticulum, gastroscopy techniques	1
Unit IV		
13.	Pyelolithotomy, lithotripsy	1
14.	Renal transplantation	1
15.	Ectopic ureter, prostatectomy, urinary incontinence	1
16.	Penile urethrotomy, urethroscopic retrieval of urolith, endoscopic ureter stunt placement	1
Unit V		
17.	Thyroidectomy in cats, liver lobectomy	1
18.	Cholelithiasis, cholecystectomy, cholecystoduo denostomy	1
19.	Porto caval shunt, adrenalectomy	1
Unit VI		
20.	Skin grafting, subdermal, axial skeletal, omocervical axial pattern flap	1
21.	Thoracodorsal axial pattern flap, superficial brachial axial pattern flap, caudal superficial epigastric axial pattern flap	1
22.	Cranial superficial epigastric axial pattern flap, deep circumflex iliac dorsal axial pattern flap	1
23.	Deep circumflex iliac ventral axial pattern flap, genicular axial pattern flap	1
24.	Reverse saphenous conduit flap, caudal auricular axial pattern flap,	1
25.	Split thickness and full thickness grafts	1
26.	Reconstructive surgical procedures	1
Practical		
1.	Endoscopic surgical procedures in small and large animals	1
2.	Chest tube placement	1
3.	Rhinoscopy	1
4.	Thoracoscopy	1
5.	Bronchoscopy	1
6.	Gastroscopy	1
7.	Colonoscopy	1



S. No.	Topics	No. of Lectures/ Practicals
8.	Urethrocystoscopy	1
9.	Laparoscopic surgical techniques	2
10.	Skin flap and grafting techniques	3
11.	Tracheostomy	1
12.	Renal graft cystoplasty	1

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.
- Yool DA. 2012. *Small Animal Soft Tissue Surgery*. CABI

VSR 612: Advances in Ophthalmology (1+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Embryology of the eye, study of ocular physiology and biochemistry	1
2.	Structure and function of eye and adnexa, physiology of vision, electrophysiology of visual system	1
Unit II		
3.	Advances in diagnosis and diseases of the eye and adnexa	2
Unit III		
4.	Ocular neoplasia, advances in neuro ophthalmology	1
5.	Advances in ophthalmic pharmacology, microbiology and nutrition	1
Unit IV		
6.	Advances in ocular imaging	1
7.	Advances in ocular anaesthesia and analgesia	1
Unit V		
8.	Advances in ocular emergencies	1
9.	Ophthalmology of exotic species	1
10.	Ophthalmology of lab animals	1
11.	Ocular toxicology	1
Unit VI		
12.	Corneal grafting	1
13.	Application of nanotechnology in veterinary ophthalmology	1
14.	Application of stem cell therapy in veterinary ophthalmology	1
Practical		
1.	Exposure to latest ophthalmic instrumentation like phaco	1
2.	Exposure to latest ophthalmic instrumentation like ultrasound	1
3.	Exposure to cataract surgery and lens implantation	10
4.	Corneal transplantation	3



Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders
- Gelatt KN. 2014. *Essentials of Veterinary Ophthalmology*. 3rd ed. Wiley Blackwell. US.
- Gilger BC. 2017. *Equine Ophthalmology*, 3rd ed. Wiley Blackwell.
- Maggs DJ, Miller PE and Ofri R. 2017. *Slatter's Fundamentals of Veterinary Ophthalmology*. 6th ed. Saunders.
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.

VSR 613: Surgical Oncology (1+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
Unit I		
1.	Biology of neoplastic disease: etiology, cellular mechanism	1
2.	Principles of surgical oncology	1
Unit II		
3.	Diagnosis, classification and clinical staging of tumors and decision making for therapy, metastasis	2
Unit III		
4.	Surgical management: surgical excision of tumors, cytoreductive surgery	1
5.	Surgical management: surgery for metastatic disease, palliative surgery, evaluation and interpretation of surgical margins	1
Unit IV		
6.	Clinical signs, diagnosis and treatment options of tumors of skin, soft tissues	1
7.	Clinical signs, diagnosis and treatment options of tumors of skeletal system, head and neck	1
8.	Clinical signs, diagnosis and treatment options of tumors of gastro-intestinal tract, respiratory tract	1
9.	Clinical signs, diagnosis and treatment options of tumors of urinary tract, genital tract, mammary gland	1
10.	Clinical signs, diagnosis and treatment options of tumors of nervous system, endocrine system, haematopoietic system	1
11.	Clinical signs, diagnosis and treatment options of tumors of the eye and orbit and miscellaneous tumours	1
Unit V		
12.	Radiation therapy, chemotherapy	1
13.	Electrochemotherapy, cryotherapy and targeted therapy	1
14.	Side effects of radio and chemotherapy	1
15.	Nutritional management of cancer patients, basics of immunotherapy in cancer management	1
Practical		
1.	Fine needle aspiration biopsy	1
2.	Needle core biopsy	1
3.	Excisional biopsy	1
4.	Incisional biopsy	1
5.	Bone marrow biopsy	1
6.	Lymph node biopsy	1



S. No.	Topics	No. of Lectures/ Practicals
7.	Percutaneous lung biopsy	1
8.	Bone biopsy	1
9.	Ultrasound guided biopsy	1
10.	Laparoscope guided biopsy	1

Suggested Reading

- Kudnig ST and Sequin B. 2012. *Veterinary Surgical Oncology*, Wiley Blackwell.
- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders.
- Maggs DJ, Miller PE and Ofri R. 2017. *Slatter's Fundamentals of Veterinary Ophthalmology*. 6th ed. Saunders.
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.

Minor Courses for Ph.D. Degree programme

Courses of any one department/ discipline from the list given below:

- Veterinary Physiology
- Veterinary Biochemistry
- Veterinary Biotechnology
- Veterinary Anatomy
- Veterinary Medicine
- Veterinary Pathology
- Animal Reproduction, Gynaecology and Obstetrics
- Animal Biotechnology

Supporting Courses

It could be any subject considered relevant for student's research work. This will be decided by Advisor/ Guide concerned.

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Veterinary Clinical Subjects

– Veterinary Medicine

Preamble

(Veterinary Medicine)

Presently, the veterinary education at undergraduate level is regulated by Veterinary Council of India. Two separate departments of Veterinary Clinical Medicine, Ethics and Jurisprudence and Veterinary Epidemiology and Preventive Medicine were merged in 2008 following implementation of VCI norms as per Minimum Standards of Veterinary Education-2008 (MSVE-2008) and also being followed and strictly implemented as per revised VCI norms (MSVE-2016) issued by The Gazette of India Notification. Single department of Veterinary Medicine is functional in most of the colleges and universities of Veterinary Sciences including Indian Veterinary Research Institute (IVRI), Izatnagar, Bareilly. Therefore, the courses in clinical and preventive medicine have been redesigned under the subject of veterinary medicine. The national eligibility test (NET), being conducted by ICAR, New Delhi, in the subject of veterinary medicine includes syllabus for both clinical and infectious diseases. Course curriculum related to Epidemiology will be covered by the Department of Veterinary Public Health and Epidemiology as per the mandate of the BSMA Committee constituted by ICAR on the recommendation by National Core Group.

The Master's and Doctoral courses and the contents were critically examined for revisions in the light of advances transpired in the discipline of veterinary medicine during the last ten years. Precedence has been given to important species, viz., cattle, buffalo, sheep, goat, pig, canine, feline and equine in the course curriculum for M.V.Sc. programme. The courses have been reorganized with respect to species, viz., ruminant, canine and feline and equine, etc. and attempt has been made to cover all the systemic diseases in a comprehensive manner. Contents of the courses have been revised by including newer trends in diagnosis, treatment, management and prevention of various diseases. Different disease conditions have been listed precisely in ruminant and equine medicine courses so as to remove ambiguity in covering of the various topics.

Small animal practice has grown exponentially in last decade. Accordingly, courses in small animal have been recasted by giving emphasis on diseases of gastro-intestinal, respiratory, cardiovascular system. Endocrine disorders, coagulopathies, immune mediated diseases and neoplastic diseases have been given special emphasis. Problem oriented approach to common disease manifestations for better understanding and applications has been added in canine and feline courses for improving diagnostic skills of the students. In recent times, small animals are also frequently presented for behavior disorders. Therefore, topics on pet psychology, pet behavior, adaptation needs and behavioral medicine have been incorporated.

Two separate courses on clinical diagnostic techniques and emergency medicine have been designed to provide hands on training on diagnostic procedures and practical training. Topics have been included to train the students for special examination of different body systems. Emerging diseases have been added to the course curriculum. Two new courses, viz., Geriatrics and Paediatrics, Oncology and Ethno-Veterinary Medicine have been added. To provide practical approach to the diagnosis and investigation of infectious diseases, a special course on investigation of disease outbreaks has been included in the revised curriculum.

Ph.D. courses have been designed according to body systems. This approach will help students in better comprehension of the diseases as already being followed in all veterinary colleges of countries with very high standards of veterinary education and research (USA, Canada and Europe). The doctorates, following new restructured Ph.D. curricula should, in future, manifest as specialists in the field of their specialization.

Management of emergency cases and critically ill patients is an upcoming challenge for practicing veterinarians. Special training is required for monitoring and resuscitation of critically ill patients as well as diagnosis, management and emergency care procedures for common emergencies. Therefore, a special course on 'Veterinary Emergency and Critical Care Medicine, has been designed for Ph.D. programme. Similarly, a new course on 'Advances in Veterinary Diagnostics' has been added to enhance the diagnosis skills and hands on training on the use of ophthalmoscopy, ultrasonography, endoscopy, pulse-oximetry electrocardiography, echocardiography and their interpretations.

The revision of courses has been given due importance in consonance with the national initiatives and key Central Government policies to improve productivity and livestock health. The course contents have been revised comprehensively to cover syllabi, which will be immensely helpful in introducing and exploring new insights and improving clinical knowledge and skill competency of the students, keeping in view the global trends and developments in veterinary clinical diagnosis, education and research.



Course Title with Credit Load M.V.Sc. in Veterinary Medicine

Course Code	Course Title	Credit Hours
VMD 501*	Ruminant Medicine-internal	3+0
VMD 502*	Ruminant Medicine-infectious	3+0
VMD 503	Equine Medicine	2+0
VMD 504*	Canine and Feline Medicine-I	2+0
VMD 505*	Canine and Feline Medicine-II	2+0
VMD 506	Metabolic and Endocrine Diseases, Nutritional Deficiencies and Diseases of Mammary Gland	2+0
VMD 507	Paediatrics and Geriatrics	2+0
VMD 508	Avian and Swine Medicine	2+0
VMD 509	Zoo, Wild and Laboratory Animal Medicine	1+0
VMD 510	Toxicology and Forensic Medicine	1+0
VMD 511*	Clinical Diagnostic Techniques	0+2
VMD 512	Emergency Medicine	0+2
VMD 513*	Diagnosis of Veterinary Infectious Diseases	0+1
VMD 514	Oncology and Ethno-veterinary Medicine	1+0
VMD 515	Animal Disease Investigation and Biosecurity	1+1
VMD 516*	Clinical Practice-I	0+3
VMD 517*	Clinical Practice-II	0+3
VMD 591	Master's Seminar	1+0
VMD 599	Master's Research	0+30

Course Contents

M.V.Sc. in Veterinary Medicine

- I. Course Title** : Ruminant Medicine - Internal
II. Course Code : VMD 501
III. Credit Hours : 3+0
IV. Aim of the course

Internal diseases of Digestive, Respiratory, Urinary, Cardiovascular, Blood and blood forming organs, Nervous, Musculoskeletal system, Skin, eye and ear of bovine, Sheep, and goat.

V. Theory

Unit I

Examination of alimentary tract and abdomen; Diseases of the buccal cavity and related organs including pharynx, Oesophagus. Reticulo-ruminal fermentative disorders (simple indigestion, impaction, ruminal lactic acidosis), Primary and secondary bloat, Diaphragmatic hernia, Traumatic reticulo-peritonitis and Omasal impaction.

Unit II

Diseases of abomasum (impaction, displacements, ulcers, bloat), Acute and chronic diarrhoea, Intestinal obstructive disorders (intussusception, volvulus), Peritonitis, caecal dilatation and hemorrhagic bowel syndrome.

Unit III

Manifestations of liver and biliary diseases, Focal and diffuse diseases of liver. Disease of nasal cavity, sinuses, disease of larynx and trachea, pneumonias, pleuritis, manifestations Principles of treatment in uro-genital system; Rupture, Paralysis and infections of urinary bladder, Urolithiasis, Nephritis and renal failure, Nephrosis, renal ischemia, Hemolytic uremic like syndrome, Uremia and neoplasms of urinary tract.

Unit IV

Examination of cardiac system and Special examination of heart (ECG, echocardiography, Markers for diagnosis of cardiac disorders. Principal manifestations of cardiovascular diseases, congenital cardiac diseases, myocarditis), cardiomyopathy, endocarditis, pericarditis, phlebitis, thrombosis, anemia, lymphangitis, lymphadenopathies and thrombocytopenia.

Unit V

Principles of nervous dysfunction, Clinical manifestation and special examination, Localization of lesion in brain and spinal cord, Cortical diseases, Brain abscess, Meningitis, Diseases of brainstem, Cerebellar diseases, Spinal cord compression and peripheral nerve paralysis. Principal manifestations and special examination of musculoskeletal system, Myositis, Myopathies, Foot lameness, Arthritis, Osteodystrophies, Degenerative joint disease and nutritional deficiency diseases affecting musculoskeletal system; conjunctivitis, Keratitis, uveitis, Horner syndrome,



neoplasms of eye, otitis media, otitis externa; Skin diseases: folliculitis, furunculosis and skin neoplasms.

- I. Course Title : Ruminant Medicine-infectious**
II. Course Code : VMD 502
III. Credit Hours : 3+0

IV. Aim of the course

Bacterial, fungal, chlamydial, viral, parasitic, mycoplasmal, prions and rickettsial diseases of bovine, sheep, and goat.

V. Theory

Unit I

Clostridial diseases-black quarter, Botulism, Bacillary hemoglobinuria, Braxy, Enterotoxemia, Malignant edema, Pulpy kidney disease, Tetanus, Collibacillosis, Salmonellosis, Compylobacteriosis, Listeriosis, Actinobacillosis, Actinomycosis, Anthrax, Tuberculosis, Johne's disease, Leptospirosis, Pasteurellosis, Ulcerative lymphangitis, Infectious bovine keratoconjunctivitis, Chlamydiosis infections, Dermatophytosis, Cutaneous streptothricosis, Candidiasis and Rhinosporidiosis.

Unit II

Foot and mouth disease, Vesicular stomatitis, Vesicular exanthema, Rinderpest, PPR, Bovine viral diarrhea, Mucosal disease, Ephemeral fever, Bovine herpes viral diseases, Leucosis, Viral pneumonia, Pox diseases, Infectious gastroenteritis of viral etiology. Malignant catarrh fever, Rabies, Bluetongue, Louping ill, Papillomatosis, Contagious ecthyma (orf), Caprine arthritis and Encephalopathy(CAE), Contagious bovine pleuropneumonia and Contagious caprine pleuropneumonia.

Unit III

Bovine spongiform Encephalopathy, Scrapie, Bovine Anaplasmosis, Theileriasis, Babesiosis, Fascioliosis, Amphistomiosis, Gastrointestinal nematodiosis, Schistosomiosis, Lung worm infection, Echinococcosis, Coenurosis and Tapeworm infections, Coccidiosis, Thelaziasis, parasitic dermatitis (scabies, psoroptes).

- I. Course Title : Equine Medicine**
II. Course Code : VMD 503
III. Credit Hours : 2+0

IV. Aim of the course

Internal and infectious diseases of Equines

V. Theory

Unit I

Diseases of buccal cavity (dental diseases, stomatitis), Oesophagus, Gastric dilatation, gastro-duodenal ulceration, Acute and chronic diarrhea, Colic, Acute and chronic hepatitis.

Unit II

Diseases of cardio-vascular system and blood forming organs; Manifestations and principles of treatment in respiratory disorders, Epistaxis, Ethmoidal hematoma,

pharyngitis, sinusitis, Guttural pouch diseases, Tracheal collapse, Adult pneumonia, foal pneumonia, Recurrent air way obstruction, Inflammatory airway disease, Pleura-pneumonia, Pulmonary congestion and edema; Manifestations and principles of treatment of urinary system diseases, Rupture of urinary bladder, Paralysis, urolithiasis, Urinary tract infections, Acute and chronic renal failure and Neoplasms of urinary tract.

Unit III

Principal manifestations of musculoskeletal diseases, Laminitis, Inflammatory Myopathy, Exertional Myopathies, Myotonia, Hyperkalemic periodic paralysis and Nutritional deficiency diseases affecting musculoskeletal system.

Nervous diseases, Viral encephalitis, Intracarotid drug injection, Trauma to brain and cranial nerves, Brain abscess, Peripheral vestibular disease, Temporo-hyoid osteoarthropathy, Ataxia (sorghum toxicity, spinal abscesses), Peripheral facial nerve paralysis, Peripheral nerve disorders; Skin diseases, bacterial, fungal, parasitic and allergic dermatitis (culicoides hypersensitivity), Cutaneous eczema, Cutaneous acne, Cutaneous pustular dermatitis, Candidiasis, Histoplasmosis, Coccidioidomycosis and dermatophytosis.

Unit IV

Bacterial, fungal and viral keratitis, Equine recurrent uveitis, Uveitis, Ocular neoplasia. Trypanosomiasis/ dourine, Babesiosis, Parasitic pneumonia, Strangles, equine influenza, Equine herpes virus infection, Potomac horse fever, Equine infectious anaemia and setariasis.

I. Course Title : Canine and Feline Medicine-I

II. Course Code : VMD 504

III. Credit Hours : 2+0

IV. Aim of the course

Internal (digestive, liver, pancreas, cardiovascular, blood and blood forming organs) and infectious (bacterial, parasitic and protozoal) diseases of dogs and cats.

V. Theory

Unit I

Diagnostic approach to common manifestations of disease: Vomiting, acute diarrhea, Chronic diarrhea, Syncope, Anemia, Jaundice, Fever, Weight loss, Edema, Dyspnoea, coughing and nasal discharge.

Unit II

Etiology, pathogenesis, clinical signs, clinical pathology, diagnosis, Differential diagnosis and treatment of diseases of the oral cavity, oesophagus, acute gastritis, chronic gastritis, Gastric dilatation, Volvulus, Tumors of the stomach, Intussusception, Acute enteritis, Chronic enteritis, Inflammatory bowel disease, Colitis, Gastric and Intestinal foreign bodies, Diseases of rectum and anal sac, Peritonitis, Acute hepatitis, Chronic hepatitis, Diseases of gall bladder, Cholangitis, Vascular liver diseases, Extra hepatic biliary system, Acute pancreatitis and Exocrine pancreatic insufficiency.

Unit III

Anemia, Lymphangitis, Lymphadenopathies, Coagulopathies, Immune mediated



diseases, Neoplastic diseases of hemo-lymphatic system; Examination of cardiac system and special examination of heart (ECG, Echocardiography, Holter and markers for diagnosis of cardiac disorders), Congenital heart diseases, Dilated cardiomyopathy, Endocardiosis, Cardiac arrhythmias, Pericardial disorders. Pet psychology, Pet behaviour, Adaptation needs and Behavioural medicine

Unit IV

Leptospirosis, Tetanus, Brucellosis, Lyme disease, Rocky mountain spotted fever, Kennel cough, Trypanosomiasis, Ehrlichiosis, Ancylostomiasis, Dirofilariasis, Giardiasis, Coccidiosis/ Isosporosis, Toxoplasmosis, Babesiosis, Neosporosis, Hepatozoonosis and Tape worm infections.

I. Course Title : Canine and Feline Medicine-II

II. Course Code : VMD 505

III. Credit Hours : 2+0

IV. Aim of the course

Internal (respiratory, nervous, urogenital, musculoskeletal, eye, ear and skin) and infectious (viral and fungal) diseases of dogs and cats.

V. Theory

Unit I

Principles of treatment in respiratory disorders, Diseases of nasal cavity, Tracheobronchitis, Chronic bronchitis, Pulmonary congestion and edema, Acute pneumonia, Chronic pneumonia, Feline asthma, Pleural effusions and Neoplasms of respiratory tract.

Diagnostic approach to common manifestations of disease: Seizures, Coma, Monoparesis, Pelvic limb paralysis, Pruritis, alopecia, Obesity, Urinary incontinence, Hematuria; Focal, diffuse and multifocal diseases of brain. Diseases of spinal cord and Peripheral nervous system, Vestibular diseases and toxins affecting nervous system.

Unit II

Diseases of muscles- congenital and inherited diseases of muscles, bone and joints, Myasthenia, Myopathy; Nutritional deficiency diseases- Rickets, Primary and Secondary Hyperparathyroidism, Osteodystrophy and Osteomyelitis.

Diseases of eyelids, Epiphora, Keratitis, Conjunctivitis, Uveitis, Glaucoma, Acute blindness and Neoplasms of eye.

Unit III

Skin diseases, Common pyodermas, Atopy, Dermatophytosis and Dermatomycesis, Demodicosis, Scabies, Myiasis, and Nutritional disorders related to skin and its therapeutic management, Flea allergy and its treatment and control measures, Alopecia. Cutaneous manifestations of hormonal imbalances and systemic disorders, Auto immune diseases of skin, Diseases of the pinna, Otitis and principles of treatment in otic infections.

Manifestations and principles of treatment of urinary system diseases, Urinary tract infections, Urolithiasis, Nephritis, Nephrosis, Pyelonephritis, Renal failure and neoplasms of urinary tract.

**Unit IV**

Viral diseases: Canine parvovirus, Canine distemper, Corona viral gastroenteritis, Infectious hepatitis, Infectious tracheobronchitis, Canine herpes virus, Rabies, Feline Panleukopenia, Infectious peritonitis (FIP), Feline leukemia virus infection, Feline immunodeficiency virus, Vaccination schedule for canine and feline diseases, Dermatophytosis, Blastomycosis, Histoplasmosis, Sporotrichosis, and coccidioidomycosis.

I. Course Title : Metabolic and Endocrine Diseases, Nutritional Deficiencies and Diseases of Mammary Gland

II. Course Code : VMD 506

III. Credit Hours : 2+0

IV. Aim of the course

Study of diagnosis, management and control of metabolic, endocrine, nutritional and mammary gland diseases.

V. Theory**Unit I**

Metabolic profile test parturient paresis, Downer cow syndrome, Acute hypokalemia in cattle, Transit recumbency, Lactation tetany of mares, Hypomagnesemia, Tetany of calves, Ketosis, sub-clinical ketosis, Pregnancy toxemia, Fatty liver syndrome, Equine hyperlipidemia, Steatitis, Neonatal hypoglycemia, low milk fat syndrome, Peri-parturient hemoglobinuria and Eclampsia in bitches.

Unit II

Deficiency of energy and protein, Deficiency of fat and water soluble vitamins and deficiency of macro- micro minerals.

Unit III

Mastitis, Diseases of teats and udder in ruminants, “mastitis-metritis-agalactia” in sow and congenital abnormalities of udder and teats.

Unit IV

Diabetes mellitus, Diabetes insipidus, Hypothyroidism, Obesity, Hypo- and hyperadrenocorticism.

I. Course Title : Paediatrics and Geriatrics

II. Course Code : VMD 507

III. Credit Hours : 2+0

IV. Aim of the course

Study of non-infectious and infectious diseases of neonates and geriatric animals.

V. Theory**Unit I**

Perinatal management, Perinatal adaptation, Neonatal health, Asphyxia and Resuscitation; Physical examination of the neonate, perinatal and neonatal mortality, Colostrum and its substitutes, Manifestations of disease.



Unit II

Immunization of neonates, Fluid replacement therapy, Nutritional support, Blood and Serum transfusion, Antimicrobial therapy and neonatal diarrhoea.

Unit III

Non-infectious and infectious diseases of viral, bacterial, mycoplasma and parasitic origin of neonates, Young and aged farm and companion animals; Diseases acquired from dam, Congenital disorders, Metabolic disorders, Nutritional deficiencies, Miscellaneous conditions (hypothermia, hyperthermia, starvation, arthritis), Management of shock and other emergencies, Detection and correction of failure of passive transfer of immunity.

Unit IV

Geriatric diseases: Senility, Dental diseases, Glaucoma, Cataract, Keratitis sicca, Urinary incontinence, Renal insufficiency, Cardiac diseases, Pulmonary diseases, Neoplasia, Bone and joint diseases, Neurologic disorders, Otologic disorders, Endocrine diseases (diabetes mellitus, cushing's disease, hypothyroidism), Liver diseases, Psychological and behaviour disorders.

- I. Course Title : Avian and Swine Medicine**
II. Course Code : VMD 508
III. Credit Hours : 2+0
IV. Aim of the course

Recent concepts in non-infectious and infectious diseases of avian species and pigs.

V. Theory

Unit I

Specific needs of avian species; Diseases due to deficiency of vitamins (vitamins A, B complex, C, D, E, K); minerals (calcium, phosphorus, manganese, zinc, etc.) and sodium chloride.

Unit II

Miscellaneous diseases/ conditions/ vices (cage layer fatigue, beak necrosis, blue comb disease, round heart disease, kerato- conjunctivitis, ascites, urolithiasis, fatty liver, kidney hemorrhagic syndrome, heat stroke, cannibalism, vent picking), egg bound peritonitis, diseases of feather, skin, beak and foot, bumble foot, gout, infectious diseases of poultry (marek's disease, lymphoid leukosis, new castle disease, infectious coryza, fowl typhoid, CRD, pullorum disease, coccidiosis, chlamydia, avian pox, infectious bursal disease, infectious bronchitis, infectious laryngo-tracheitis, etc.)

Unit III

Nutritional deficiency diseases of pigs, swine influenza, hog cholera, african swine fever, swine pox, vesicular exanthema, vesicular stomatitis, rabies. porcine enteroviruses, pseudorabies, listeriosis, leptospirosis, brucellosis, anthrax, salmonellosis, swine erysipelas, pasteurellosis, tuberculosis, mange, etc.

Unit IV

Handling, physical examination, sampling, diagnostic techniques and medication.



- I. Course Title : Zoo, Wild and Laboratory Animal Medicine**
II. Course Code : VMD 509
III. Credit Hours : 1+0

IV. Aim of the course

Study of diagnosis, management and control of Zoo, wild and laboratory animals.

V. Theory

Unit I

Study of diseases and health management of zoo, Wild and laboratory animals; Etiology, Clinical signs, Diagnosis and management of various diseases of zoo, wild and laboratory animals. Restraint, Feeding, Diseases and health management of exotic animals kept as pets.

Unit II

Specific diseases of laboratory animals caused by bacteria, viruses, fungi and parasites.

Specific diseases of zoo (captive) animals caused by bacteria, viruses, fungi and parasites.

- I. Course Title : Toxicology and Forensic Medicine**
II. Course Code : VMD 510
III. Credit Hours : 1+0

IV. Aim of the course

Study of diseases caused by physical, chemical, other toxicants in domestic animals and animal welfare issues.

V. Theory

Unit I

Diseases caused by physical agents and poisoning of organic and inorganic compounds. Diseases caused by farm chemicals and phytotoxins. Diseases caused by mycotoxins and zootoxins.

Unit II

Collection, Dispatch and Examination of vetro-legal samples. Examination of wounds, blood, offenses and frauds in animal sales. Animal cruelty and welfare related issues. Study of common laws related to vetro-legal aspects.

- I. Course Title : Clinical Diagnostic Techniques**
II. Course Code : VMD 511
III. Credit Hours : 0+2

IV. Aim of the course

To impart training on diagnostic procedures for various diseases of farm and companion animals and their interpretations.

V. Theory

Unit I

Peritoneal fluid analysis, Gastrointestinal endoscopy, Colonoscopy, Proctoscopy,



Ultrasonography, Liver biopsy, Interventional imaging, Rhinoscopy, Bronchoscopy, Transtracheal lavage, Endotracheal lavage, Broncho-alveolar lavage, Thoracocentesis, Pericardiocentesis, Interpretation of hemogram, Renal and Hepatic function tests. Neurological examination.

Unit II

Electrocardiography, Echocardiography, Pulse oximetry, Blood and blood component therapy, Bone marrow biopsy, Arterial blood gas analysis, Cerebrospinal fluid analysis, Cystocentesis, Urinary catheterization, Renal function tests, Specific gravity of urine by refractometer, Skin-biopsy, Cytology- scrapings, Otoscopy, Direct and indirect ophthalmoscopy, Shirmer tear test, Tonometry. Diagnosis tests in mastitis. Assay for T_3 , T_4 , lipase, Amylase, Radio immunoassay and indications of CT, MRI, nuclear medicine.

I. Course Title : Emergency Medicine

II. Course Code : VMD 512

III. Credit Hours : 0+2

IV. Aim of the course

Diagnosis and management of common emergencies in animals.

V. Practical

- Diagnosis and therapeutic management of various emergencies of cardiovascular, respiratory, gastrointestinal, urinary and nervous systems.
- Diagnosis and therapeutic management of various emergencies of toxicities, sting bites, snake bite and burns in farm and companion animals.
- Monitoring critical ill patient, application of emergency care procedures for resuscitation of critically ill patients.
- Placement of central venous catheters, introsseous fluid administration, endotracheal intubation, gastric lavage, decompression of guttural pouch, stomach, cecum, ventilation, nebulization, fluid therapy, CPR, oxygen therapy, enteral nutrition, nasogastric intubation, Blood transfusion

I. Course Title : Diagnosis of Veterinary Infectious Diseases

II. Course Code : VMD 513

III. Credit Hours : 0+1

IV. Aim of the course

Concepts and diagnostic tests in veterinary infectious diseases.

V. Practical

- Sampling techniques for collection of samples during research;
- Sensitivity and specificity of diagnostic tests including false positive and false negative tests. Mastitis diagnostic tests;
- Culture and staining techniques;
- Diagnosis of fungal diseases, protozoan and rickettsial diseases, fecal examination for endoparasites, skin scrapping examination for mites, fleas and lice;
- ELISA, PCR, culture sensitivity tests on milk and other body fluids, molecular techniques and types of PCR, Molecular epidemiology tools including RFLP, etc.



- I. Course Title** : **Oncology and Ethno-veterinary Medicine**
II. Course Code : **VMD 514**
III. Credit Hours : **1+0**

IV. Aim of the course

Study of diagnosis and management of tumors, natural remedies and alternative systems of medicine.

V. Theory

Unit I

Tumors related to different systems - biology and pathogenesis of cancer, diagnostic procedures, oncology medicine, chemotherapy, radiation therapy, immuno-therapy and miscellaneous therapeutic measures, including advancements of therapeutic approaches, supportive care for the cancer patient.

Unit II

Natural remedies and products for use towards therapy in animal ailments.

Unit III

Acupuncture, physiotherapy, laser therapy, nutraceuticals and dietary supplements.

- I. Course Title** : **Animal Disease Investigation and Biosecurity**
II. Course Code : **VMD 515**
III. Credit Hours : **1+1**

IV. Aim of the course

Concepts in investigation of infectious diseases and their prevention.

V. Theory

Unit I

Investigation and diagnosis on dead and live diseased animal (s) and poultry. Point source epidemics and propagating epidemics, Collection, Preservation and transport of material in the face of disease outbreak, and processing of material in the laboratory for diagnosis; Recording and analysis of epidemiological data. Establishing working hypothesis and formulating and advising and/ or implementing treatment, control and prevention measures.

Unit II

Biosecurity definition, Related concepts, Principles and basic components of biosecurity, Physical and operational elements of biosecurity. Routes of entry and transmission dynamics of pathogens. Shedding pattern of pathogens by infected animals and their survival in the environment. Protection of susceptible animals, interruption of pathways of transmission, role of disinfection to break cycle of infection. Sterilization, fumigation and disinfection methods, disinfectants and its classification, Microbial resistance to disinfectants, Risk assessment and its management. Principles of biosecurity in laboratory animal house, Biosecurity measures for collection of specimen from wild animals. Biosecurity in research laboratories. Vaccines-success stories of disease eradication through vaccination.

VI. Practical

- Isolation and identification of field isolates and vaccine strains by conventional,



immunoassays and molecular techniques.

- To perform an outbreak investigation of infectious diseases and toxicological conditions in livestock and poultry in the field/ organised livestock farms.
- Practical use of disinfectants in destruction of microbes in laboratory and under field conditions. Determination of efficacy/ phenol coefficient of commonly used disinfectants.
- Approaches in animal disease control and eradication. Preliminary steps to control animal disease outbreaks.
- Types of vaccines, vaccination schedule in livestock, pets and poultry

I. Course Title : Clinical Practice-I

II. Course Code : VMD 516

III. Credit Hours : 0+3

IV. Aim of the course

Application of the theoretical concepts in practice.

V. Practical

- Diagnostic and therapeutic protocol application, specimen collection, examination and management of sick farm and companion animals, use of diagnostic techniques for diagnosis of medicinal cases, acquaintance with different equipment, client management, public relations, code of conduct, hospital management, database management and maintenance of case records, disaster management
- **Note:** This course shall be conducted in Veterinary Clinical Complex (VCC), where students shall participate in diagnosis and treatment of diseased animals.

I. Course Title : Clinical Practice-II

II. Course Code : VMD 517

III. Credit Hours : 0+3

IV. Aim of the course

Application of the theoretical concepts in practice.

V. Practical

- Diagnostic and therapeutic protocol application, specimen collection, examination and management of sick farm and companion animals, use of diagnostic techniques for diagnosis of medicinal cases, acquaintance with different equipment, client management, public relations, code of conduct, hospital management, database management and maintenance of case records, disaster management.
- **Note:** This course shall be conducted in Veterinary Clinical Complex (VCC), where students shall participate in diagnosis and treatment of diseased animals.

Course Outline: Lecture wise

VMD 501: Ruminant Medicine-internal 3+0

S. No.	Topics	No. of Lectures
1.	Examination of alimentary tract and abdomen	1
2.	Diseases of the buccal cavity and related organs including pharynx, oesophagus	2
3.	Reticulo-ruminal fermentative disorders (simple indigestion, impaction, ruminal lactic acidosis, alkalosis)	2
4.	Primary and secondary bloat, diaphragmatic hernia	1
5.	Traumatic reticulo-peritonitis, vagal indigestion syndrome, generalised peritonitis vagal indigestion syndrome, generalised peritonitis and omasal impaction	1
6.	Diseases of abomasum (impaction, displacements)	2
7.	(Acute and chronic diarrhoea), hemorrhagic diarrhea	2
8.	Intestinal obstructive disorders (intussusception, volvulus), strangulation	2
9.	Caecal dilatation and volvulus	1
10.	Manifestations of liver and biliary diseases	1
11.	Focal and diffuse diseases of liver, fatty liver syndrome	1
12.	Principle of treatment of respiratory diseases, respiratory insufficiency, anoxias, diseases of nasal cavity, sinuses, diseases of larynx and trachea	2
13.	Epistaxis, hemoptysis, congestion and edema of lungs, hydro and hemothorax	1
14.	Pneumonias and pleuritis	2
15.	Manifestations and principles of treatment in uro-genital system; rupture, paralysis	1
16.	Infections of urinary bladder	1
17.	Urolithiasis, nephritis and renal failure, nephrosis	2
18.	Hemolytic uremic like syndrome, uremia and neoplasms of urinary tract	1
19.	Examination of cardiac system and special examination of heart (ECG, echocardiography disorders)	1
20.	Principal manifestations of cardiovascular diseases	1
21.	Congenital cardiac diseases, Myocarditis	1
22.	Cardiomyopathy, endocarditis, pericarditis	1
23.	Phlebitis, thrombosis, anemia, lymphangitis, lymphadenopathies and thrombocytopenia, lymphosarcoma	2
24.	Principles of nervous dysfunctions, clinical manifestation SOL special examination	1
25.	Localization of lesion in brain and spinal cord	2
26.	Cortical diseases, brain abscess, SOL, meningitis, diseases of brainstem, cerebellar diseases	2
27.	Spinal cord compression, peripheral nerve paralysis, Horner Syndrome, facial nerve paralysis	2
28.	Principle manifestations and special examination of musculoskeletal system	1



S. No.	Topics	No. of Lectures
29.	Foot lameness, arthritis, osteodystrophies, degenerative joint disease and nutritional deficiency diseases affecting musculoskeletal system	3
30.	Diseases of eyes, neoplasms of eyes	1
31.	Conjunctivitis, keratitis, uveitis	1
32.	Diseases of pinna, otitis media, otitis externa	2
33.	Skin diseases: folliculitis, furunculosis, and skin neoplasms, skin tumors	1

Suggested Books

- Bradford Smith, David Van Metre, Nicola Pusterla. 2019. *Large Animal Internal Medicine*. 6th Edition, Mosby.
- Neil V Anderson, 1992. *Veterinary Gastroenterology*. 2nd Revised edition, Lea and Febiger, USA.
- Simon F Peek, Thomas J Divers. 2018. *Rebhun's Diseases of Dairy Cattle*. 3rd Edition, Elseviers.
- Research and Review Papers in Current Journals.

VMD 502: Ruminant Medicine-infectious 3+0

S. No.	Topics	No. of Lectures
1.	Principles of prevention and control of infectious diseases	1
2.	Anthrax	1
3.	Brucellosis	1
4.	Mastitis	1
5.	Foot rot/ Joint ill	1
6.	Black quarter/ Braxy	1
7.	Tetanus	1
8.	Enterotoxemia	1
9.	Bacillary haemoglobinuria	1
10.	Botulism	1
11.	Colibacillosis	1
12.	Pasteurellosis/ Hemorrhagic septicemia	1
13.	Tuberculosis	1
14.	Paratuberculosis	1
15.	Listeriosis	1
16.	Leptospirosis	1
17.	Actinomycosis/ Actinobacillosis	1
18.	Ringworm	1
19.	Systemic mycotic infections (Aspergillosis, candidiasis, histoplasmosis, sporotrichosis, coccidioidomycosis, mycotoxiosis)	1
20.	Dermatophilosis	1
21.	Campylobacteriosis	1
22.	Salmonellosis	1
23.	Contagious bovine pleuropneumonia	1
24.	Contagious agalactia	1
25.	Anaplasmosis	1
26.	Chlamydiosis, Q fever, ehrlichiosis	1
27.	Blue tongue	1
28.	Sheep and goat pox	1
29.	Peste des petits ruminants	1
30.	Scrapie, louping ill	1



S. No.	Topics	No. of Lectures
31.	Maedi, visna, jagaskiae disease	1
32.	Rift valley fever	1
33.	Rinderpest	1
34.	Bovine viral diarrhoea	1
35.	Malignant catarrhal fever	1
36.	Infectious bovine rhinotracheitis	1
37.	Enzootic bovine leucosis	1
38.	Ephemeral fever	1
39.	Foot and mouth disease	1
40.	Rabies	1
41.	Principles of control of parasitic diseases	1
42.	Amphistomosis	1
43.	Fascioliosis	1
44.	Gastrointestinal nematodiasis, schistosomiasis	1
45.	Echinococcosis, tapeworm (cysticercosis)	1
46.	Verminous bronchitis, coenurosis,	1
47.	Trypanosomiasis, babesiosis	1
48.	Theileriosis, hepatozoonosis	1

Suggested Books

- *Dairy Herd Health*. 2012. MJ Green, Andrew J. Bradley. CABI Publishing.
- *Merck's Veterinary Manual* K. 2016. Susan E Aiello, Michael A Moses. (11th Edition). Merck Sharp and Dohme
- *Veterinary Medicine* 2016. Peter Constable, Kenneth W Hinchcliff, Stanley Done, Walter Gruenberg. 11th Edition. Saunders Ltd.
- Research and Review Papers in Current Journals.

VMD 503: Equine Medicine (2+0)

S. No.	Topics	No. of Lectures
1.	Manifestations and principles of treatment of gastrointestinal diseases	1
2.	Diseases of the buccal cavity and oesophagus	2
3.	Gastric dilation and rupture, gastro-duodenal ulceration	1
4.	Diseases of the intestine (colic, duodenitis-proximal jejunitis, acute and chronic diarrhoea)	3
5.	Diseases of liver	1
6.	Diseases of the pericardium, myocardium and endocardium	2
7.	Cardiac arrhythmias, thrombosis	1
8.	Purpura haemorrhagica, immune-mediated thrombocytopenia of the neonates, neonatal isoerythrolysis	1
9.	Sinusitis, ethmoidal hematoma, guttural pouch tympany/ emphysema/ mycosis, pharyngitis, recurrent laryngeal neuropathy	2
10.	Pneumonia and pleuropneumonia,	2
11.	Inflammatory airway disease	1
12.	Recurrent airway obstruction	1
13.	Acute renal failure and chronic renal failure	1
14.	Urinary tract infections	1
15.	Exertional myopathy/ Tying up syndrome, myositis	1
16.	Hyperkalemic periodic paralysis, narcolepsy, myotonia	1
17.	Osteodystrophies	1



S. No.	Topics	No. of Lectures
18.	Encephalitis, meningo-encephalitis	2
19.	Facial nerve paralysis, radial nerve paralysis, sciatic nerve paralysis, femoral nerve paralysis, polyneuritis equi (cauda equine neuritis)	1
20.	Bacterial dermatitis (Dermatophilosis, furunculosis, cellulitis, ulcerative lymphangitis, fistulous withers, bacterial psuedomycosis (botryomycosis)	1
21.	Viral skin diseases	1
22.	Allergic dermatitis: Culicoides hypersensitivity, eosinophilic granuloma, anhidrosis, equine sarcoidosis	2
23.	Fungal skin diseases	1
24.	Parasitic skin diseases- habronemiasis, onchocerciasis	1

Suggested Books

- *Equine Internal Medicine*. 2017. Stephen Reed, Warwick Bayly, Debra Sellon, 4th Edition, Elsevier, Saunders.
- *Large Animal Internal Medicine*. 2019. Bradford Smith, David Van Metre, Nicola Pusterla, 6th Edition, Mosby
- Research and Review Papers in Current Journals.

VMD 504: Canine and Feline Medicine-I (2+0)

S. No.	Topics	No. of Lectures
1.	Diagnostic approach to manifestations of gastrointestinal disorders	2
2.	Disorders of oral cavity, pharynx and oesophagus	1
3.	Common disorders of stomach	1
4.	Disorders of small intestine	1
5.	Disorders of large intestine, rectum and anus	1
6.	Diagnostic approach to manifestations of hepato-biliary diseases	2
7.	Hepato-biliary diseases of dogs and cats	1
8.	Exocrine pancreatic disorders of dogs and cats	1
9.	Diagnostic approach to manifestations of hemo-lymphatic disorders	2
10.	Disorders of hematopoietic system	1
11.	Disorders of lymphatic system	1
12.	Diagnostic approach to manifestations of cardiac diseases	1
13.	Congenital heart diseases	1
14.	Acquired valvular diseases, myocardial and pericardial diseases	1
15.	Behaviour disorders of canine and feline	1
16.	Polysystemic protozoal infection of dogs and cats (Hepatozoonosis, babesiosis, trypanosomiasis, neosporosis, toxoplasmosis)	2
17.	Polysystemic rickettsial diseases of dogs and cats (Ehrlichiosis, lyme disease and rocky mountain spotted fever)	2
18.	Important bacterial diseases of canine and feline (Leptospirosis, tetanus, brucellosis and kennel cough)	2
19.	Endoparasitic infestation of dogs and cats	1
20.	Viral diseases of dogs (Canine parvo viral gastroenteritis, canine distemper, corona virus infection, Infectious hepatitis, Infectious tracheobronchitis, canine herpes virus and rabies)	3
21.	Viral diseases of cats (Feline panleukopenia, feline infectious peritonitis, feline leukemia virus, feline immunodeficiency virus)	2
22.	Fungal diseases of dogs and cats	1
23.	Vaccination schedule of dogs and cats	1

**Suggested Books**

- *Small Animal Internal Medicine* 2013. Nelson and Couto, 5th edition, Elsevier Mosby, St. Louis, Missouri
- *Text book of Veterinary Internal Medicine* 2001. Part I and II, Ettinger and Feldman, 7th Edition, *Publisher:* Saunders
- *Small Animal Medical Diagnosis* 2009. MD Lorenz, TM Neer and PL Demars, 3rd Edition, Wiley Blackwell, Iowa, USA.
- Research and Review Papers in Current Journals.

VMD 505: Canine and Feline Medicine-II (2+0)

S. No.	Topics	No. of Lectures
1.	Clinical manifestations of upper and lower respiratory tract disorders	1
2.	Canine infectious tracheobronchitis, chronic bronchitis in dogs. feline bronchitis.	1
3.	Pneumonia (viral, bacterial, fungal), pulmonary neoplasia, pulmonary edema	1
4.	Diagnostic approach to pleural effusions	1
5.	Diagnostic approach to diseases of nasal cavity	1
6.	Principles of therapeutic management of respiratory tract disorders	1
7.	Clinical manifestations of urinary tract disorders	1
8.	Acute and chronic renal failure	1
9.	Canine and feline urinary tract infections	1
10.	Disorders of micturition	1
11.	Neoplasms of urinary tract	1
12.	Neurological manifestations of systemic diseases	1
13.	Diagnostic approach to seizures, ataxia, paresis and paralysis	1
14.	Inflammatory brain disorders (bacterial, viral, protozoal, mycotic, parasitic)	2
15.	Diseases of spinal cord (osteomyelitis, intervertebral disc disease)	1
16.	Disorder of peripheral nerves (developmental and congenital disorders, metabolic and toxic disorders, inflammatory and immune mediated neuropathies)	2
17.	Joint diseases of dogs and cats (Non inflammatory and inflammatory)	1
18.	Disorders of muscles (inflammatory myopathies, bacterial, parasitic, immunemediated, degenerative and inherited myopathies)	1
19.	Nutritional secondary hyperparathyroidism, rickets	1
20.	Diseases of ears (otitis externa, interna, media), neoplasms, principles of treatment of otitic infections	1
21.	Skin (endocrinopathies, bacterial, parasitic, fungal skin disorders, nutritional disorders related to skin)	2
22.	Alopecia, atopy, flea allergy dermatitis	1
23.	Diagnostic cytology of skin lesions, treatment and control measures.	1
24.	Eyes (diseases of eye lids, keratitis, conjunctivitis, uveitis, glaucoma, acute blindness, neoplasms of eye.	1
25.	Viral diseases of dogs and cats	2
26.	Vaccination for canine and feline diseases	1
27.	Fungal diseases of dogs and cats	2

Suggested books

- *Small Animal Internal Medicine* 2013. by Nelson RW and Couto, CG 5th edition, Elsevier Mosby, St. Louis Missouri



- *Text book of Veterinary Internal Medicine* 2010. by Ettinger and Feldman, 7th Edition, Publisher: Saunders
- Research and Review Papers in Current Journals.

VMD 506: Metabolic and Endocrine Diseases, Nutritional Deficiencies and Diseases of Mammary Gland (2+0)

S. No.	Topics	No. of lectures
1.	General aspects of production diseases and metabolic profile test	1
2.	Parturient paresis in dairy animals - etiology, pathogenesis, diagnosis, prevention and therapeutic management	1
3.	Downers cow syndrome and lactation tetany of mares	1
4.	Ketosis, sub clinical ketosis and fatty liver syndrome	1
5.	Nutritional haemoglobinuria in dairy animals	1
6.	Hypomagnesemic tetany in cattle	1
7.	Pregnancy toxemia in sheep	1
8.	Eclampsia in bitches-etiology, pathogenesis, diagnosis, prevention and therapeutic management	1
9.	Acute hypokalemia and transit recumbency of ruminants	1
10.	Equine hyperlipemia, steatitis and neonatal hypoglycaemia	1
11.	Deficiencies of energy and protein	1
12.	Iodine deficiency disorders of ruminants	1
13.	Copper deficiency diseases of ruminants	1
14.	Diseases associated with deficiency of zinc and manganese	1
15.	Diseases associated with deficiency of iron and cobalt	1
16.	Vitamin E and selenium deficiency	1
17.	Diseases associated with deficiency of vitamin B-complex	1
18.	Diseases associated with deficiencies of vitamin A and K	1
19.	Rickets, osteoporosis and osteodystrophic fibrosa	1
20.	Diabetes mellitus in dogs	1
21.	Diabetes insipidus in dogs	1
22.	Hypo- and hyperthyroidism in dogs	1
23.	Hypo- and hyperadrenocorticism in dogs	1
24.	Anatomy of the mammary glands, physiology of lactation and congenital abnormalities of udder and teats	1
25.	Physical and chemical tests for detection of mastitis	1
26.	Detection and identification of pathogenic bacteria in milk	1
27.	Epidemiology, treatment and control of mastitis caused by contagious, environment and opportunistic pathogens	2
28.	Specific and non-specific viral lesions of teats and udder	1
29.	Teat stenosis; udder oedema; galactorrhagia, galactagogue;agalactia	1
30.	Heifer and goat mastitis, mastitis-metritis-agalactia in sows	1
31.	Public health importance of mastitis	1

Suggested books

- *Veterinary Medicine* 2007. *A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs and Goats* by Otto M Radostits, Clive C Gay, Kenneth W Hinchcliff and Peter D Constable. 10th Edition. Saunders.
- *Clinical Endocrinology of Companion Animals* (2013). Ed. J Rand 1st Edition ed. by Jacquie Rand (Editor), Ellen Behrend (Editor), Danielle Gunn-Moore (Editor), Michelle Campbell-Ward (Editor). Wiley-Blackwell.
- Research and Review Papers in Current Journals.

**VMD 507: Paediatrics and Geriatrics (2+0)**

S. No.	Topics	No. of Lectures
Unit I		
1.	Perinatal adaptation, neonatal health, asphyxia and resuscitation	1
2.	Physical examination of the neonate, disease manifestation, supportive care of the abnormal newborn	1
3.	Failure of passive transfer of immunity and its management.	1
Unit II		
4.	Pediatric pharmacology	1
5.	Fluid replacement therapy	1
6.	Immunization of neonates, nutritional support, blood and serum transfusion	1
Unit III		
7.	Distended and painful abdomen, bloat	1
8.	Respiratory distress in the neonates	1
9.	Viral diseases of pups, foals and calves	2
10.	Bacterial diseases of pups, foals and calves	2
11.	Neonatal isoerythrolysis in foals, pups and kittens	1
12.	Congenital abnormalities of pups, foals and calves	1
13.	Peri-natal care and diseases of the newborn	1
14.	Non infectious diseases of pups	1
15.	Metabolic disorders, nutritional deficiencies, miscellaneous conditions (hypothermia, hyperthermia, starvation)	2
16.	Care, management and treatment of sick puppies	1
Unit IV		
17.	Guidelines for care of geriatric dogs	1
18.	Neuromuscular dysfunctions in geriatric dogs	1
19.	Common eye and ear affections in older canine and feline patients	1
20.	Hepatic and pancreatic disorders in older dogs and cats	1
21.	Paresis and/ or depressed mentation	1
22.	Urinary system diseases in geriatric dogs and cats	1
23.	Endocrine and metabolic disorders in geriatric patients	1
24.	Respiratory diseases in older dogs and cats	2
25.	Cardiac disorders in geriatric dogs and cats	1
26.	Cancer therapy in geriatric patients	1
27.	Skeletal disorders in geriatric patients	1
28.	Behaviour disorders in geriatric dogs	1

Suggested Readings

- *Equine Pediatric Medicine*. 2018. WV Bernard, BS Barr, 2nd edition, CRC Press.
- *Treatment and Care of the Geriatric Veterinary Patients* 2017. Mary Gardne and Dani McVety, Wiley-Blackwell.
- *Small Animal Pediatrics* 2011. Michael E. Peterson and Michelle Anne Kutzler, Elsevier.
- Research and Review Papers in Current Journals.

VMD 508: Avian and Swine Medicine (2+0)

S. No.	Topics	No. of Lectures
1.	General handling, sample collection and medication in various Avian Spps.	1



S. No.	Topics	No. of Lectures
2.	Etio-pathogenesis, symptomatology, diagnosis and treatment of diseases due to riboflavin deficiency in poultry	1
3.	Encephalomalacia (Crazy chick disease)	1
4.	Rickets and calcium deficiency in poultry	1
5.	Fatty liver and kidney syndrome	1
6.	Manganese and zinc deficiency in poultry	1
7.	Colibacillosis (including peritonitis in layers and salpingitis)	1
8.	Fowl cholera	1
9.	Yolk sac infection and omphalitis	1
10.	Salmonellosis and mycoplasmosis in poultry	1
11.	Infectious bursal disease (Gumboro disease) and Inclusion body hepatitis	1
12.	Infectious laryngotracheitis and infectious bronchitis	1
13.	New castle disease and marek's disease (including transient paralysis)	1
14.	Egg drop syndrome 76 (127 adenovirus/ BC14 infection)	1
15.	Lymphoid leukosis and other leukoses	1
16.	Parasitic diseases (Ascariasis and coccidiosis)	1
17.	Miscellaneous poultry diseases (cage layer fatigue, cannibalism, moult and prolapse of oviduct)	1
18.	General handling, physical examination and sample collection in pigs	1
19.	Mineral deficiency diseases in pigs (Calcium, phosphorus, iron, copper and zinc)	1
20.	Vitamin deficiency diseases in pigs (vitamin A, D, E, K, riboflavin and niacin)	1
21.	Swine influenza	1
22.	Swine fever (African and classical)	1
23.	Swine Pox	1
24.	Vesicular exanthema and vesicular stomatitis	1
25.	Swine dysentery (scours) and transmissible gastro-enteritis (TGE)	1
26.	Streptococcal meningitis	1
27.	Porcine reproductive and respiratory syndrome (PRRS)	1
28.	Pneumonia in pigs	1
29.	Glassers disease and greasy pig disease	1
30.	Swine erysipelas and mange	1
31.	FMD and brucellosis	1
32.	New and emerging diseases (Nipah virus)	1

Suggested Poultry Books

- *Diseases of Poultry*. 2013. DE Swayne, JR Glisson, LR McDougald, LK Nolan, DL Suarwz, and VL Nair. 13th Edition, Wiley-Blackwell.
- *Diseases of poultry and their control*. 2001. R. Chandra, VDP Rao, JC Gomez-Villamandos, SK Shukla and PS Banerjee. 1st edition, International book distributing Co., Lucknow, India. 2001.
- Research and Review Papers in Current Journals.

Suggested Swine Books

- *Diseases of Swine*. 2012. JJ Zimmerman, LA Karkiker, A Ramirez, KJ Schwartz and GW. Stevenson. 12th edition, Wiley-Blackwell.
- *Diseases of Swine* 2006. BE Straw, JJ Zimmerman, SD'Allaire and DJ Taylor. 9th edition, Blackwell Publishing.
- Research and Review Papers in Current Journals.

**VMD 509: Zoo, Wild and Laboratory Animal Medicine (1+0)**

S. No.	Topics	No. of Lectures
1.	Taxonomy of various genera of wild/ zoo animals of India along with their descriptions.	1
2.	Basic principles of habitat and housing of various classes of wild and zoo animals.	1
3.	Nutrient requirements, feeding habits and feeds of zoo, wild and laboratory animals.	2
4.	Diet formulation and feeding of various age groups, sick and geriatric animals.	1
5.	Post mortem examination, handling, processing and interpretation of pathological materials from zoo and wild animals.	1
6.	Breeding for conservation of wild animals.	1
7.	Population dynamics of wild animals, effective population size of wild animals in captivity/ zoo/ natural habitats.	1
8.	Restrain, capture, handling, physical examination and transport of wild and zoo animals.	1
9.	Principles of anesthesia, anesthetics, chemicals of restraining, common surgical Interventions; Capture myopathy.	2
10.	Acts and Rules related to zoo and wild animals.	1
11.	Principles of zoo hygiene, public health problems arising from zoos.	1
12.	Prevention, control and treatment of infectious, parasitic, nutritional and metabolic diseases in zoo and wild animals.	2
13.	Prevention, control and treatment of infectious, parasitic, nutritional and metabolic diseases of laboratory animals.	1

Suggested Books

- *Wild Mammals in Captivity: Principles and Techniques for Zoo Management* (2010). 2nd ed. - Kleiman, DG, University of Chicago Press
- *Zoo and Wild Animal Medicine Current Therapy* (2007). 6th ed. -C Fowler, ME
- *Zoo Animal and Wildlife Immobilization and Anesthesia* (2014). 2nd Ed.-C West, D Heard. N Caulkett, Wiley Blackwell
- Research and Review Papers in Current Journals.

VMD 510: Toxicology and Forensic Medicine (1+0)

S. No.	Topics	No. of Lectures
1.	Lead poisoning	1
2.	Arsenic and selenium poisoning	1
3.	Fluoride and copper toxicity	1
4.	Diseases associated with physical agents	1
5.	Chlorinated hydrocarbons, organophosphorous compounds and carbamates poisoning	1
6.	Nitrate nitrite poisoning, cyanide and urea poisoning	1
7.	Poisoning by mycotoxins and important phytotoxicoses	1
8.	Snakebite poisoning; Bee stings	1
9.	Examination of blood stains	1
10.	The vetero-legal wounds, causes of death from wounds	1
11.	Post-mortem examination of veterolegal case, submission of specimens in suspected cases of poisoning,	1



S. No.	Topics	No. of Lectures
12.	Collection and submission of specimens for histo-pathological examination, and various modern techniques for diagnosis of veterolegal cases	1
13.	Common frauds in the sale of livestock and livestock products	1
14.	Common offenses against animals in India	1
15.	Laws related to animal welfare in India	1
16.	Functioning of Animal welfare board	1

Suggested Books

- *Veterinary Toxicology*. 2014. SK Garg, CBS Publishers.
- *Veterinary Medicine- A textbook of the diseases of cattle, horses, sheep, pigs and goats* by Constable *et al.* 11th Ed., Saunders Ltd.
- *Animal Welfare Ethics and Jurisprudence* 2014. Kirti Dua, 1st Ed., Kalyani Publishers.
- *Veterinary Jurisprudence*. 2015. SN Sharma AK Gahlot and RK Tanwar. 7th Ed., NBS Publisher and Distributor.
- Research and Review Papers in Current Journals.

VMD 511: Clinical Diagnostic Techniques (0+2)

S. No.	Topics	No. of Practicals
1.	Endoscopy in small animals	1
2.	Endoscopic examination of URT in ruminants and equines	1
3.	Tracheo-broncheal lavage in ruminants, horses and dogs	2
4.	Thoracocentesis in dogs, cattle/ buffalo and horses	2
5.	Peritoneal fluid collection and examination in dogs, cattle, buffalo and horse	1
6.	Cystocentesis in dogs and urine examination	1
7.	Electrocardiography in dogs and its interpretation	1
8.	Electrocardiography in large animals and its interpretation	1
9.	Techniques in ocular examination	1
10.	Cerebrospinal fluid collection and examination	1
11.	Dermatological examination	1
12.	Collection of biopsy samples (Skin and liver)	2
13.	Diagnosis tests in mastitis	1
14.	Nasogastric/ orogastric intubation in large animals	1
15.	Echocardiography in large and small animals	2
16.	Liver function tests and their interpretation	1
17.	Pericardiocentesis in large and small animals	1
18.	Urinary Catheterization in male and female dogs	1
19.	Urinary Catheterization in a cattle/ buffalo and a mare	1
20.	Renal function tests and their interpretation	1
21.	Arterial blood collection and interpretation of acid base and blood gas analysis	1
22.	Diagnostic tests in ear affections	1
23.	Physical and special examination of musculoskeletal system	1
24.	Neurological examination in small and large animals	2
25.	Bone marrow collection in small and large animals	2
26.	Ultrasonography of chest and abdomen in large animal disease diagnosis	1
27.	CT, MRI, Pulse Oximetry, Radioimmuno assay, Nuclear Medicine	2

Suggested Books

- *Large Animal Internal Medicine*. 2015. Bradford P. Smith, 5th Edition, Mosby Elsevier.
- *Small Animal Clinical Techniques*. 2010. Susan M. Taylor, Saunders Elsevier.
- *Handbook of Veterinary Neurology*. 2010. Michael D. Lorenz, Joan R. Coates and Marc Kent, 5th Edition, Saunders Elsevier.
- *Handbook of Equine Respiratory Endoscopy*. 2007. Safia Barakzai, First Edition, Saunders Elsevier.
- *Manual of Canine and Feline Cardiology*. 2008. Larry P. Tilley, Francis W.K. Smith Jr., M.A. Oyama and M.M. Sleeper, 4th Edition, Saunders Elsevier.
- *Diagnostic Techniques in Equine Medicine: A Textbook for Students and Practitioners Describing Diagnostic Techniques Applicable to the Adult Horse* (2009), Frank GR Taylor, Tim J Brazil and Mark H Hillyer, 2nd Edition, Saunders Elsevier.
- Research and Review Papers in Current Journals.

VMD 512: Emergency Medicine (0+2)

S. No.	Topics	No. of Practicals
1.	Triage and stabilization of critical ill patient	1
2.	Cardiopulmonary resuscitation (CPR) in dogs	1
3.	Oxygen therapy in dogs	1
3.	Gastrointestinal decompression in large and small animals	2
4.	Management of Acute respiratory distress syndrome in small animals	1
5.	Trans-thoracic drainage of pleural effusions in large and small animals	2
6.	Trans-thoracic drainage of pericardial effusions in large and small animals	2
8.	Intra-osseous fluid administration in pups	1
9.	Management of gastrointestinal emergencies; gastric lavage, pain management	1
10.	Endotracheal intubation in dogs	1
11.	Clinical examination and therapeutic management of status epilepticus in small animals	1
12.	Management of the shock patient	1
13.	Blood transfusion in small and large animals	2
14.	Enteral nutrition in horse and dog	2
15.	Management of metabolic emergencies (Addison's disease, Diabetic ketoacidosis, Eclampsia, etc.)	2
16.	Management of acute renal failure	1
17.	Diagnosis and management of cardiac arrhythmias	1
18.	Acute obstructive colic and its management	1
19.	Poisons and toxins	2
20.	Urinary tract emergencies	2
21.	Ocular emergencies	2
22.	Neurological emergencies	2

Suggested Books

- *Kirk and Bistner's Handbook of Veterinary Procedures and Emergency Treatment*. 2012. Richard B. Ford and Elisa Mazaferro, 9th Edition, Saunders Elsevier.
- *Blackwell's Five Minute Veterinary Consult Clinical Companion, Small Animal Emergency and Critical Care*. 2010. Mazzaferro, M. E. 1st Edition, (Wiley Blackwell)
- *Equine Emergencies Treatment and Procedures*. 2008. Orsini J.A. and Divers T.J., 3rd Edition, Saunders Elsevier.
- Research and Review Papers in Current Journals.



VMD 513: Diagnosis of Veterinary Infectious Diseases (0+1)

S. No.	Topics	No. of Practicals
Practical		
1.	Techniques of random/ probability sampling and using survey tool box software for random selection of villages/ animals from a state population	1
2.	Sources of data and collection of animal health information using passive data and active surveillance	1
3.	Significance of sensitivity and specificity of a diagnostic test and false positive/ negative reactions of a particular test	1
4.	Diagnosis of mastitis by BTB card, SLS paddle test, electrical conductivity meter and somatic cell count.	1
5.	Inoculation of sample on culture media, and isolation/ identification of the organism	1
6.	Culture sensitivity tests on milk and other body fluids	1
7.	Collection and examination of samples for fungal infections	1
8.	Preparation of blood smear for protozoan and rickettsial disease examination	1
9.	Examination of parasitic eggs and along with their identification points including McMaster egg counting technique	1
10.	Collection and/ or examination of skin scrapings for mites, ticks, lice or fleas	1
11.	Screening tests for animal infectious diseases, including TB, JD, glanders and brucellosis	2
12.	Enzyme linked immunosorbant assay (ELISA): direct, indirect and competitive	1
13.	Use of Polymerase chain reaction (PCR) in animal disease diagnosis and its types	2
14.	Molecular epidemiology tools to study strain variation including RFLP, PCR-RFLP, etc.	1

Suggested Books

- *Veterinary Epidemiology* (2018). Michael Thrusfield, Robert Christley. Wiley-Blackwell
- *Veterinary Epidemiologic Research*. (2003). Ian Dohoo, Wayne Martin and Henryk Stryhn, AVC Inc., Charlottetown.
- *Diseases of Animals: Diagnosis and Management* (2013). Singh, Bhoj and Somvanshi, R. Indian Veterinary Research Institute
- *Veterinarian's Guide to the Laboratory Diagnosis of Infectious Diseases* (1986). Gordon R. Carter. Veterinary Medicine Publishing Company
- Research and Review Papers in Current Journals.

VMD 514: Oncology and Ethno-veterinary Medicine (1+0)

S. No.	Topics	No. of Lectures
1.	Introduction to tumors	1
2.	Conventional and advanced diagnostic techniques for diagnosis of tumors	1
3.	Basic and advancements in chemotherapy and radiation therapy for tumors	1
4.	Immune-therapy and other miscellaneous therapy for cancer patients	1
5.	Principles of nutrition and management of chronic pain in cancer patients	1



S. No.	Topics	No. of Lectures
6.	Tumors associated with gastrointestinal tracts	1
7.	Tumors associated with liver and spleen	1
8.	Tumors associated with endocrine system and urinary system	1
9.	Tumors associated with skin, subcutaneous tissues, eye and ear	1
10.	Tumors associated with hemopoietic and respiratory systems	1
11.	Principles of herbal medicines and their use in treating animal diseases	1
12.	Principles of homeopathic medicines and their use in treating animal diseases	1
13.	Application of acupuncture in the management of animal diseases	1
14.	Physiotherapy and laser therapy in animal diseases	1
15.	Common nutraceutical ingredients (prebiotics, probiotics, synbiotics, enzymes and antibacterial alternatives)	1
16.	Use of nutraceuticals in prevention and treatment of various animal diseases	1

Suggested Books

- *BSAVA Manual of Canine and Feline Oncology* by Dobson, Jane M. and Lascelles, B Duncan X. 3rd Ed., BSAVA.
- *Veterinary Herbal Medicine* by SG Wynn and BJ Fougere. 1st Ed., Mosby Elsevier.
- *Textbook of Veterinary Homeopathy*, by J Saxton and P Gregory. Beaconsfield Publishers, Beaconsfield
- *Complementary and Alternative Veterinary Medicine* by Narda G Robinson In: Merck Veterinary Manual. 11th Ed., Wiley.
- *Nutraceuticals in Veterinary Medicine* by, Ramesh C Gupta, Ajay Srivastava and Rajiv Lall. 1st Ed., 2019 Springer.
- Research and Review Papers in Current Journals.

VMD 515: Animal Disease Investigation and Biosecurity (1+1)

S. No.	Topics	No. of lectures/ Practicals
Theory		
1.	Investigation and diagnosis on dead animals and poultry	1
2.	Investigation and diagnosis on live animals and poultry	1
3.	Point source epidemics and propagating epidemics	1
4.	Collection, preservation and transport of material in the face of disease outbreak	1
5.	Processing of material in the laboratory for diagnosis	1
6.	Recording and analysis of epidemiological data	1
7.	Establishing working hypothesis	1
8.	Formulating and advising and/ or implementing treatment, control and prevention strategies	1
9.	Definition and related concepts of biosecurity, principles and basic components of biosecurity, physical operational elements of biosecurity	1
10.	Routes of entry and transmission dynamics of pathogens	1
11.	Shedding pattern of pathogens by infected animals and their survival in the environment	1
12.	Protection of susceptible animals, interruption of pathways of transmission	1
13.	Role of disinfection to break cycle of infection, sterilization, fumigation and disinfection methods	1



S. No.	Topics	No. of Lectures/ Practicals
14.	Disinfectants and its classification; microbial resistance to disinfectants, risk assessment and its management	1
15.	Principles of biosecurity for laboratory animal house, biosecurity in research laboratories, biosecurity measures for collection of specimen from wild animals	1
16.	Vaccines- success stories of disease eradication through vaccination	1
Practical		
1.	Isolation and identification of field isolates and vaccine strains by conventional, immunoassays and molecular techniques	3
2.	Outbreak investigation of infectious diseases in livestock and poultry in the field/ organized livestock farms	2
3.	Outbreak investigation of toxicological conditions in livestock and poultry in the field/ organized livestock farms	1
4.	Practical use of disinfectants in destruction of microbes in the laboratory and under field conditions	1
5.	Determination of efficacy/ phenol coefficient of commonly used disinfectants	1
6.	Approaches in animal disease control and eradication	1
7.	Preliminary steps to control animal disease outbreaks	1
8.	Types of vaccines- conventional and recombinants	1
9.	Vaccination schedule in cattle, sheep and, goats	2
10.	Vaccination schedule in horses and pigs	1
11.	Vaccination schedule of pets including dogs and cats	1
12.	Vaccination schedule of poultry including layers and broilers	1

Suggested Books

- *History of the Surveillance and Control of Transmissible Animal Diseases.* (2003). Jean Blancou. Office International des Epizooties
- *Veterinary Epidemiology* (2018). Michael Thrusfield, Robert Christley. Wiley-Blackwell
- *Biosecurity in Animal Production and Veterinary Medicine* (2018). Jeroen Dewulf, Filip Van Immerseel. *From Principles to Practice.* AMSTERDAM University Press
- Research and Review Papers in Current Journals.

Minor Courses for M.V.Sc. Degree programme

Courses of any one department/ discipline from the list given below:

- Veterinary Physiology
- Veterinary Microbiology
- Veterinary Parasitology
- Veterinary Pharmacology and Toxicology
- Veterinary Surgery and Radiology
- Veterinary Public Health and Epidemiology

Supporting Courses

It could be any subject considered relevant for student's research work. This will be decided by Advisor/ guide concerned.

Common Courses

The following courses (one credit each) will be offered to all students undergoing Master's degree programme.



-
- Library and Information Services
 - Technical Writing and Communications Skills
 - Intellectual Property and its management in Agriculture
 - Basic Concepts in Laboratory Techniques
 - Agricultural Research, Research Ethics and Rural Development Programmes



Course Contents

Ph.D. in Veterinary Medicine

Course Code	Course Title	Credit Hours
VMD 601	Farm Animal Gastroenterology	2+0
VMD 602	Farm Animal Cardiopulmonary and Urinary System Diseases	2+0
VMD 603	Farm Animal Neurological and Musculo-skeletal System Diseases	1+0
VMD 604	Farm Animal Neonatology	1+0
VMD 605	Herd Health Management	2+1
VMD 606	Canine and Feline Gastroenterology	2+0
VMD 607	Advances in Neurological and Musculoskeletal System Diseases of Canine and Feline	1+0
VMD 608	Canine and Feline Cardiopulmonary and Urinary System Diseases	1+0
VMD 609	Dermatology and Endocrinology	1+0
VMD 610	Canine and Feline Eye and Ear Diseases	1+0
VMD 611	Veterinary Diagnostics	0+2
VMD 612	Metabolic and Nutritional Deficiency Diseases	2+0
VMD 613	Emergency and Critical Care Medicine	1+1
VMD 614	Emerging and Re-emerging Animal Diseases	2+0
VMD 615	Prevention and Control of Infectious Diseases of Ruminants	2+0
VMD 616*	Clinical Practice-I	0+2
VMD 617*	Clinical Practice-II	0+2
VMD 618*	Clinical Practice-III	0+2
VMD 691	Doctoral Seminar-I	1+0
VMD 692	Doctoral Seminar-II	1+0

Course Contents

Ph.D. in Veterinary Medicine

I. Course Title : Farm Animal Gastroenterology

II. Course Code : VMD 601

III. Credit Hours : 2+0

IV. Aim of the course

Study of contemporary advancements in farm animal gastroenterology.

V. Theory

Unit I

Advances in diagnosis, Therapy and control of diseases of gastrointestinal system and associated organs of farm animals.

Unit II

Advances in diagnosis, Therapy, Control and prevention of infectious diseases of gastrointestinal system and associated organs of farm animals.

I. Course Title : Farm Animal Cardiopulmonary and Urinary System Diseases

II. Course Code : VMD 602

III. Credit Hours : 2+0

IV. Aim of the course

Advances in diseases of cardio-pulmonary and urinary systems.

V. Theory

Unit I

Advances in diagnosis and therapeutic management of internal diseases of circulatory system and urinary systems.

Unit II

Advances in diagnosis and therapeutic management of internal diseases of respiratory system.

Unit III

Advances in diagnosis, control, prevention and therapeutic management of infectious diseases of cardiopulmonary and urinary systems.

I. Course Title : Farm Animal Neurological and Musculo-skeletal System Diseases

II. Course Code : VMD 603

III. Credit Hours : 1+0

IV. Aim of the course

Study of recent advances in diseases of neurological and musculoskeletal systems.



V. Theory

Unit I

Advances in diagnosis, Therapy and control of internal diseases of nervous and musculoskeletal system.

Unit II

Advances in diagnosis, Therapy, Control and prevention of infectious diseases of nervous and musculo-skeletal systems.

I. Course Title : Farm Animal Neonatology

II. Course Code : VMD 604

III. Credit Hours : 1+0

IV. Aim of the course

Study of recent advances in care and disease management of equine and ruminant neonates.

V. Theory

Unit I

Advances in diagnosis, Therapy, Prevention and control of internal and infectious diseases of equine neonate.

Unit II

Advances in diagnosis, Therapy, Prevention and control of internal and infectious diseases of ruminant neonate.

I. Course Title : Herd Health Management

II. Course Code : VMD 605

III. Credit Hours : 2+1

IV. Aim of the course

Recent concepts in herd health medicine.

V. Theory

Unit I

General principles, Interactions between health and production, Herd medicine and population health.

Unit II

Herd health management programme for enzootic herds/ flocks.

Unit III

Recent concepts on herd management of chronic Bacterial, parasitic and fungal and rickettsial diseases.

Unit IV

Biosecurity and infection control, Herd and flock immunity, Quality management of herd health, Control of infectious diseases in the herd, Herd health economics.

VI. Practical

Visit to farms, Assessment of their problems, Estimating the presence and prevalence



of a disease and new proposals for prevention and control strategies of a specific disease and its impact.

- I. Course Title** : **Canine and Feline Gastroenterology**
II. Course Code : **VMD 606**
III. Credit Hours : **2+0**
IV. Aim of the course

Study of advancements in canine and feline gastroenterology.

V. Theory

Unit I

Advances in diagnosis, Therapy and control of internal diseases of gastrointestinal system and associated organs of canine and feline.

Unit II

Advances in diagnosis, Therapy, Control and prevention of infectious diseases of gastrointestinal system and associated organs in canine and feline.

- I. Course Title** : **Advances in Neurological and Musculoskeletal System Diseases of Canine and Feline**
II. Course Code : **VMD 607**
III. Credit Hours : **1+0**
IV. Aim of the course

Study of recent advances in the field of neurological and musculoskeletal diseases.

V. Theory

Unit I

Advances in diagnosis, Therapy and control of internal diseases of nervous and musculoskeletal systems.

Unit II

Advances in diagnosis, Therapy and control of infectious diseases of nervous and musculoskeletal systems.

- I. Course Title** : **Canine and Feline Cardiopulmonary and Urinary System Diseases**
II. Course Code : **VMD 608**
III. Credit Hours : **1+0**
IV. Aim of the course

Advances in cardiopulmonary and urinary systems.

V. Theory

Unit I

Advances in diagnosis and therapeutic management of internal diseases of circulatory and urinary systems.

Unit II

Advances in diagnosis, therapeutic management of internal diseases of respiratory system.



Unit III

Advances in diagnosis, therapeutic management, prevention and control of infectious diseases of cardiopulmonary and urinary systems.

- I. Course Title : Dermatology and Endocrinology**
- II. Course Code : VMD 609**
- III. Credit Hours : 1+0**

IV. Aim of the course

Recent concepts in diagnosis, management and control of diseases of skin and endocrine organs.

V. Theory

Unit I

Advances in diagnosis, therapy, prevention and control of infectious and non-infectious diseases of skin and integumentary systems.

Unit II

Advances in diagnosis, therapy and control of diseases of endocrine system.

- I. Course Title : Canine and Feline Eye and Ear Diseases**
- II. Course Code : VMD 610**
- III. Credit Hours : 1+0**

IV. Aim of the course

Study of recent advances in eye and ear diseases of canine and feline.

V. Theory

Unit I

Advances in examination, diagnosis and therapy of diseases of eye.

Unit II

Advances in diagnosis and therapy of diseases of ear.

- I. Course Title : Veterinary Diagnostics**
- II. Course Code : VMD 611**
- III. Credit Hours : 0+2**

IV. Aim of the course

Study of recent advances in diagnostics.

V. Practical

Unit I

Analysis and interpretation of hemogram, serum and blood biochemicals.

Unit II

Imaging techniques for the diagnosis of animal diseases (electrocardiography, echocardiography, etc.)

**Unit III**

Ophthalmoscopy, Ultrasonography, Pulse-oximetry. Assignments on advanced diagnostic techniques for various diseases of domestic animals. Use of above mentioned advanced diagnostic techniques where ever possible. Collection and examination of CSF, gastric/ rumen/ abomasal, peritoneal fluid, absorption and digestion tests, low and high dose dexamethasone test, ACTH stimulation test, hormone profile and enzyme profile.

- I. Course Title : Metabolic and Nutritional Deficiency Diseases**
II. Course Code : VMD 612
III. Credit Hours : 2+0
IV. Aim of the course

Recent trends in diagnosis, management and control of metabolic and nutritional diseases.

V. Theory**Unit I**

Metabolic profile tests, Parturient paresis, Downer's cow syndrome, Acute hypokalemia in cattle, Transit recumbency and lactation tetany of mares, Hypomagnesemic tetany of calves, Ketosis, Subclinical ketosis, Pregnancy toxemia, Fatty liver syndrome, Equine hyperlipidemia, Steatitis, Neonatal hypoglycemia, Low milk fat syndrome, Postparturient hemoglobinuria and eclampsia in bitches.

Unit II

Deficiency of energy and protein, Deficiency of fat. Deficiency of fat and water soluble vitamins, Deficiency of macro and micro minerals.

Unit III

Diabetes mellitus, diabetes insipidus, hypothyroidism, obesity, hypo- and hyperadrenocorticism, hormone deficiency syndromes.

- I. Course Title : Emergency and Critical Care Medicine**
II. Course Code : VMD 613
III. Credit Hours : 1+1
IV. Aim of the course

Recent advancement in emergency medicine and critical care.

V. Theory**Unit**

Diagnosis and therapeutic management of various emergencies of cardiovascular, respiratory, gastrointestinal, urinary and nervous systems.

Unit

Diagnosis and therapeutic management of various emergencies of toxicities, sting bites and burns in farm and companion animals.

Unit

Monitoring critical ill patient, application of emergency care procedures for resuscitation of critically ill patients.



VI. Practical

- Placement of central venous catheters, Intra-osseous fluid administration, Endotracheal intubation, Gastric lavage, Decompression of guttural pouch, Stomach, Cecum, Ventilation, Nebulisation, Fluid therapy, CPR, oxygen therapy, Enteral nutrition, Nasogastric intubation.
- Continuous rate infusion, Defibrillation– Demonstration, Peritoneal dialysis, Peritoneal diagnostic lavage, Management of hypo/ hyper thermia, Trocarization.

I. Course Title : Emerging and Re-emerging Animal Diseases

II. Course Code : VMD 614

III. Credit Hours : 2+0

IV. Aim of the course

Study on emerging and re-emerging diseases of animals.

Unit I

General concepts for emergence of new diseases and re-emergence of old diseases. Factors and determinants of emerging diseases. The role of wildlife in emerging and re-emerging diseases.

Unit II

Microbial adaptation and change; Epidemiological processes involved in the emergence of vector-borne diseases. Epidemiology of globally and nationally important emerging/ re-emerging diseases and designing of strategies for their prevention and control.

I. Course Title : Prevention and Control of Infectious Diseases of Ruminants

II. Course Code : VMD 615

III. Credit Hours : 2+0

IV. Aim of the course

Recent concepts in prevention and control of infectious diseases of ruminants.

V. Theory

Unit I

Bacterial and viral diseases of economic importance in bovines, sheep and goats.

Unit II

Fungal and parasitic diseases of economic importance in bovines, sheep and goats.

Unit III

Blood protozoan and rickettsial diseases of economic importance in bovines, sheep and goats.

I. Course Title : Clinical Practice-I

II. Course Code : VMD 616

III. Credit Hours : 0+2

IV. Aim of the course

Application of the theoretical concepts in practice.

**V. Practical**

Diagnostic and therapeutic protocol application, Specimen collection, Examination and management of sick farm and companion animals, Use of diagnostic techniques for diagnosis of medicinal cases, Acquaintance with different equipment, Client management, public relations, Code of conduct, hospital management, Database management and maintenance of case records, Disaster management.

Note: This course shall be conducted in Veterinary Clinical Complex (VCC) where students shall participate in diagnosis and treatment of diseased animals.

I. Course Title : Clinical Practice-II

II. Course Code : VMD 617

III. Credit Hours : 0+2

IV. Aim of the course

Application of the theoretical concepts in practice.

V. Practical

Diagnostic and therapeutic protocol application, Specimen collection, Examination and management of sick farm and companion animals, Use of diagnostic techniques for diagnosis of medicinal cases, Acquaintance with different equipment, Client management, Public relations, Code of conduct, Hospital management, Database management and maintenance of case records, Disaster management.

Note: This course shall be conducted in Veterinary Clinical Complex (VCC) where students shall participate in diagnosis and treatment of diseased animals.

I. Course Title : Clinical Practice-III

II. Course Code : VMD 618

III. Credit Hours : 0+2

IV. Aim of the course

Application of the theoretical concepts in practice.

V. Practical

Diagnostic and therapeutic protocol application, Specimen collection, Examination and management of sick farm and companion animals, Use of diagnostic techniques for diagnosis of medicinal cases, Acquaintance with different equipment, Client management, Public relations, Code of conduct, Hospital management, Database management and maintenance of case records, Disaster management.

Course Outline: Lecture wise

VMD 601: Farm Animal Gastroenterology (2+0)

S. No.	Topics	No. of Lectures
1.	Physical examination in gastrointestinal disease diagnostic strategies and initial plan in assessment of gastrointestinal function	1
2.	Imaging techniques for the gastrointestinal system radiography of the gastrointestinal system veterinary nuclear medicine	1
3.	Clinical pharmacology of the gastrointestinal tract	1
4.	Principles of fluid therapy in cattle, horse, pig, sheep and goat	1
5.	Diseases of the buccal cavity and related organs including pharynx, oesophagus	1
6.	Reticulo-ruminal disorders – recent concepts in fermentative disorders-simple indigestion, impaction, ruminal lactic acidosis, alkalosis	2
7.	Primary and secondary bloat- diagnosis	1
8.	Traumatic reticulo-peritonitis, vagal indigestion syndrome, generalised peritonitis, omasal impaction and abdominal distension	2
9.	Diseases of abomasum (impaction, displacements, ulcers)	1
10.	Intestinal disorders (intussusception, volvulus), strangulation, caecal dilatation and volvulus in ruminants.	1
11.	Diseases of bovine liver	1
12.	Diarrhea in cattle and small ruminants	1
13.	Bacterial and viral diseases: Campylobacteriosis, intestinal chlamydial infection, salmonellosis, tyzzer's disease, infectious disease involving gut such as RP, BVD, FMD, actinomycosis, actinobacillosis	3
14.	Protozoal diseases: Coccidiosis, cryptosporidiosis	1
15.	Gastrointestinal parasites of pigs: Ascaris sp, oesophagostomum, stomach worms, strongyloides sp, trichuris sp	1
16.	Gastrointestinal parasites of horses: Gastrophilus, habronema, oxyuris, parascaris, large strongyles, small strongyles, strongyloides, tapeworms, trichostrongylus	2
17.	Gastrointestinal Parasites of cattle: Cooperia, bunostomum, strongyloides, nematodirus, toxocara, oesophagostomum, chabertia, trichuris, tapeworms	2
18.	Gastrointestinal parasites of sheep and goats: Haemonchus, ostertagia, and trichostrongylus, intestinal trichostrongylosis, nematodirus, oesophagostomum, chabertia, strongyloides, trichuris, tapeworms	2
19.	Gastrointestinal diseases – Horse and Pigs	1
20.	Dysphagia in horses	1
21.	Diseases of stomach: GIT ulceration, gastric dilation, impaction, gastric parasitism in horses and pigs	1
22.	Diseases causing equine colic such as anterior enteritis, small intestine strangulation, intestine impaction. Protocol and management of equine colic	1
23.	Obstructive intestinal diseases in horse	1
26.	Chronic weight loss without diarrhea, pain or icterus in horse	1
27.	Swine dysentery, hog cholera	1

Suggested Books

- *Equine Internal Medicine*. 2017. Stephen Reed, Warwick Bayly and Debra Sellon, 4th Edition, Elsevier, Saunders.
- *Large Animal Internal Medicine*. 2019. Bradford Smith, David Van Metre and Nicola Pusterla, 6th Edition, Mosby
- *Rebhun's Diseases of Dairy Cattle*. 2018. Simon F Peek and Thomas J Divers, 3rd Edition, Elseviers
- *Veterinary Gastroenterology*. 1992. Neil V. Anderson, 2nd Revised edition, Lea and Febiger, USA.
- Research and Review Papers in Current Journals.

VMD 602: Farm Animal Cardiopulmonary and Urinary System Diseases (2+0)

S. No	Topics	No. of Lectures
1.	Evaluation of patient with respiratory signs	1
2.	Diagnostic aids in evaluation of respiratory line	1
3.	Retropharyngeal lymph node abscessation in horses	1
4.	Pharyngeal affections in horses and Pharyngeal trauma in ruminants	1
5.	Diseases of guttural pouch in horses	1
6.	Laryngeal granuloma, abscess, edema	1
7.	Tracheal collapse and stenosis in farm animals	1
8.	Ethmoid hematoma in horses, diseases of paranasal sinuses in farm animals	1
9.	Disorders of equine soft palate	1
10.	Bacterial pneumonia and pleuropneumonia in adult horses	1
11.	Pneumonia in foals	1
12.	Pulmonary edema and smoke inhalation	1
13.	Recurrent airway obstruction in horses	1
14.	Inflammatory airway disease in horses	1
15.	Epistaxis and Exercise induced pulmonary hemorrhage in horses	1
16.	Bronchopneumonia and interstitial pneumonia in ruminants	1
17.	Hypersensitivity and metastatic pneumonia	1
18.	Progressive viral pneumonia of sheep and goats	1
19.	Pleuritis and pleural effusions, pneumothorax and lung tumors	1
20.	Viral pneumonia of sheep	1
21.	Congenital cardiac diseases	1
22.	Pericardial diseases	1
23.	Myocardial diseases	1
24.	Endocardial diseases	1
25.	Cardiac arrhythmias	1
26.	Anaemia	1
27.	Bleeding disorders	1
28.	Renal failure in horses	1
29.	Urinary incontinence and urethral obstruction in equine and bovine	1
30.	Polyuria and polydypsia in horses, urinary system disorders in the foal	1
31.	Ulcerative posthitis and vulvitis in small ruminants	1
32.	Bacterial pyelonephritis and urinary tract infection, leptospirosis	1

Suggested Books

- *Large Animal Internal Medicine*. 2019. Bradford Smith, David Van Metre and Nicola Pusterla, 6th Edition, Mosby
- *Veterinary Medicine: A textbook of the diseases of cattle, horses, sheep, pigs and goats* by Otto M Radostits, Clive C Gay, Kenneth W Hinchcliff and Peter D Constable. 10th Edition. Saunders



- *Rebhun's Diseases of Dairy Cattle*. 2018. Simon F Peek, Thomas and J Divers, 3rd Edition, Elseviers
- Research and Review Papers in Current Journals.

VMD 603: Farm Animal Neurological and Musculo-skeletal System Diseases (1+0)

S. No.	Topic	No. of Lectures
1.	Neurological examination in bovine and equine patients; Localization of lesions in nervous system	1
2.	Disease of brain stem in equines and bovines	1
3.	Diseases producing cortical signs in equines and bovines	1
4.	Diseases of spinal cord and Peripheral neuropathies	1
5.	Viral/ Prions encephalopathies: Equine herpes virus, Eastern/ Western equine encephalopathies, Bovine Spongiform Encephalopathy, etc.	2
6.	Parasitic thromboembolism and Equine Protozoal encephalomyelitis	1
7.	Encephalomalacia, Narcolepsy and Hyperkalemic periodic paralysis	1
8.	Diagnostic approach to musculoskeletal abnormalities	1
9.	Diseases of Muscle tone; Muscle Cramping	1
10.	Nonexertional Rhabdomyolysis in Horses: Inflammatory myopathies, nutritional, toxic and traumatic rhabdomyolysis	1
11.	Exertional Myopathies in Horses: Congenital, acquired and metabolic disorders	1
12.	Osteochondrosis, Septic (Infectious) arthritis osteomyelitis, osteoarthritis, laminitis in horse	1
13.	Bovine foot lameness: Characteristics of lameness, metabolic and infectious causes and conformation defects	2
14.	Nutrition and Lameness, Claw trimming and foot baths	1

Suggested Books

- *Bovine Laminitis and Lameness*. 2007. Paul R Greenough, First Edition, Saunders Elsevier.
- *Large Animal Internal Medicine*. 2019. Bradford Smith, David Van Metre, Nicola Pusterla, 6th Edition, Mosby
- *Handbook of Veterinary Neurology*. 2010. Michael D Lorenz, Joan R Coates and Marc Kent, 5th Edition, Saunders Elsevier.
- *Equine Internal Medicine*. 2004. Stephen M Reed, Warwick M Bayly and Debra C Sellon, 2nd Edition, Saunders Elsevier.
- Research and Review Papers in Current Journals.

VMD 604: Farm Animal Neonatology (1+0)

S. No.	Topics	No. of Lectures
1.	Advances in management during perinatal adaption period	1
2.	Manifestations of neonatal diseases in calves	2
3.	Manifestations of neonatal diseases in foals	2
4.	Manifestations of neonatal diseases in lambs and kids	2
5.	Neonatal infection and sepsis	1
6.	Advances in diagnostic procedures in neonates	2
7.	Advances in intensive care of management of critically ill neonates	2
8.	Advances in chemotherapeutic management of neonatal diseases	2
9.	Vaccination and maternal antibody interference	1
10.	Advances in management of orphan neonates	1

Suggested Books

- *Equine Pediatric Medicine*. 2018. W V Bernard, BS Barr, 2nd edition, CRC Press
- *Practical Lambing and Lamb Care*. 2018. N Sargison, JP Crilly and A Hopker, 4th edition, Wiley Blackwell
- *Equine Neonatal Medicine*. 2006. MR Paradis, 1st edition, Saunders
- *Bovine Neonatology*. 2009. *Veterinary Clinics of North America: Food Animal Practice*. 1st Edition, Saunders
- Research and Review Papers in Current Journals.

VMD 605: Herd Health Management (2+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
1.	General principles of herd health management	2
2.	Factors to be considered for successful implementation of herd health program	1
3.	Interaction between health and production	2
4.	Monitoring young stock health	1
5.	Targets for young stock rearing and dairy cow culling	1
6.	Disease control in rearing period	1
7.	Herd Medicine and population health	2
8.	Herd nutrition for optimum health	2
9.	Recent concepts on herd management of bacterial diseases	2
10.	Recent concepts on herd management of viral diseases	2
11.	Recent concepts on herd management of parasitic diseases	1
12.	Recent concepts on herd management of fungal diseases	1
13.	Recent concepts on herd management of rickettsial diseases	1
14.	Herd management of metabolic diseases	1
15.	Herd management of deficiency diseases	1
16.	Biosecurity and infection control	1
17.	Herd and flock immunity	1
18.	Quality management of herd health	1
19.	Control of infectious diseases in the herd	1
20.	Herd health economics	1
21.	Importance and steps of record keeping	2
22.	Control of lameness	1
23.	Diagnosis and control of mastitis and enhancement of milk quality	2
Practicals		
1.	Recent advances in calf management and diseases	1
2.	Appropriate animal housing	1
3.	Epidemiological investigations for problem identification at farm	1
4.	Farm biosecurity	1
5.	Recent advances in disinfection of farm sheds and other equipments	1
6.	Stress control of farm animals with respect to environmental and production stress	1
7.	Record keeping	1
8.	Recent advances in disease testing (TB, JD, Brucellosis, Mastitis)	1
9.	Routine farm procedures	2
10.	Herd vaccination	1
11.	Ecto and endo parasitism: principles and latest control trends	1
12.	Recent advances in mastitis control	1



S. No.	Topics	No. of Lectures/ Practicals
13.	Recent advances in lameness control	1
14.	Establishment of farm laboratoty	1
15.	Use of medicines and food safety	1

Suggested Books

- *Dairy Herd Health*. 2012. MJ Green and Andrew J Bradley. CABI Publishing
- *Herd Health: Food, Animal, Production, Medicine*. 1994. OM Radostits, KE Leslie, J Fetrow and WB. Saunders,
- *Veterinary Epidemiology*. 2018. Michael Thrusfield, Robert Christley. Wiley-Blackwell
- *The Keys to Herd Health*. 2006. Jerry Brunetti. Acres U.S.A.
- *Herd Health and Production Management in Dairy Practice*. 2003. Arie Brand. International Book Distributing Company
- Research and Review Papers in Current Journals.

VMD 606: Canine and Feline Gastroenterology (2+0)

S. No.	Topics	No. of Lectures
1.	Introduction to gastrointestinal function and microbiota	02
2.	Diagnostic approach to anorexia, abdominal pain and vomiting	02
3.	Approach to clinical signs of diarrhea, constipation and tenesmus	02
4.	Diagnostic and therapeutic approach to hematochezia and melena	02
5.	Diagnostic approach to hepato-biliary diseases and pancreatic diseases, coagulopathy, icterus, ascites and hepatoencephalopathy	02
6.	Approach to clinical signs of weight loss and cachexia	01
7.	Nutritional approach to gastrointestinal disease management	02
8.	Pharmacological approach to gastrointestinal disease: antiemetic, antidiarrhoeal and cytoprotective agents	01
9.	Pharmacological approach to gastrointestinal disease: antimicrobial and anthelmintic agents	01
10.	Pharmacological approach to gastrointestinal disease: prokinetics, probiotics and laxatives	01
11.	Chemotherapy and immunosuppressive drugs in gastrointesinal disease	01
12.	Dentistry and diseases of oropharynx	01
13.	Diagnostic evaluation and diseases of esophagus	01
14.	Gastric diseases: Gastritis, ulceration, neoplasia and dysmotility	02
15.	Advances in treatment and management of Small intestinal diseases	01
16.	Diagnostic approach and management of inflammatory bowel disease (IBD), Ulcerative colitis, bacterial, parasitic and fungal infections of large intestine	02
17.	Diagnostic evaluation and treatment of diseases of anorectum	01
18.	Diagnostic evaluation and common affections of pancreas	01
19.	Liver: Parenchymal, neoplastic, metabolic and biliary disorders	03
20.	Breed related gastrointestinal disorders	01
21.	Behaviour and gastrointestinal disease	01

Suggested books

- *Canine and Feline Gastroenterology*. 2013. RJ Washabau and MJ Day, Elsevier Mosby, St. Louis Missouri
- *Text Book of Veterinary Internal Medicine*. 2001. Part I and II, Ettinger and Feldman, 7th Edition, Saunders



- *Small Animal Medical Diagnosis*. 2009. MD Lorenz, TM. Neer and PL Demars, 3rd Edition, Wiley Blackwell, Iowa, USA.
- Research and Review Papers in Current Journals.

VMD-607 Advances in Neurological and Musculoskeletal System Diseases of Canine and Feline (1+0)

S. No	Topics	No. of Lectures
1.	Classification and general diagnostic features of acquired myopathies in dogs and cats	1
2.	Developmental and genetic bone disorders	1
3.	Idiopathic bone disorders	1
4.	Metabolic, nutritional and endocrine bone disorders	1
5.	Neoplasms of bones	1
6.	Focal brain diseases of rapid onset- idiopathic epilepsy, idiopathic vestibular disease, trigeminal neuropathy, idiopathic facial nerve paralysis	1
7.	Brain diseases of intermediate onset- brain abscesses	1
8.	Focal brain diseases of slow onset- Thiamine deficiency, hypoglycemia, poisons	1
9.	Inflammatory brain disorders- viral, bacterial, protozoal and mycotic encephalitis	1
10.	Inflammatory meningitis-granulomatous meningo-encephalitis, Pug encephalitis, rickettsial diseases	1
11.	Metabolic diseases with neurological signs	1
12.	Diseases affecting cervical spinal cord and brachial plexus	1
13.	Diseases affecting thoraco-lumbar and lumbo-sacral segments of spinal cord	2
14.	Inflammatory and immune mediated neuropathies	1
15.	Metabolic and toxic causes affecting peripheral nerves dysfunctions	1

Suggested Books

- *Handbook of Veterinary Neurology*. 2011. MD Lorenz, JR Coates and Marc Kent 5th Edition. Elsevier Saunders
- *Textbook of Veterinary Internal Medicine: Diseases of the Dog and Cat*. 2010. Stephen J. Ettinger and Edward C. Feldman, Elsevier Saunders 7th Edition.
- *Veterinary Clinics of North America: Small Animal Practice*, Elsevier, Monthly
- Research and Review Papers in Current Journals.

VMD 608: Canine and Feline Cardiopulmonary and Urinary System Diseases (1+0)

S. No	Topic	No. of Lectures
1.	Pathophysiology of heart failure, Clinical manifestations of cardiac diseases	1
2.	Diagnostic tests for cardiovascular system (radiography, electrocardiography and echocardiography)	1
3.	Therapeutic management of heart failure	1
4.	Cardiac arrhythmias and anti-arrhythmic therapy	1
5.	Acquired valvular heart diseases (Degenerative atrioventricular valve diseases and infectious endocarditis)	1
6.	Myocardial diseases of dogs and cats (Canine dilated cardiomyopathy, canine hypertrophic cardiomyopathy and feline cardiomyopathies)	1



S. No.	Topics	No. of Lectures
7.	Pericardial diseases and cardiac tumors, systemic arterial hypertension	1
8.	Clinical evaluation of patient with respiratory diseases	1
9.	Feline upper respiratory tract infections	1
10.	Bacterial rhinitis, allergic rhinitis, nasal mycosis, nasal tumors, polyps in dogs and cats	1
11.	Diseases of trachea (infectious tracheobronchitis, lungworms, tracheal hypoplasia and tracheal collapse), Canine and feline bronchitis	1
12.	Pulmonary parenchymal diseases (infectious- viral, bacterial, protozoal, fungal and parasitic)	1
13.	Pulmonary neoplasia, pulmonary edema, pleural effusions, pneumothorax	1
14.	Clinical approach and laboratory evaluation of renal diseases, Glomerulonephritis, Urolithiasis	1
15.	Acute and chronic renal failure	1
16.	Canine and feline lower urinary tract disorders, Disorders of micturition, Neoplasms of urinary tract	1

Suggested Books

- *Small Animal Internal Medicine*. 2013. Nelson RW and Couto, CG 5th edition, Elsevier Mosby, St. Louis Missouri
- *Text book of Veterinary Internal Medicine*. 2010. Ettinger and Feldman, 7th Edition, Saunders
- Research and Review Papers in Current Journals.

VMD 609: Dermatology and Endocrinology (1+0)

S. No.	Topics	No. of Lectures
1.	New trends in management of adrenal gland diseases in dogs and cats	1
2.	Hyperadrenocorticism (Pituitary pars intermedia dysfunction) in horses	1
3.	Primary hyperaldosteronism and pheochromocytoma in dogs and cats	1
4.	Advances in management of diabetes mellitus and diabetic ketoacidosis	1
5.	Equine metabolic syndrome/ Insulin resistance syndrome in horses	1
6.	Hypo and hyperthyroidism in dogs and cats	1
7.	Hypo and hypercalcemia in dogs and cats	1
8.	Hyposomatotropism and acromegaly in dogs	1
9.	Advances in management of diabetes Insipidus and polyuria/ polydipsia in Dogs and cats	1
10.	Advances in management of autoimmune disorders (different forms of pemphigus)	1
11.	Diagnosis, therapy and prevention of hypersensitivity disorders –Atopy, urticaria, milk allergy, vasculitis, contact dermatitis, culicoides hypersensitivity	1
12.	Diagnosis, therapy and prevention of bacterial skin dermatitis- dermatophyllus, folliculitis, staphylococcal cellulitis, equine corynebacterial dermatitis	1
13.	Diagnosis, therapy and prevention of fungal skin dermatitis- dermatophytosis, malassezzial dermatitis	1
14.	Diagnosis, therapy and prevention of parasitic skin dermatitis-mange, culicoides hypersensitivity, onchocerciasis, stephanofilaria, cutaneous hebronemiasis	1
15.	Diagnosis, therapy and prevention of viral diseases-warts, pox diseases	1
16.	Advanced diagnosis of skin tumors	1

Suggested Books

- *Clinical Endocrinology of companion animals*. 2013. Ed. J Rand 1st Edition ed. by Jacquie Rand (Editor), Ellen Behrend (Editor), Danielle Gunn-Moore (Editor) and Michelle Campbell-Ward (Editor). Wiley-Blackwell.
- *Muller and Kirk's Small Animal Dermatology*. 2013. 8th Edition. Edited by WH Miller, CE Griffin and KL Campbell. Elsevier, St Louis, MO, USA,
- *Equine dermatology*. 2011. 2nd Edition edited by Danny W Scott and William H. Miller, Jr 2nd edition. Elsevier, St Louis, MO, USA.
- Research and Review Papers in Current Journals.

VMD 610: Canine and Feline Eye and Ear Diseases (1+0)

S. No.	Topics	No. of Lectures
Advances in Examination, Diagnosis and Therapy of diseases of eye		
1.	Diseases of the eyelid and Conjunctiva	2
2.	Diseases of the cornea and sclera	1
3.	Disease of the lens, uvea: Glaucoma	2
4.	Disease of the retina, choroid, and optic nerve	2
5.	Disease of the Lacrimal apparatus	1
6.	Diseases of the the Orbit	1
7.	Neuro-ophthalmology	1
8.	Tumors of eye	1
Advances in Diagnosis and Therapy of diseases of ear		
1.	Otitis Externa	1
2.	Diseases of the external ear canal and pinna	1
3.	Otitis media and Otitis interna	2
4.	Tumors of ear	1

Suggested Books

- *Veterinary Ophthalmology*. 2013. Kirk N Gellat, Brian C Gilger and Thomas J Kern, 5th edition. Wiley Blackwell,
- *Saunders Manual of Small Animal Practice*. 2016. SJ Birchard and RG Sherding, WB Saunders Company
- Research and Review Papers in Current Journals.

VMD 611: Veterinary Diagnostics (0+2)

S. No.	Topics	No. of Practicals
Practical		
1.	(i) Endoscopic procedures in small animals (ii) Diagnostic aids and ancillary diagnostic tests in diseases of gastrointestinal system	2
2.	Endoscopic examination of URT in ruminants	1
3.	Endoscopic examination of URT in equines	1
4.	Tracheo-bronchial lavage in ruminants, horses and dogs	2
5.	Thoracocentesis in dogs, cattle/ buffalo and horses	2
6.	Electrocardiography in dogs and its interpretation/ Electrocardiographic diagnosis of arrhythmia in dogs	2
7.	Electrocardiography in diagnosis of arrhythmias in horses and dairy animals	1



S. No.	Topics	No. of Practicals
8.	Cerebrospinal fluid collection, examination and diagnosis and clinical case study (5 animals)	1
9.	Dermatological examination and case workup	1
10.	Biopsy collection techniques and its application on clinical cases	1
11.	Pericardiocentesis and drainage of effusions in large and small animals	1
12.	Neurological examination in small and large animals	2
13.	Techniques in ocular examination-cytology, ophthalmoscopy, measurement of intraocular pressure	2
14.	Bone marrow collection and its application in diagnosis in small and large animals	1
15.	Ultrasonography in various thoracic and abdominal affections in large animals	1
16.	Echocardiography in valvular and myocardial diseases in small animals	1
17.	Echocardiography in valvular and myocardial diseases in large animals	1
18.	Liver function tests and their interpretation with case studies	1
19.	Arterial blood collection and interpretation of acid base and blood gas analysis	1
20.	Concepts and diagnostic tests in veterinary infectious diseases Sampling techniques for collection of samples during research	2
21.	ELISA and its types, molecular techniques and types of PCR	1
22.	Molecular epidemiology tools including RFLP, etc.	2
23.	Molecular diagnostic techniques of fungal diseases, protozoan and rickettsial diseases	2

Suggested Books

- *Large Animal Internal Medicine*. 2019. Bradford Smith, David Van Metre and Nicola Pusterla, 6th Edition, Mosby
- *Small Animal Clinical Techniques*. 2010. Susan M Taylor, Saunders Elsevier
- *Handbook of Veterinary Neurology*. 2010. Michael D. Lorenz, Joan R. Coates and Marc Kent, 5th Edition, Saunders Elsevier.
- *Handbook of Equine Respiratory Endoscopy*. 2007. Safia Barakzai, 5th Edition, Saunders Elsevier.
- *Manual of Canine and Feline Cardiology*. 2008. Larry P Tilley, Francis WK Smith Jr., MA Oyama and MM Sleeper, 4th Edition, Saunders Elsevier.
- *Diagnostic Techniques in Equine Medicine: A Textbook for Students and Practitioners Describing Diagnostic Techniques Applicable to the Adult Horse*. 2009. Frank GR Taylor, Tim J Brazil and Mark H Hillyer, 2nd Edition, Saunders Elsevier.
- Research and Review Papers in Current Journals.

VMD 612: Metabolic and Nutritional Deficiency Diseases (2+0)

S. No.	Topics	No. of Lectures
1.	Strategies for transition cow health management	1
2.	Latest trends in prevention and management of parturient paresis with special reference to calcium cyclers and DCAD	1
3.	Current approach to diagnosis and management of downer's cow syndrome and acute hypokalemia in cow	1
4.	Lactation tetany and transit recumbency in mares	1
5.	Update on diagnosis and management of hypomagnesemic tetany in calves	1



S. No.	Topics	No. of Lectures
6.	Recent trends in diagnosis and management of ketosis in dairy animals with special reference towards blood metabolites and genomic tools	1
7.	Pregnancy toxemia in sheep and goats: current diagnosis and treatment strategies	1
8.	Biomarkers of fatty liver syndrome in dairy cattle: Latest diagnosis and treatment protocols	1
9.	Update on equine hyperlipidemia and steatitis	1
10.	Neonatal hypoglycemia: Recent trends in diagnosis and management	1
11.	Sub-acute ruminal acidosis (SARA) and low milk fat syndrome	1
12.	Nutritional/ parturient/ puerperal hemoglobinuria	1
13.	Recent trends in diagnosis and management of eclampsia in bitches	1
14.	Exertional myopathies in horse	1
15.	Nutritional secondary hyperparathyroidism (bighead; bran disease)	1
16.	Recent trends in mineral supplementation in livestock with special reference to chelated and non-chelated supplements	1
17.	Diseases due to trace elements deficiency in dairy cattle	1
18.	Oxidative stress during transition period: Role of various vitamins and minerals	1
19.	Recent trends in feeding strategies during transition period for prevention of vitamin and mineral deficiencies	1
20.	Update on importance of vitamin E and selenium in transition cows	1
21.	Disorders due to sodium and potassium deficiency	1
22.	Canine diabetes mellitus: Update on diagnosis and management	1
23.	Canine diabetes insipidus: Update on diagnosis and management	1
24.	Hypothyroidism in canine: Recent trends in diagnosis and management	1
25.	Obesity in pet animals: etio-pathogenesis, diagnosis and lifestyle management	1
26.	Diagnostic tools and treatment protocols for hypo and hyper adrenocorticism in dogs	1
27.	Recent trends in diagnosis, treatment and prevention of vitamin A deficiency diseases	1
28.	Diseases due to thiamine deficiency (PEM)	1
29.	Disorders due to vit K deficiency	1
30.	Approaches towards diagnosis, treatment and prevention of riboflavin (vit B2) deficiency in swine and poultry	1
31.	Update on diagnosis, treatment and prevention strategies for niacin deficiency in swine and poultry	1
32.	Diagnosis, management and prevention of Pantothenic acid deficiency in swine and poultry	1

Suggested Books

- *Veterinary Medicine*. 2006. OM Radostits, CC Gay, KW Hinchcliff and PC Constable, 10th Edition, Saunders.
- *Large Animal Internal Medicine*. 2019. Bradford Smith, David Van Metre and Nicola Pusterla, 6th Edition, Mosby
- *Textbook of Preventive Veterinary Medicine and Epidemiology*. 2010. RD Sharma, M Kumar and MC Sharma, ICAR- New Delhi.
- *Textbook of Veterinary Internal Medicine Expert Consult*. 2016. SJ Ettinger, EC Feldman and E Cote, 8th Edition, Saunders-Elsevier
- Research and Review Papers in Current Journals.

VMD 613: Emergency and Critical Care Medicine (1+1)

S. No.	Topics	No. of Lectures/ Practicals
Theory		
1.	Triage and stabilization of critical ill patient	1
2.	Newer therapeutic approach in management of a shock patient	2
3.	Advances in management of respiratory emergencies	2
4.	Gastrointestinal emergencies in small and large animals	2
5.	Management of metabolic emergencies (Addison's disease, Diabetic ketoacidosis, Eclampsia, etc.) in small animals	1
6.	Diagnosis and management of Cardiac arrhythmias	1
7.	Acute obstructive colic and its management	1
8.	Poisoning and toxocosis in animals and its management	2
9.	Urinary system emergencies	1
10.	Ocular emergencies	1
11.	Neurological emergencies	1
12.	Pain, assessment and its management	1
Practicals		
1.	Cardiopulmonary resuscitation (CPR) in dogs and monitoring of critical ill patient and oxygen therapy in dogs	1
2.	Gastrointestinal decompression in large and small animals	1
3.	Clinical approach to acute respiratory distress syndrome in small animals	1
4.	Trans-thoracic drainage of pleural effusions in large animals	1
5.	Trans-thoracic drainage of pericardial effusions in large and small animals	1
6.	Intra-osseous fluid administration in pups	1
7.	Procedures for gastrointestinal emergencies in small animals	1
8.	Procedures for gastrointestinal emergencies in large animals	1
9.	Blood component therapy in critical patients	1
10.	Endotracheal intubation in dogs	1
11.	Clinical examination and therapeutic management of status epilepticus in small animals	1
12.	Case Studies on GIT emergencies	1
13.	Case Studies on Respiratory emergencies	1
14.	Case Studies on Cardiac emergencies	1
15.	Case Studies on hematological emergencies	1
16.	Case Studies on metabolic emergencies	1

Suggested Books

- *Kirk and Bistner's Handbook of Veterinary Procedures and Emergency Treatment*. 2012. Richard B Ford and Elisa Mazzaferro, 9th Edition, Saunders Elsevier.
- *Blackwell's Five Minute Veterinary Consult Clinical Companion, Small Animal Emergency and Critical Care*. 2010. Mazzaferro ME. 1st Edition, (Wiley Blackwell)
- *Equine Emergencies Treatment and Procedures*. 2008. Orsini JA and Divers TJ, 3rd Edition, Saunders Elsevier.
- Research and Review Papers in Current Journals.

VMD 614: Emerging and Re-emerging Animal Diseases (2+0)

S. No.	Topics	No. of lectures
1.	Definitions and concepts of emerging, re-emerging, exotic, exzootic and endemic diseases	2



S. No.	Topics	No. of lectures
2.	General concepts of new animal diseases	1
3.	Conditions for emergence of new animal diseases	2
4.	General concepts for re-emergence of old animal diseases	1
5.	Conditions for re-emergence of old animal diseases	2
6.	Factors and determinants of emerging diseases	3
7.	Effect of climate change on emergence of diseases	2
8.	The role of wildlife in the emergence and re-emergence of animal diseases	2
9.	Microbial adaptation and change	2
10.	Epidemiological processes involved in the emergence of vector-borne diseases	2
Epidemiology of globally and nationally important emerging/ re-emerging diseases and designing of strategies for prevention and control of nationally important emerging/ re-emerging diseases		
11.	Tuberculosis	1
12.	Foot and mouth disease	1
13.	Hemorrhagic septicemia	1
14.	Bovine viral diarrhea	1
15.	Anthrax	1
16.	PPR	1
17.	Blue tongue	1
18.	Swine flu	1
19.	Swine fever	1
20.	Paratuberculosis	1
21.	Glanders	1
22.	Equine diseases manifested by nervous signs	1
23.	Equine infectious anemia and African horse sickness	1

Suggested Books

- *Veterinary Epidemiology*. 2018. Michael Thrusfield, Robert Christley. Wiley-Blackwell
- *Emerging Diseases of Animals*. 2000. Corrie Brown and Carole Bolin. ASM Press
- *Emerging and Re-emerging Infectious Diseases of Livestock*. 2017. Jagadeesh Bayry. Springer
- *Transboundary and Emerging Diseases of Animals*. 2016. Anna Rovid Spickler, James A Roth, Gayle Brown and Jane Galyon. Center for Food Security and Public Health
- Research and Review Papers in Current Journals.

VMD 615: Prevention and Control of Infectious Diseases of Ruminants (2+0)

S. No.	Topics	No. of Lectures
1.	Advances in principles of prevention and control of infectious diseases	1
2.	Anthrax as a biological weapon: strategies for its control in animals	1
3.	Screening and control of Brucellosis in organized dairy herds	1
4.	Diagnosis and management of Mastitis	1
5.	Pathogenesis and symptomatology of Clostridial diseases	2
6.	Pathogenesis and control of Colibacillosis	1
7.	Recent advances in diagnosis and control of Hemorrhagic septicemia	1
8.	Approaches in diagnosis of Tuberculosis	1
9.	Paratuberculosis: differential diagnosis and control	1
10.	Epidemiology, pathogenesis and diagnosis of Listeriosis	1
11.	Pathogenesis and control of Leptospirosis in animals	1



S. No.	Topics	No. of lectures
12.	Clinical presentation, differential diagnosis and treatment of Actinomycosis and Actinobacillosis	1
13.	Advancement in diagnosis and treatment of dermatophytosis and other fungal infections	1
14.	Differential diagnosis and control of campylobacteriosis	1
15.	Latest advancements in Salmonellosis	1
16.	Advancement in diagnosis and control of Mycoplasma infections	1
17.	Latest trends in diagnosis and treatment of anaplasmosis	1
18.	Latest trends in diagnosis and control of Blue tongue	1
19.	Recent advancement in management of sheep and goat pox	1
20.	Recent literature on diagnosis and control of Peste des petits ruminants	1
21.	Lessons to be learnt from eradication of Rinderpest	1
22.	Recent advances in Bovine viral diarrhea and malignant catarrhal fever	1
23.	Recent literature on Infectious bovine rhinotracheitis	1
24.	Recent studies on clinical symptomatology and diagnosis of ephemeral fever	1
25.	Advancements in diagnosis and control of Foot and mouth disease	1
26.	Recent approaches in diagnosis and control of Rabies	1
27.	Principles of control of parasitic diseases	1
28.	Recent trends in Clinical symptomatology, diagnosis and control of Amphistomosis and fascioliosis	1
29.	Recent approaches in control of major endoparasitic infestations	1
30.	Recent advancements in diagnosis and control of trypanosomosis	1
31.	Recent advancements in diagnosis and control of babesiosis and theileriosis	1

Suggested Books

- *Merck's Veterinary Manual K.* 2016. Susan E Aiello and Michael A Moses, 11th Edition, Merck Sharp and Dohme
- *Veterinary Medicine.* 2016. Peter Constable, Kenneth W Hinchcliff, Stanley Done and Walter Gruenberg, 11th Edition. Saunders Ltd.
- *Dairy Herd Health.* 2012. MJ Green and Andrew J Bradley. CABI Publishing
- Research and Review Papers in Current Journals.

Minor Courses for Ph.D. Degree programme

Courses of any one department/ discipline from the list given below:

- Veterinary Physiology
- Veterinary Microbiology
- Veterinary Parasitology
- Veterinary Pharmacology and Toxicology
- Veterinary Surgery and Radiology
- Veterinary Public Health and Epidemiology

Supporting Courses

It could be any subject considered relevant for student's research work. This will be decided by Advisor/ guide concerned.

ANNEXURE I

List of BSMA Committee Members for Veterinary Clinical Subjects

1. Animal Reproduction Gynaecology and Obstetrics
2. Veterinary Surgery and Radiology
3. Veterinary Medicine

Name	Address	Specialization
Dr Jit Singh Former Dean	Udaipur Veterinary College Flat No.310, Manglam Residency, Rose Block, New Navratan Complex, Bhuwana, Udaipur -313001	Chairman
Dr D.B. Patil Director Research and Dean PGS	Kamdhenu University Gandhinagar-382010, Gujarat	Convener
Dr J. K. Prasad Principal Scientist	Indian Veterinary Research Institute Division of Animal Reproduction, Gynaecology and Obstetrics, Izatnagar, Bareilly, (UP)-243122	Animal Reproduction Gynaecology and Obstetrics
Dr K.N. Aravinda Ghosh Former Professor and Head	College of Vety. and Animal Sciences Animal Reproduction Gynaecology and Obstetrics Department, Mannuthy, Kerala -680651	
Dr Naveen Kumar Principal Scientist	Indian Veterinary Research Institute Division of Veterinary Surgery Izatnagar, Bareilly- 243122 (UP)	Veterinary Surgery and Radiology
Dr Vinod Kumar Gupta Former Principal Scientist	Indian Veterinary Research Institute Division of Veterinary Medicine Izatnagar, Bareilly-243122 (UP)	Veterinary Medicine
Dr S. N. S. Randhawa Professor and Head	Khalsa College of Veterinary and Animal Sciences Ram Tirath Road, Amritsar Punjab-143002	

Veterinary Para-Clinical Subjects

- Veterinary Microbiology
- Veterinary Pathology
- Veterinary Parasitology
- Veterinary Public Health and Epidemiology
- Veterinary Pharmacology and Toxicology

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Acknowledgements

The Chairperson and Convener of BSMA for Veterinary Paraclinical disciplines, express their sincere thanks and gratitude to all the committee members, experts and other stake holders for their direct and indirect contribution in formulation and revision of course curriculum and syllabi. The permission, logistic support and local hospitality provided by the administration of ICAR – Indian Veterinary Research Institute, Izatnagar, CoVAS, CSK HPKV, Palampur, Himachal Pradesh and SKUAST, JAMMU, J&K is duly acknowledged. The BSMA committee also express their deepest sense of gratitude to the Education Division, Indian Council of Agricultural Research (ICAR), New Delhi for giving the opportunity to revise and update the syllabus.

Minimum Credit requirements:

Subject	Master's Programme	Doctoral Programme
i. Course work		
Major courses	20	12
Minor courses	08	06
Supporting courses	06	05
Common courses	05	–
ii. Seminar		
	01	02
iii. Thesis/ Research		
	30	75
Total	70	100

Major courses

From the Discipline in which a student takes admission. Among the listed courses, the core courses compulsorily to be taken is given *mark

Minor courses

From the subjects closely related to a student's major subject.

Supporting courses

The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her overall competence.

Common Courses

For Master's degree programme.

Course Code	Course Title	Credits
PGS 501	Library and Information Services	0+1
PGS 502	Technical writing and communication skills	0+1



Course Code	Course Title	Credit Hours
PGS 503	Intellectual Property and its management	1+0
PGS 504	Basic concepts in laboratory techniques	0+1
PGS 505	Agricultural research, research ethics and rural development programmes	1+0
*A student shall be required to register for all the 5 credit hours core courses		
*Mandatory Course for Doctoral Degree Programme.		
CPE-RPE	Research and Publication Ethics	2+0

Preamble

During the recent years, there has been appreciable advancement in Veterinary Sciences and livestock sector. In order to reduce animal sufferings, ensuring food security and human health, livestock rearing have been gradually changed from subsistence to commercial and organized system. Moreover, the futuristic requirement of the society for better animal health care, public health, food safety, environment, etc. have posed greater challenge for veterinary academicians, scientific community and service providers. Therefore, in tune with the change of development in science and technology, industrial and economic order, etc. needs to be considered for exposing the post graduate students while producing the skilled veterinarians with higher qualification and experiential training. The course curricula and syllabi of all the Veterinary Para-clinical disciplines have been reviewed and revised looking into the contemporary developments in the field of veterinary sciences and other related fields. Several new courses have been introduced as per need of the day along with revision of the contents of earlier courses. The implementations of the new and restructured course curricula is expected to build and improve knowledge, skill and competence of the students so as to enhance their employability and render efficient service to the society, farming community and the Livestock Industry.

Academicians and Researchers are being involved in devising means and methods of developing diagnostics against prevalent and emerging pathogens, prevention and control of animal diseases and zoonosis, monitoring and surveillance of disease of livestock and poultry, combating bio-terrorism, genetic engineering to optimize production and develop disease resistance breeds of animals. Bio-medical research, being heavily dependent upon animal experimentation, demands deeper scientific knowledge of veterinary science. The dominant forces shaping the Veterinary-business and Veterinary-education are global and virtual with a large number of specialists offering tele-veterinary services from off-shore locations like India. The ever changing and demanding public service sector has necessitated re-look into the veterinary higher education. At undergraduate level, veterinary students acquire comprehensive knowledge and skills in basic, para-clinical and clinical subjects required for performing multi-tasking role of a veterinarian. However, at post graduate level, in depth knowledge of theory, practical aspects and research methodology in each subject is of paramount importance. Detailed study of the course curricula and syllabi, being implemented by veterinary colleges in India, revealed that there was enormous heterogeneity in the course structure, nomenclature and contents. In view of the above, the task of formulating need based contemporary post graduate courses and syllabi for implementation of post graduate education uniformly at national level was essential.

Five BSMA committees, constituted by ICAR vide Office order No. F.No.7/ 6/2017-EQR Dated 4th April, 2018 for restructuring of Master's and Doctorate course curricula and syllabi, worked in unison to formulate common basic format. The BSMA committee for Veterinary Para-clinical Subjects (Microbiology, Pathology, Parasitology, Public Health and Epidemiology and Pharmacology and Toxicology) was constituted for developing uniform course curricula, syllabi and academic regulations in line with changing global scenario. The new and restructured Post-Graduate curricula and syllabi in respect of Veterinary

Para-Clinical subjects contain several innovative and practically applicable courses and extensively revamped course contents, viz., ultra-structural studies, molecular techniques in understanding the disease pathogenesis, diagnosis and monitoring surveillance. Veterinary Para-clinical subjects provide essential support by employing disease diagnostic technologies for prevention and control of animal diseases, maintenance of biodiversity, etc. New courses in Veterinary Microbiology, on Cytokines and Chemokines, Immunoregulations and Techniques in Molecular Microbiology, in Veterinary Pathology, courses on Molecular and Ultra structural bases of cell injury, molecular bases of inflammation and pathology of laboratory animal diseases, in Veterinary Parasitology, courses on Biology and Ecology of Parasites, Molecular Veterinary Parasitology and Immunology of Parasitic Diseases, in Veterinary Public Health and Epidemiology, courses on Ecology and Animal/ Human Health, Surveys, Surveillance and Data Management, risk analysis and predictive modeling, Food Safety Standards and Regulations have been included, in Veterinary Pharmacology and Toxicology, courses on Bio-transformation of Xenobiotics, Molecular Pharmacology, Fundamentals of Pharmacokinetics. The contents of most of the courses have been revised and updated to include the latest developments. The learning of research methodology, scientific thinking, planning and experimentation and special problems has been introduced in all the subjects.

The implementations of the new and restructured post graduate course curricula is expected to build knowledge and skill of the students so as to enhance their employability and marketability as multi-service providers with practical skills and comprehensive knowledge of the entire subject area after Masters. The Doctorates should in turn prove as specialists, in their respective disciplines. The valuable inputs received from the stake holders', viz., eminent academicians, scientists, extension workers, leading veterinary practitioners, state animal husbandry department, etc. have immensely helped in preparation of this document.

Major changes made in the revised syllabi including addition of New Courses and updation of contents:

Veterinary Microbiology (VMC)

Masters Degree Programme

- VMC 501 : General Bacteriology (2+1), course name changed (Bacteriology – I) credit hour decreased and course contents updated.
- VMC 502 : Systematic Veterinary Bacteriology (2+1), course name changed (Bacteriology – II) with change in course contents.
- VMC 503 : General Virology (2+1), course number changed
- VMC 504 : Systematic Veterinary Virology (2+1), course number changed, 01 credit hour decreased with changes in course contents.
- VMC 505 : Principles of Veterinary Immunology (2+1), course number and name changed with changes in course contents.
- VMC 506 : Veterinary Mycology (1+1), course number and contents changed.
- VMC 507 : Vaccinology (2+0), course contents revised and updated.
- VMC 508 : Techniques In Microbiology (0+2), New course.
- VMC 509 : Techniques In Molecular Microbiology (1+2), New course.
- VMC 510 : Molecular Immunology (1+1), New course.
- VMC 511 : Mucosal Immunology (1+0), New course.
- VMC 512 : Introduction to Microbial Bioinformatics (1+0), New course



Doctoral Degree Programme

- VMC 601 : Advances in Veterinary Bacteriology (2+1), course contents revised and updated.
- VMC 602 : Advances in Veterinary Mycology (2+1), course contents revised and updated.
- VMC 603 : Bacterial Genetics (2+0), 01 credit hour (P) decreased with change in course contents.
- VMC 604 : Microbial Toxins (2+1), course contents revised and updated.
- VMC 605 : Bacterial Pathogenesis (2+0), course name changed (Molecular determinants of Bacterial Pathogenesis), 01 credit hour (P) decreased.
- VMC 606 : Advances in Veterinary Virology (2+1), course name changed (Advances in Virology), change in course contents.
- VMC 607 : Molecular Viral Pathogenesis (2+1), course name changed (Molecular and Genetic aspects of Viral Pathogenesis), change in course contents.
- VMC 608 : Structure Function Relationship of DNA and RNA Viruses (2+0), 01 credit hour (T) decreased.
- VMC 610 : Slow Viral Infections and Prions (1+0), 01 credit hour (T) decreased.
- VMC 611 : Advances in Veterinary Immunology (2+1), course name changed (Molecular Immunology), changes in course contents.
- VMC 612 : Cytokines and Chemokines (2+ 0), New course
- VMC 613 : Immunoregulation (1+0), New course
- VMC 614 : Advances in Vaccinology (2+0), Course contents revised and updated.
- VMC 615 : Current Topics in Infection and Immunity (2+0), 01 credit hour (T) decreased.

Veterinary Pathology (VPL)

Masters Degree Programme

- VPL 503 : Animal Oncology (1+1), course contents revised and updated.
- VPL 505 : Necropsy Procedures and Interpretations (1+1), 02 courses VPL (VPL – 605, 606) have been merged and course contents revised.
- VPL 506 : Necropsy Conference (0+1), New Course
- VPL 508 : Pathology of Infectious Diseases of Domestic Animals (2+1), course contents updated.
- VPL 509 : Toxicopathology (2+1), course contents revised.
- VPL 510 : Avian Pathology (2+1), course contents updated.
- VPL 511 : Pathology of Wild/ Zoo and Aquatic Animal Diseases (2+1), course reframed, Wild/ Zoo/ Fish diseases included.
- VPL 512 : Pathology of Laboratory Animal Diseases (2+1). New course

Doctoral Degree Programme

- VPL 601 : Molecular and Ultrastructural Basis of Cell Injury (2+1), New course with the merging of contents of molecular pathology of cell injury.
- VPL 602 : Molecular Basis of Inflammation (1+1), New course
- VPL 603 : Molecular Basis of Neoplasia (1+1), New course
- VPL 605 : Advances in Diagnostic Pathology (1+2), course contents revised and updated.
- VPL 607 : Pathology of Important Emerging and Re-emerging Diseases of Pets and Livestock (2+1). Course contents revised and updated.
- VPL 608 : Research Methodology in Pathology (1+0), New course

**Veterinary Parasitology (VPA)****Masters Degree Programme**

- VPA 501 : Platyhelminthes – I (1+1), Name and contents of old VPA-601 (2+1) changed.
- VPA 502 : Platyhelminthes – II (1+1), Name and contents of old VPA-601 (2+1) changed.
- VPA 503 : Nematyhelminthes and Acanthocephala (2+1), Name of old VPA 602 changed.
- VPA 504 : Arthropod Parasites (2+1), Name and contents of old VPA 603 revised and updated.
- VPA 505 : Parasitic Protozoa (2+1), old VPA 604, course contents revised and updated.
- VPA 506 : Diagnostic Parasitology (0+2), Name and contents of old VPA 605 changed and updated.
- VPA 507 : Clinical Parasitology (1+1), Name and contents of old VPA 606 changed.
- VPA 508 : Management of Parasitic Diseases (1+1), old VPA 607 with revised and updated contents.
- VPA 509 : Immunoparasitology (2+1), old VPA 608 with revised and updated course contents.
- VPA 510 : Parasitic Zoonoses (2+0), old VPA 609.
- VPA 511 : Parasites of Wildlife (1+1), old VPA 610 with change in course title.

Doctoral Degree Programme

- VPA 601 : Advances In Helminthology – I (2+1), old VPA 705 with revised and updated contents.
- VPA 602 : Advances In Helminthology – II (2+1), old VPA 706 with revised and updated contents.
- VPA 603 : Advances in Entomology and Acarology (2+1), old VPA 707 with revised and updated contents.
- VPA 604 : Advances in Protozoology (2+1), course contents revised and updated.
- VPA 605 : Immunology of Parasitic Diseases (1+2), New course.
- VPA 606 : Molecular Diagnostics and Vaccine Development in Parasitology (2+1), old VPA 702 with revised and updated course contents.
- VPA 607 : Host Parasite Interactions (2+0), old VPA 703 with revised and updated course contents.
- VPA 608 : *In-vitro* cultivation of parasites (1+2), New Course.
- VPA 609 : Emerging and Re-emerging Parasitic Diseases (2+0), No change.
- VPA 610 : Biology and Ecology of Parasites (3+0), New course including old VPA 701, 710 and 711 with revised and updated course contents.
- VPA 611 : Molecular Veterinary Parasitology (2+0), New course.
- VPA 612 : Parasite Epidemiology (2+0), New course.

Veterinary Public Health and Epidemiology (VPE)**Masters Degree Programme**

- VPE 501 : Concepts in Veterinary Public Health and One Health (2+0), title modified with updated contents.
- VPE 502 : Zoonoses – I (2+1), title modified with updated contents.



- VPE 503 : Zoonoses – II (2+1), title modified with updated contents.
- VPE 504 : Principles of Epidemiology (2+1), New course.
- VPE 505 : Hygiene and Safety of Foods of Animal and Aquatic Origin (2+1), two courses merged (milk and meat hygiene, Fish/ Fish product).
- VPE 506 : Food-borne Infections and Intoxications (2+1), course contents revised and updated.
- VPE 507 : Food Safety Standards, and Regulations (2+1), New course.
- VPE 508 : Environmental Hygiene and Safety (2+1), title modified with updated contents. 01 credit hour reduced.
- VPE 509 : Applied Epidemiology (2+1). New course.
- VPE 510 : Bio-security, Bioterrorism and Disaster Management (2+0), title modified with updated contents.
- VPE 511 : Laboratory Techniques in Veterinary Public Health (0+3), New course.

Doctoral Degree Programme

- VPE 601 : Advances in Veterinary Public Health and Epidemiology (2+1), course contents revised and updated.
- VPE 602 : Emerging, Re-emerging Zoonoses and One Health (2+1), course contents revised and updated.
- VPE 603 : Advances in Food Safety and Quality Control of Foods of Animal Aquatic origin (2+1), course contents revised and updated.
- VPE 604 : Bio-security and Occupational Health Safety (2+1), course contents revised and updated.
- VPE 605 : Recent Concepts in Epidemiology and Disease Forecasting (2+1), New course.
- VPE 606 : Risk Analysis and Predictive Modelling (2+1), New course.
- VPE 607 : Advances in Environmental Hygiene (2+1), course contents revised and updated.
- VPE 608 : Herd Health Management and Disease Economics (2+1), New course.
- VPE 609 : Epidemiology of Trans-boundary, Non-infectious and Chronic diseases (2+1), New course.
- VPE 610 : Ecology and Animal/ Human Health (2+0), New course.
- VPE 611 : Diagnostic Approaches in Epidemiology (2+1), New course.
- VPE 612 : Surveys, Surveillance and Data Management (2+1), New course.

Veterinary Pharmacology and Toxicology (VPT):

Masters Degree Programme

- VPT 501 : Concept of Pharmacology, Drug, Design and Development (2+0), course title changed with revised and updated course contents of General Pharmacology.
- VPT 504 : Digestive and Respiratory Pharmacology (2+1), one practical credit hour added.
- VPT 506 : Endocrine and Reproductive Pharmacology (2+1), one practical credit hour added.
- VPT 509 : Toxinology (2+1), course title changed and 01 practical credit hour added (Toxicology of plant and Toxins).
- VPT 510 : Pharmacological Technique (0+2), one theory credit hour converted to practical.



- VPT 511 : Techniques in Toxicology (0+2), one theory credit hour converted to practical.
- VPT 512 : Ethnopharmacology (1+1), one theory credit hour converted to practical.
- VPT 513 : Fundamental of Pharmacokinetics (1+1), New Course

Doctoral Degree Programme

- VPT 601 : Molecular Pharmacology (3+0), course contents of Advances in Neuropharmacology and Molecular Pharmacology merged.
- VPT 602 : Advances in Autacoid Pharmacology (1+0), course title changed.
- VPT 604 : Biotransformation of Xenobiotics (2+0), course title changed (Drug metabolism).
- VPT 605 : Clinical Pharmacology and Pharmacokinetics (2+1), clinical pharmacology and Pharmacokinetics have been merged.
- VPT 606 : Pharmacogenomics (2+0), course number changed with revised and updated course contents.
- VPT 607 : Immunopharmacology and Immunotoxicology (2+0), course number changed and 01 theory credit hour increased and course title changed to include immunotoxicology.
- VPT 608 : Molecular toxicology (3+0), course number changed and 01 theory credit hour increased.
- VPT 609 : Clinical Toxicology (2+1), course number and course title changed (Clinical Toxicology).
- VPT 610 : Ecotoxicology (3+0), course number changed and 01 theory credit hour increased.
- VPT 611 : Regulatory Toxicology (2+1), course number changed.

Suggested list of specified minor and supporting subjects

Veterinary Microbiology (VMC): Animal/ Veterinary Biotechnology, Veterinary Biochemistry, Veterinary Pathology, Veterinary Public Health and Epidemiology, Animal Genetics or any other discipline as per the requirement of the research problem of the student.

Veterinary Pathology (VPL): Veterinary Microbiology, Animal/ Veterinary Biotechnology, Veterinary Biochemistry, Veterinary Medicine, Veterinary Parasitology, Veterinary Public Health and Epidemiology, Veterinary Pharmacology and Toxicology or any other discipline as per the requirement of the research problem of the student.

Veterinary Parasitology (VPA): Veterinary Microbiology, Animal/ Veterinary Biotechnology, Veterinary Biochemistry, Veterinary Medicine, Veterinary Pathology, Veterinary Public Health and Epidemiology, Veterinary Pharmacology and Toxicology or any other discipline as per the requirement of the research problem of the student.

Veterinary Public Health and Epidemiology (VPE): Veterinary Microbiology, Animal/ Veterinary Biotechnology, Veterinary Medicine, Veterinary Parasitology, Veterinary Pathology, Veterinary Pharmacology and Toxicology, Statistics or any other discipline as per the requirement of the research problem of the student.

Veterinary Pharmacology and Toxicology (VPT): Veterinary Biochemistry; Animal/ Veterinary Biotechnology; Veterinary Physiology; Veterinary Microbiology; Veterinary Pathology; Veterinary Medicine; Veterinary Public Health and Epidemiology or any other discipline as per the requirement of the research problem of the student.

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Veterinary Para-Clinical Subjects

– Veterinary Microbiology



Course Title with Credit Load M.V.Sc. in Veterinary Microbiology

Course Code	Course Title	Credit Hours
VMC 501	General Bacteriology*	2+1
VMC 502	Systematic Veterinary Bacteriology	2+1
VMC 503	General Virology*	2+1
VMC 504	Systematic Veterinary Virology	2+1
VMC 505	Principles of Veterinary Immunology*	2+1
VMC 506	Veterinary Mycology*	1+1
VMC 507	Vaccinology	2+0
VMC 508	Techniques in Microbiology	0+2
VMC 509	Techniques in Molecular Microbiology	1+2
VMC 510	Molecular Immunology	1+1
VMC 511	Mucosal Immunology	1+0
VMC 512	Introduction to Microbial Bio-informatics	1+0
VMC 591	Master's Seminar*	1+0
VMC 599	Master's Research	0+30

*Core Courses



Course Contents

M.V.Sc. in Veterinary Microbiology

- I. Course Title** : General Bacteriology
II. Course Code : VMC 501
III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge of general bacteriology.

V. Theory

Unit I

Historical events of microbiology, Taxonomy and nomenclature of bacteria. Basic principles of microscopy and micrometry, Classical, Confocal, Nomarski and electron microscopy. Staining of bacteria, Structure and function of bacterial cell. Growth, Nutrition, Metabolism, Secretion and excretion systems of bacteria. General principles of bacterial disease diagnosis.

Unit II

Bacterial genetics, Bacterial variation, Horizontal genetic transfer mechanisms (transformation, transduction and conjugation), Plasmids, Transposons and drug resistance.

Unit III

Determinants of pathogenicity and its molecular basis, Markers and PAMPs, exotoxin and endotoxin.

Bacteriophages: temperate and virulent phages; lysogeny and lysogenic conversion. Antimicrobial agents and disinfectants: Mechanism of action, Resistance and susceptibility testing. Bacterial immunity.

VI. Practical

Orientation to a bacteriology laboratory, Sterilization and disinfection techniques, Laboratory biosafety and biosecurity. Cultivation of aerobic, Microaerophilic and anaerobic bacteria, Isolation of bacteria in pure culture, Microscopy, Morphological characterization of bacteria, Different staining methods and biochemical tests for identification of bacteria, Determination of bacterial number and biomass and standard protocols for antibiotic sensitivity test and detection of MIC.

- I. Course Title** : Systematic Veterinary Bacteriology
II. Course Code : VMC 502
III. Credit Hours : 2+1

IV. Aim of the course

To learn different aspects with regards to the virulence factors, Antigenic and structural components, Epidemiology, Pathogenesis, Diagnosis and control of important aerobic, Microaerophilic and anaerobic pathogenic bacteria causing



diseases in animals and disease status in India.

V. Theory

Unit I

Systematic study of following groups of bacteria:

Spirochetes: *Leptospira*, *Brachyspira* and *Borrelia*.

Gram-negative

- Aerobic/ Microaerophillic, motile helical/ vibrioid: *Campylobacter*;
- Aerobic/ Microaerophillic rods/ cocci: *Bordetella*, *Brucella*, *Moraxella*, *Pseudomonas* and *Burkholderia*;
- Facultative anaerobic Gram-negative rods: members of *Enterobacteriaceae*, *Pasteurella*, *Mannheimia* and *Haemophilus*;
- Anaerobic, straight, curved and helical rods: *Dichelobacter* and *Fusobacterium*

Unit II

Rickettsia and Chlamydia: *Rickettsia*, *Chlamydia* (*Chlamydophila*) and *Coxiella*.

Gram-positive

- Gram-positive cocci: *Staphylococcus* and *Streptococcus* including *Enterococcus*.
- Endospore-forming rods: *Bacillus* and *Clostridium*.
- Regular non-spore forming rods: *Erysipelothrix* and *Listeria*
- Irregular non-spore forming rods: *Actinomyces*, *Corynebacterium* and *Truepurella*.

Unit III

- Mycobacteria: *Mycobacterium*; *Actinomycetes*: *Nocardia* and *Rhodococcus*, *Dermatophilus*.
- Mollicutes: *Mycoplasma*.

Unit IV

- Emerging and transboundary bacterial pathogens.

VI. Practical

Collection, transport and dispatch of clinical samples from various disease conditions. Isolation of bacteria in pure cultures from different clinical samples. Identification of the bacteria using staining, biochemical tests and other molecular techniques. Preservation and storage of bacterial cultures.

I. Course Title : General Virology

II. Course Code : VMC 503

III. Credit Hours : 2+1

IV. Aim of the course

To study general aspects of viral structure, classification, replication, interactions and immunity against viruses.

V. Theory

Unit I

History of virology, Origin and nature of viruses, Morphological structure and chemical composition of viruses, Nomenclature and classification of viruses, Cultivation and purification of viruses, Laboratory diagnosis of viral infections, Viroid and Prions.

**Unit II**

Replication of DNA and RNA viruses, genetic and non-genetic interactions between viruses.

Unit III

Virus-cell interactions, viral pathogenesis, viral persistence, oncogenic, oncolytic viruses and epidemiology of viral infections.

Unit IV

Immune response to viruses, viral vaccines, viral chemotherapy.

VI. Practical

Orientation to a virology laboratory, Preparation of glassware, Plasticware, Media and reagents for cell culture and other items required for virus cultivation. Protocols for primary and secondary cell cultures, Maintenance of cell lines, Cryopreservation of cells and their revival. Staining of virus infected cultured cells and demonstration of inclusion bodies. Viable cell counting. Cultivation of viruses in embryonated chicken eggs and cell cultures.

I. Course Title : Systematic Veterinary Virology

II. Course Code : VMC 504

III. Credit Hours : 2+1

IV. Aim of the course

To study viral properties, epidemiology, pathogenesis and disease status in India, diagnosis, immunity and control of diseases caused by viruses belonging to different families of animal viruses.

V. Theory**Unit I: Double and Single stranded DNA virus families**

Poxviridae, Asfarviridae, Herpesviridae, Adenoviridae, Papillomaviridae, Polyomaviridae, Parvoviridae, Circoviridae and Hepdnaviridae.

Unit II: Single stranded Negative sense and Double stranded RNA viruses

Orthomyxoviridae, Paramyxoviridae, Rhabdoviridae, Bornaviridae, Reoviridae and Birnaviridae.

Unit III: Single stranded Positive sense RNA viruses

Picornaviridae, Caliciviridae, Togaviridae, Flaviviridae, Coronaviridae, Arteriviridae, Astroviridae and Retroviridae.

Unit IV: Prions

BSE, Scrapie and introduction to virioids.

Unit V

Emerging, re-emerging and transboundary viral pathogens

VI. Practical

Collection, Preservation, Transportation of clinical samples and their processing for virus isolation and identification. Isolation and cultivation of viruses from clinical samples, using different methods and its plaque purification. Titration of viruses for 50% end points using different methods, Serum neutralization test.



Electrophoretotyping. Concentration and purification of viruses by chemical agents, differential centrifugation, density gradient centrifugation and ultra-filtration. Methods for preservation of animal viruses.

- I. Course Title** : Principles of Veterinary Immunology
II. Course Code : VMC 505
III. Credit Hours : 2+1

IV. Aim of the course

To understand the fundamental principles of veterinary immunology and its applications.

V. Theory

Unit I

Introduction to livestock and poultry immune system: ontogeny and phylogeny of vertebrate immune system, cells and organs of immune system. Types of immunity: Innate and adaptive immune system.

Unit II: Antigen and its characteristics

Characteristic of ideal antigen; Classification of antigens, Factors affecting immunogenicity, Concept of hapten and carrier. Antigenic determinant/ epitope and cross reactivity. B-cell epitope and T cell epitope. Immunoglobulins: Basic structure and function of immunoglobulins, Immunoglobulin diversity and immunoglobulin classes.

Antigen recognition by B cell and T cell: B cell receptor, T cell receptor, receptor diversity, B cell and T cell activation.

Unit III: Major Histocompatibility Complex

General feature, structure, function, gene organization, MHC and immune response. Immune-response development: Phases of humoral and cell mediated immune response. Immunoregulation with B and T cells: Antigen recognition, antigen presentation and processing, antigen recognition by TCR, MHC restriction, Cytokines and chemokines. Cell mediated immune response: General properties of effector T cells, cytotoxic T cells, NK-cells and ADCC. Role of integrin and selectin.

Unit IV: Complement System

Basic concept of complement, mechanism of complement activation, complement pathways and Complement deficiencies. Autoimmunity and autoimmune diseases, immunological tolerance and hypersensitivity: classification, mechanism of induction with examples.

Immunodeficiency: Types with examples. Immune response in foetus and new born.

Unit V: Antigen antibody interaction

Antibody affinity, avidity, cross reactivity, precipitation and agglutination test, radio-immunoprecipitation assay (RIPA), ELISA, Western blotting, Immunodiagnosics and Immunotherapy. Monoclonal antibodies and methods for production and characterization of monoclonal antibodies.

VI. Practical

Preparation of antigens, raising of antisera against soluble and insoluble antigens.



Detection of antibody by gel diffusion, radial immunodiffusion, immune-electrophoresis techniques. Haemagglutination and haemagglutination inhibition test, ELISA and its modifications. Immunoblotting. Agglutination tests. Separation and purification of Immunoglobulin from serum. Separation of mononuclear cells from blood by density gradient centrifugation, viable count of lymphocyte by dye exclusion method. Measurement of T cell response (DTH, lymphoproliferative assay).

- I. Course Title** : **Veterinary Mycology**
II. Course Code : **VMC 506**
III. Credit Hours : **1+1**

IV. Aim of the course

To learn detailed morphological, cultural features, virulence factors, antigenic and structural components, epidemiology, pathogenesis, diagnosis and control of fungal infections.

V. Theory

Unit I

History of mycology, Glossary of mycological terms; Morphology of fungi: structure and ultra-structure, differentiation, nutrition, physiology, reproduction, spores, cultural characters and classification of fungi of veterinary importance. Fungal immunity. Antifungal agents and important techniques in diagnosis of fungal infections.

Unit II: Systematic study of animal mycoses:

Aspergillosis, Candidiasis, Cryptococcosis, Epizootic lymphangitis, Rhinosporodiosis, Zygomycosis, Blastomycosis, Sporotrichosis, Histoplasmosis, Coccidioidomycosis, Mycetomas, Dermatophytoses, Dermatomycosis, Mycotoxicosis, Malassezia infections, Mycotic abortion, Mycotic mastitis, and Emerging mycoses.

VI. Practical

Collection and processing of clinical material for isolation of fungi. Microscopy of fungi: Lactophenol cotton blue and India ink preparations. Preparation of basal and special fungal media of veterinary importance. Slide culture and cellophane tape technique for fungi. Diagnosis of dermatophytes. Biosafety precautions in handling yeast and dimorphic fungi. Study of gross and microscopic characters of pathogenic fungi, antifungal sensitivity testing, detection of mycotoxin. Serological and molecular diagnosis in fungi.

- I. Course Title** : **Vaccinology**
II. Course Code : **VMC 507**
III. Credit Hours : **2+0**

IV. Aim of the course

To understand different aspects of vaccines, their production, standardization and quality control of various vaccine used in animals.

Unit I

Types of vaccines and vaccine components, factors influencing choice of vaccines. **New generation vaccines:** subunit vaccines, peptide vaccines, recombinant



vaccines, reverse genetics vaccines, Marker and DIVA enabled vaccines and transmission blocking vaccines.

Unit II: Preparation of vaccines

Identification of candidate strain, identification of epitopes, seed and challenge strain maintenance. Classical methods of exaltation and attenuation of pathogens and their molecular basis. Technology of production of different types of vaccines. Multicomponent vaccines. Recent advances in vaccine delivery systems. Advances in vaccines adjuvants with their classification and mode of action.

Unit III

Standardization of veterinary vaccines as per National and Global standards. Laws and regulatory requirements about veterinary biological and Indian pharmacopoeia.

Unit IV

Vaccine failure and post vaccinal reactions. Factors affecting response to vaccines: maintenance of vaccines and cold chain. Quality control. Principles of development of vaccination schedule, methods of conducting vaccine trials (lab to field use) and pharmaco-vigilance. Scaling up methods of vaccine production.

I. Course Title : Techniques in Microbiology

II. Course Code : VMC 508

III. Credit Hours : 0+2

(Course to be offered to the students not majoring in Veterinary Microbiology)

IV. Aim of the course

To give overview of the techniques used in microbiology.

V. Practical

Unit I

Orientation to a microbiology laboratory. Different sterilization and disinfection techniques. Laboratory biosafety and biosecurity. Microscopy, media preparation, isolation, cultivation and purification of bacteria and fungi and their morphological and biochemical characterization. Antibacterial sensitivity test by Disc diffusion, broth dilution and MIC determination technique.

Unit II

Cultivation of viruses in embryonated eggs and cell culture. Virus Neutralization test.

Unit III

Different immunological techniques: Agglutination, precipitation, ELISA, Haemagglutination and Haemagglutination Inhibition and other immunological assays.

I. Course Title : Techniques in Molecular Microbiology

II. Course Code : VMC 509

III. Credit Hours : 1+2

IV. Aim of the course

To provide training in molecular biology and other diagnostic techniques used in microbiology.



V. Theory

Unit I

Basic requirements for establishing molecular diagnostics Laboratory. Principles of molecular diagnostic tests. Methods of nucleic acid extraction from pathogenic microorganisms.

Unit II

PCR, and variants of PCR. Principles of primer designing. Gel electrophoresis methods and blotting techniques: Southern blotting, northern blotting, western blotting, dot-blot. Microarrays, nucleic acid sequencing methods. Sequence analysis-sequence editing, sequence alignment, sequence comparison and phylogenetic analysis. Gene cloning and expression. Molecular diagnosis as epidemiological tool. Development and validation of diagnostic tests.

VI. Practical

Unit I

Orientation of molecular diagnosis laboratory: especially RNA and diagnostic PCR laboratory (handling RNA and DNA). Extraction of nucleic acid from different microbes: Gram positive bacteria, Gram negative bacteria, DNA viruses, RNA Viruses and fungi, DNA and RNA isolation from cell culture and blood and isolation of plasmids. Quality and quantity check of nucleic acids.

Unit II

Principles for Primer designing. Procedure for molecular diagnostic tests like PCR, RT-PCR and LAMP. Absolute and relative quantitation of DNA/ RNA using Q-PCR. SDS PAGE of proteins and RNA, study of nucleic acid and proteins by blotting techniques. Restriction Enzyme digestion Techniques and RFLP; PCR product concentration and purification for sequencing. Nucleic acid sequence analysis. Gene Cloning, expression and purification of expression products. An introduction to high throughput sequencing and MALDI-TOF.

I. Course Title : Molecular Immunology

II. Course Code : VMC 510

III. Credit Hours : 1+1

IV. Aim of the course

To learn about molecular aspects of immunology.

V. Theory

Unit I

Molecular Structure and function of PRRs. Ligands of PRRs, signal transduction through PRRs and inflammasome. Cytokines, Lymphocyte markers and CD nomenclature.

Unit II

Molecular structure of Immunoglobulin and class, Isotypes, Synthesis and expression of immunoglobulin, Rearrangement and its organization, Immunoglobulin gene diversity and mechanism of recombination of B cell gene. Theory of antibody



generation. Signature molecules of T cell and T regulatory cell. T cell receptor and T cell gene diversity.

Unit III

MHC structure, Genomic organization of the MHC gene haplotype. Concept of congenic and syngeneic, concept of polymorphism of MHC gene, pathway of signal transduction, role of co-stimulators in B cell and T cell activation and recruitment of adaptor proteins. Molecular mechanisms (events) of cell cytotoxicity.

VI. Practical

Isolation and purification of mammalian and avian immunoglobulin by precipitation technique: Caprylic acid, PEG, Ammonium Sulphate, Sodium Sulphate. Separation of immunoglobulins by size, charge and ligand affinity: size exclusion chromatography (gel filtration on Sephadex G200), ion exchange chromatography, affinity chromatography (Protein-A-Sepharose). Immuno-electrophoresis Technique: polyacrylamide gel electrophoresis innative and reducing conditions, fixed and gradient gel, Western blot, Crossed immune-electrophoresis. Chemiluminescence assay and Cell cytotoxicity assays; Non-radioactive methods like LDH release assay. Antigen detection by Immuno PCR. Haplotype matching between individuals, Flow cytometry for CD4 and CD8 ratio determination and other applications. ELISpot test for cytokine assay.

I. Course Title : Mucosal Immunology

II. Course Code : VMC 511

III. Credit Hours : 1+0

IV. Aim of the course

To learn about mucosal immunity.

V. Theory

Unit I: Innate Mechanisms

Mucosal barrier: Development and physiology of mucosal defense. Cells and lymphoid tissues of mucosal immune system: MALT, GALT, NALT and BALT. Innate immune response at mucosal surfaces: mucus, antimicrobial peptides, role of PPRs, intestinal Dendritic cell, intestinal macrophage, mucosal inductive and effector sites. Antigen uptake and presentation at mucosal sites, transepithelial transport of antigen.

Unit II: Acquired response

Mucosal Immunoglobulin, IgA synthesis and transport to intestinal lumen. Description and role of Paneth cell and crypto patches. M-cells and their functions. Mucosal immune effector mechanisms including secretory IgA response. Extrathymic T cell development in mucosal tissues and their phenotypes and functions.

Unit III: Applications

Importance and limitations of mucosal immunization. Mucosal adjuvants and delivery systems. Oral tolerance mechanistic approach. Immunopathology at mucosal surfaces: Celiac disease, Inflammatory bowel disease, Jhone's disease; Assessment of mucosal immune response and potency testing.



- I. Course Title** : **Introduction to Microbial Bioinformatics**
II. Course Code : **VMC 512**
III. Credit Hours : **1+0**

(Relevant practical demonstrations be given along with theory topic)

IV. Aim of the courses

To learn about key bioinformatics techniques, tools and databases.

V. Theory

Unit I

Introduction to Bioinformatics; History, Scope and Application, Internet and world wide web. Bioinformatics resources and information retrieval system. Nucleic acid sequence databases, Genome databases, Protein sequence databases, Metabolic pathways databases, NCBI, ExPASy and Ensembl Genome browser.

Unit II

Sequence comparison and alignment methods; Introduction to sequence alignment, principal methods of pairwise sequence alignment and Dot plot analysis. Significance of BLAST and FASTA programs in DNA and protein sequence analysis, variants of BLAST and FASTA programs. Introduction to multiple sequence alignment and Phylogenetic analysis to retrieve evolutionary information, Global multiple sequence alignment tool- CLUSTAL-W.

Unit III

Overview of protein structure and databases, Structure based protein classification, Protein structure database (CASP), Protein structure alignment tools (VAST, DALI), Protein 3-D structure visualization and modeling using SWISS PROT.

Course Outline-cum-Lecture Schedule for Master degree Programme

VMC 501: General Bacteriology (2+1)

S.No.	Topic of Syllabus	Lecture/ Practical
Theory		
1.	Historical events of Microbiology	2
2.	Taxonomy and nomenclature of bacteria	1
3.	Basic principle of microscopy and micrometry	1
4.	Classical, Confocal, Nomaraski and Electron Microscopy	2
5.	Staining of bacteria	1
6.	Structure and function of bacterial cell	3
7.	Bacterial growth, nutrition and metabolism	3
8.	Secretion and excretion systems of bacteria	2
9.	General Principles of bacterial disease diagnosis	2
10.	Bacterial genetics and Bacterial variation	1
11.	Horizontal genetic transfer mechanisms- transformation, transduction and conjugation	1
12.	Plasmids, transposons and drug resistance	1
13.	Determinants of pathogenicity and its molecular basis	2
14.	Markers and PAMPs, exotoxin and endotoxin	1
15.	Bacteriophages- temperate and virulent phages, lysogeny and lysogenic conversion	2
16.	Antimicrobial agents	2
17.	Disinfectants -Mechanism of action	2
18.	Disinfectants -resistance and susceptibility testing	1
19.	Bacterial immunity	2
	Total	32
Practical		
1.	Orientation to a bacteriology laboratory	1
2.	Different sterilization and disinfection techniques	2
3.	Laboratory biosafety and biosecurity	1
4.	Cultivation of aerobic, microaerophilic and anaerobic Bacteria using bacteriological media	2
5.	Isolation of bacteria in pure culture	2
6.	Microscopy	1
7.	Morphological characterization of bacteria by different staining methods	2
8.	Important biochemical tests for identification of bacteria	2
9.	Determination of bacterial number and biomass by different methods	1
10.	Standard protocols for antibiotic sensitivity test	2
11.	Detection of MIC	1
	Total	16

**VMC 502: Systematic Veterinary Bacteriology (2+1)**

S.No.	Topic of Syllabus	Lecture/ Practical
Theory		
1.	Spirochetes: <i>Leptospira</i> , <i>Brachyspira</i> and <i>Borrelia</i>	2
2.	<i>Campylobacter</i>	1
3.	<i>Bordetella</i> and <i>Moraxella</i>	1
4.	<i>Brucella</i>	2
5.	<i>Pseudomonas</i> and <i>Burkholderia</i>	1
6.	<i>Enterobacteriaceae</i>	3
7.	<i>Pasteurella</i> and <i>Mannheimia</i>	2
8.	<i>Haemophilus</i>	1
9.	<i>Dichelobacter</i> and <i>Fusobacterium</i>	1
10.	Rickettsia and Chlamydia- <i>Rickettsia</i>	1
11.	Rickettsia and Chlamydia- <i>Chlamydia (Chlamydophila)</i> and <i>Coxiella</i>	1
12.	<i>Staphylococcus</i>	1
13.	<i>Streptococcus</i> and <i>Enterococcus</i>	2
14.	<i>Bacillus</i>	1
15.	<i>Clostridium</i>	3
16.	<i>Erysipelothrix</i> and <i>Listeria</i>	2
17.	<i>Actinomyces</i> , <i>Corynebacterium</i> and <i>Truepurella</i> .	1
18.	<i>Mycobacterium</i>	2
19.	Actinomycetes: <i>Nocardia</i> and <i>Rhodococcus</i> and <i>Dermatophilus</i>	2
20.	Mollicutes (<i>Mycoplasma</i>)	1
21.	Emerging and transboundary bacterial pathogens	2
	Total	32
Practical		
1.	Collection, transport and dispatch of clinical samples from various disease conditions	2
2.	Isolation of bacteria in pure cultures from different clinical samples	12
3.	Identification of the bacteria using staining, biochemical tests and other molecular techniques	
4.	Preservation and storage of bacterial cultures	2
	Total	16

VMC 503: General Virology (2+1)

S.No.	Topic of Syllabus	Lecture/ Practical
Theory		
1.	History of virology	1
2.	Origin and nature of viruses	1
3.	Morphological structure and chemical composition of viruses	2
4.	Nomenclature and classification of viruses	2
5.	Cultivation and purifications of viruses	2
6.	Laboratory diagnosis of viral infections	2
7.	Viroid and Prions	1
8.	Replication of DNA viruses	2
9.	Replication of RNA viruses	3
10.	Genetic and non-genetic interactions between viruses	2
11.	Virus-cell interactions	1
12.	Viral pathogenesis	2



S.No.	Topic of Syllabus	Lectures/ Practicals
13.	Viral persistence	1
14.	Oncogenic and oncolytic viruses	2
15.	Epidemiology of viral infections	2
16.	Immune response to viruses	2
17.	Viral vaccines	2
18.	Viral chemotherapy	2
	Total	32
Practical		
1.	Orientation to a virology laboratory	1
2.	Preparation of glassware, plasticware, media and reagents for cell culture	2
3.	Other items required for virus cultivation	1
4.	Protocols for primary and secondary cell cultures	2
5.	Maintenance of cell lines	1
6.	Cryopreservation of cells and their revival	2
7.	Staining of virus infected cultured cells	1
8.	Demonstration of inclusion bodies	1
9.	Viable cell counting	1
10.	Cultivation of viruses in embryonated chicken eggs	2
11.	Virus cultivation in primary cell cultures and cell lines	2
	Total	16

VMC 504: Systematic Veterinary Virology (2+1)

S.No.	Topic of Syllabus	Lectures/ Practicals
Theory		
1.	<i>Poxviridae</i>	2
2.	<i>Asfarviridae</i>	1
3.	<i>Herpesviridae</i>	3
4.	<i>Adenoviridae</i>	2
5.	<i>Papillomaviridae</i> and <i>Polyomaviridae</i>	1
6.	<i>Parvoviridae</i>	1
7.	<i>Circoviridae</i> and <i>Hepadnaviridae</i>	1
8.	<i>Orthomyxoviridae</i>	2
9.	<i>Paramyxoviridae</i>	2
10.	<i>Rhabdoviridae</i>	2
11.	<i>Bornaviridae</i>	1
12.	<i>Reoviridae</i>	2
13.	<i>Birnaviridae</i>	1
14.	<i>Picornaviridae</i> and <i>Caliciviridae</i>	2
15.	<i>Togaviridae</i> and <i>Flaviviridae</i>	2
16.	<i>Coronaviridae</i>	1
17.	<i>Arteriviridae</i> and <i>Astroviridae</i>	1
18.	<i>Retroviridae</i>	2
19.	Prions: BSE, Scrapie and introduction to viroids	2
20.	Emerging, re-emerging and transboundary viral pathogens	1
	Total	32
Practical		
1.	Collection, preservation, transportation of clinical samples	1



S.No.	Topic of Syllabus	Lectures/ Practicals
2.	Processing clinical samples for virus isolation and identification	6
3.	Isolation and cultivation of viruses from clinical samples, using different methods and its plaque purification	
4.	Titration of viruses for 50% end points using different methods	2
5.	Detection of viral antibodies by serum neutralization test	2
6.	Electropherotyping	2
7.	Concentration and purification of animal viruses by chemical agents, differential centrifugation, density gradient centrifugation and ultra-filtration	2
8.	Methods for preservation of animal viruses	1
	Total	16

VMC 505: Principles of Veterinary Immunology (2+1)

S.No.	Topic of Syllabus	Lectures/ Practicals
Theory		
1.	Introduction to livestock and poultry immune system	1
2.	Ontogeny and phylogeny of vertebrate immune system	1
3.	Cells and organs of immune system	1
4.	Types of immunity- Innate and adaptive immune system	1
5.	Antigen and its characteristics- Characteristic of ideal antigen, classification of antigens, Factors affecting immunogenicity, Concept of hapten and carrier, Antigenic determinant/ epitope and cross reactivity, B-cell epitope and T cell epitope	2
6.	Immunoglobulins- Basic structure and function of immunoglobulins	1
7.	Immunoglobulin diversity and Immunoglobulin classes	1
8.	Antigen recognition by B cell and T cell	1
9.	B cell receptor/ immunoglobulins and T cell receptor	1
10.	Receptor diversity- B cell and T cell activation	1
11.	Major Histocompatibility Complex(General feature, structure, function, gene organization, MHC and immune response and Cytokines and chemokines)	2
12.	Immune response development- Phases of humoral and cell mediated immune response	2
13.	Immunoregulation with B and T cells(Antigen recognition, Antigen presentation and processing, Antigen recognition by TCR and MHC restriction)	1
14.	Cell mediated immune response- General properties of effector T cells, cytotoxic T cells, NK-cells and ADCC, Role of integrin and selectin	2
15.	Complement System- Basic concept of complement, Mechanism of complement activation, complement pathways and Complement deficiencies	2
16.	Autoimmunity, autoimmune diseases and Immunological tolerance	1
17.	Hypersensitivity- Classification and mechanism of induction with examples	2
18.	Immunodeficiency- Types with examples	1
19.	Immune response in foetus and new born	1
20.	Antigen antibody interaction- Antibody affinity, avidity, cross reactivity, precipitation and agglutination test	2
21.	ELISA and Western blotting	1



S.No.	Topic of Syllabus	Lectures/ Practicals
22.	Immunodiagnosics and Immunotherapy	1
23.	Monoclonal antibodies and methods for production of monoclonal antibodies	1
	Total	32
Practical		
1.	Preparation of antigens	1
2.	Raising of antisera against soluble and insoluble antigens	1
3.	Detection of antibody by gel diffusion, radial immune-diffusion and immune-electrophoresis techniques	2
4.	Haemagglutination and haemagglutination inhibition test	2
5.	ELISA and its modifications	2
6.	Immunoblotting	1
7.	Different agglutination tests	2
8.	Separation and purification of Immunoglobulin from serum	1
9.	Separation of mononuclear cells from blood by density gradient centrifugation	1
10.	Viable count of lymphocyte by dye exclusion method	1
11.	Measurement of T cell response- DTH and lymphoproliferative assay	2
	Total	16

VMC 506: Veterinary Mycology (1+1)

S.No.	Topic of Syllabus	Lectures/ Practicals
Theory		
1.	History of mycology and Morphology of fungi	1
2.	Structure and Ultra structure	1
3.	Differentiation, nutrition, physiology, reproduction, spores and cultural characters	2
4.	Classification of fungi of veterinary importance	1
5.	Glossary of mycological terms and antifungal agents	1
6.	Important techniques in diagnosis of fungal infections	1
7.	Aspergillosis	1
8.	Candidiasis, Cryptococcosis and Pachydermatitis	1
9.	Epizootic lymphangitis and Rhinosporodiosis	1
10.	Zygomycosis and Blastomycosis	1
11.	Sporotrichosis and Histoplasmosis	1
12.	Coccidioidomycosis and Mycetomas	1
13.	Mycotic abortion and mycotic mastitis	1
14.	Dermatophytoses and dermatomycosis	2
15.	Mycotoxicosis and Emerging mycoses	1
	Total	16
Practical		
1.	Collection and processing of clinical material for isolation of fungi	1
2.	Microscopy of fungi-Lactophenol cotton blue and india ink preparations	2
3.	Preparation of basal and special fungal media of veterinary importance	1
4.	Slide culture and cellophane tape technique for fungi	2
5.	Biosafety precautions in handling yeast and dimorphic fungi	1
6.	Study of gross and microscopic characters of pathogenic fungi	5
7.	Diagnosis of dermatophytes	1



S.No.	Topic of Syllabus	Lectures/ Practicals
8.	Antifungal sensitivity testing	1
9.	Detection of mycotoxin	1
10.	Serological and molecular diagnosis in fungi	1
	Total	16

VMC 507: Vaccinology (2+0)

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Types of vaccines	1
2.	Vaccine components, Immunogens and factors influencing choice of vaccines	1
3.	New generation vaccines- subunit vaccines, peptide vaccines and recombinant vaccines	2
4.	Reverse genetics vaccines, Marker and DIVA vaccines and transmission blocking vaccines	2
5.	Preparation of vaccines- Identification of candidate strain, identification of epitopes	2
6.	Seed and challenge strain maintenance	1
7.	Classical methods of exaltation and attenuation of pathogens and their molecular basis	2
8.	Technology of production of different types of vaccines	1
9.	Recent advances in vaccine delivery systems and multicomponent vaccines	2
10.	Advances in vaccines, adjuvants with their classification and mode of action	2
11.	Standardization of veterinary vaccines as per National and Global standards	2
12.	Laws and regulatory requirements concerning veterinary biologicals	2
13.	Indian pharmacopoeia	2
14.	Vaccine failure and Post vaccinal reactions	1
15.	Factors affecting response to vaccines and Quality control	2
16.	Principles of development of vaccination schedule	1
17.	Principles of development of vaccination schedule	1
18.	Methods of conducting vaccine trials (lab to field use)	1
19.	Pharmaco-vigilance	1
20.	Scaling up methods of vaccine production	1
	Total	32

VMC 508: Techniques in Microbiology (0+2)

S.No.	Topic of Syllabus	Practicals
Practical		
1.	Orientation to a microbiology laboratory	1
2.	Different sterilization and disinfection techniques	2
3.	Laboratory biosafety and biosecurity	1
4.	Microscopy	2



S.No.	Topic of Syllabus	Practicals
5.	Media preparation	2
6.	Isolation, cultivation and purification of bacteria and fungi	2
7.	Morphological and biochemical characterization	3
8.	Antibacterial sensitivity test by Disc diffusion, broth dilution and MIC determination technique	3
9.	Cultivation of viruses in embryonated eggs	2
10.	Cultivation of viruses in cell culture	3
11.	VNT	1
12.	Different immunological techniques- Agglutination	2
13.	Precipitation	2
14.	HA and HI	2
15.	ELISA	2
16.	Other immunological assays	2
	Total	32

VMC 509: Techniques in Molecular Microbiology (1+2)

S.No.	Topic of Syllabus	Lectures/ Practical
Theory		
1.	Basic requirements for establishing molecular diagnostics Laboratory	1
2.	Principles of molecular diagnostic tests	2
3.	Methods of nucleic acid extraction from pathogenic microorganisms	2
4.	PCR and variants of PCR	3
5.	Principles of primer designing	1
6.	Gel electrophoresis methods	1
7.	Blotting Techniques- Southern blotting, northern blotting, western blotting and dot-blot	1
8.	Nucleic acid sequencing methods	1
9.	Sequence analysis-sequence editing, sequence alignment, sequence comparison and phylogentic analysis	1
10.	Gene cloning and expression	1
11.	Molecular diagnosis as epidemiological tool	1
12.	Development and validation of diagnostic tests	1
	Total	16
Practical		
1.	Orientation of molecular diagnosis laboratory	1
2.	RNA and Diagnostic PCR lab (Handling RNA and DNA)	2
3.	Extraction of nucleic acid from different microbes(Gram Positive bacteria, Gram Negative bacteria, DNA viruses and RNA Viruses and fungi)	4
4.	DNA and RNA isolation from cell culture and blood	2
5.	Quality and quantity check of nucleic acid-Microlitre spectrophotometry and gel electrophoresis	2
6.	Principles for Primer designing	1
7.	Procedure for molecular diagnostic tests like PCR, RT-PCR and LAMP	3
8.	Absolute and relative quantitation of DNA/ RNA using Real time PCR.	2
9.	SDS PAGE of proteins and RNA	2
10.	Study of nucleic acid and proteins by blotting techniques	2
11.	Restriction Enzyme Techniques (REA and RFLP)	2
12.	PCR product concentration and purification for sequencing	2



S.No.	Topic of Syllabus	Lectures/ Practicals
13.	Nucleic acid sequence analysis	2
14.	Gene Cloning, expression and purification of expression products	3
15.	Idea of high throughput sequencing and MALDI-TOF	2
	Total	32

VMC 510: Molecular Immunology (1+1)

S.No.	Topic of Syllabus	Lectures/ Practicals
Theory		
1.	Molecular Structure and function of PRRs	1
2.	Ligands of PRRs and signal transduction through TLR,	1
3.	Inflammosome	1
4.	Cytokines	1
5.	Lymphocyte markers and CD nomenclature	1
6.	Molecular structure of Immunoglobulin and class, isotypes, synthesis and expression of immunoglobulin,	1
7.	Rearrangement and its organization, immunoglobulin gene diversity and mechanism of recombination of B cell gene	2
8.	Theory of antibody generation	1
9.	Signature molecules of T cell and T reg cell, T cell receptor and T cell gene diversity	2
10.	MHC structure, Genomic organization of the MHC gene haplotype and pathway of signal transduction	1
11.	Concept of congenic and syngeneic and Concept of polymorphism of MHC gene	1
12.	Role co-stimulators in B cell and T cell activation and recruitment of adaptor proteins	1
13.	Molecular mechanisms (events) of cell cytotoxicity	2
	Total	16
Practical		
1.	Isolation and purification of mammalian and avian immunoglobulin by precipitation technique: - Caprylic acid, PEG, Ammonium Sulphate and Sodium Sulphate	2
2.	Separation of immunoglobulins by size, charge and ligand affinity size exclusion chromatography (Sephadex 200), Ion exchange chromatography (DEAE), affinity chromatography (Protein-A, Sepharose) Immuno-electrophoresis Technique	2
3.	Polyacrylamide gel electrophoresis innative and reducing conditions; fixed and gradient gel	2
4.	Western blot and Crossed immune-electrophoresis	2
5.	Solid Phase ELISA and Chemiluminescence assay	1
6.	Cell cytotoxicity assaya - Non radioactive methods like LDH release assay	2
7.	Antigen detection by Immuno PCR	1
8.	Haplotype matching between individuals	2
9.	Flow cytometry for CD4 and CD8 ratio determination and other applications	1
10.	ELISPOT test for cytokine assay	1
	Total	16


VMC 511: Mucosal Immunology (1+0)

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Mucosal barrier- Development and physiology of mucosal defence. Mucosal inductive and effector sites	1
2.	Cells and lymphoid tissues of mucosal immune system	1
3.	MALT, GALT, NALT and BALT	1
4.	Innate immune response at mucosal surfaces: Mucus, Antimicrobial peptides and Role of PPRs	1
5.	Intestinal Dendritic cell and intestinal macrophage	1
6.	Antigen uptake and presentation at mucosal sites and transepithelial transport of antigen	1
7.	Mucosal Immunoglobulin, IgA synthesis and transport to intestinal lumen	1
8.	Extrathymic Description and role of Paneth cell and crypto patches	1
9.	M-cells and their functions	1
10.	Mucosal immune effector mechanisms including secretory IgA response	1
11.	T cell development in mucosal tissues and their phenotypes and functions	1
12.	Importance and limitations of mucosal immunization.	1
13.	Mucosal adjuvants and delivery systems	1
14.	Oral tolerance mechanistic approach.	1
15.	Immunopathology at mucosal surfaces: Celiac disease, Inflammatory bowel disease, Jhone's disease	1
16.	Assessment of mucosal immune response and potency testing	1
	Total	16

VMC 512: Introduction to Microbial Bio-informatics (1+0)

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Introduction to Bioinformatics; History, Scope and Application	1
2.	Bioinformatics Resources and databases	1
3.	Introduction to NCBI, ExPASy and Ensembl Genome browser	1
4.	Sequence comparison and alignment methods	1
5.	Principal and methods of Pairwise sequence alignment	1
6.	Dotplot analysis	1
7.	BLAST and FASTA programs and their variants	1
8.	DNA and protein sequence analysis	1
9.	Introduction to Multiple sequence alignment	1
10.	Introduction to Phylogenetic analysis	1
11.	Global multiple sequence alignment (CLUSTAL-W)	1
12.	Introduction to protein structure and databases	1
13.	Structure based protein classification	1
14.	Protein structure database -CASP	1
15.	Protein structure alignment tools (VAST, DALI)	1
16.	Protein 3-D structure visualization and modeling	1
	Total	16

Course Title with Credit Load

Ph.D. in Veterinary Microbiology

Course Code	Course Title	Credit Hours
VMC 601	Advances in Veterinary Bacteriology*	2+1
VMC 602	Advances in Veterinary Mycology	2+1
VMC 603	Bacterial Genetics	2+0
VMC 604	Microbial Toxins	2+1
VMC 605	Bacterial Pathogenesis	2+0
VMC 606	Advances in Veterinary Virology*	2+1
VMC 607	Molecular Viral Pathogenesis	2+1
VMC 608	Structure Function Relationship of DNA and RNA Viruses	2+0
VMC 609	Oncogenic Viruses	2+0
VMC 610	Slow Viral Infections and Prions	1+0
VMC 611	Advances in Veterinary Immunology*	2+1
VMC 612	Cytokines and Chemokines	2+ 0
VMC 613	Immunoregulation	1+0
VMC 614	Advances in Vaccinology	2+0
VMC 615	Current topics in Infection and Immunity	2+0
VMC 616	Veterinary Microbial Biotechnology	2+1
VMC 690	Special Problem	0+1
VMC 691	Doctoral Seminar-I*	1+0
VMC 692	Doctoral Seminar-II*	1+0
VMC 699	Doctoral Research	0+75

* Core courses



Course Contents

Ph.D. in Veterinary Microbiology

- I. Course Title** : Advances in Veterinary Bacteriology
II. Course Code : VMC 601
III. Credit Hours : 2+1

IV. Aim of the course

To learn about the latest development in field of bacteriology.

V. Theory

Unit I

Recent advances in bacterial taxonomy and phylogeny, advanced studies on cytology, molecular structure and function of bacterial cell surface, peptidoglycans, walls of Gram-positive and Gram-negative bacteria, Cell surface appendages: Flagella and Fimbriae. Role of bacteria cell envelope in pathogenicity and immunogenicity, Biochemical activities, Antigenic structure. Bacterial secretory and excretory system.

Unit II

Bacterial whole genome sequence analysis and its application.

VI. Practical

Isolation of bacterial LPS, OMP, Peptidoglycans, Capsule, Flagellar antigen, genotyping, phage typing, serotyping of bacteria, studies on host pathogen interactions.

- I. Course Title** : Advances in Veterinary Mycology
II. Course Code : VMC 602
III. Credit Hours : 2+1

IV. Aim of the course

To learn about the latest development in the field of mycology.

V. Theory

Unit I

Advanced studies on taxonomy, Genetics, Physiology and Antigenic characterization of pathogenic fungi.

Unit II

Advanced studies on molecular approaches for identification of fungi; immunology and serology of mycoses, antifungal therapy, fungal vaccines, fungal viruses.

VI. Practical

Morphological, Biochemical and Physiological studies of various fungi. *In vivo* pathogenicity study. Molecular detection and characterization of fungi.



- I. Course Title : Bacterial Genetic**
II. Course Code : VMC 603
III. Credit Hours : 2+0

IV. Aim of the course

To learn the various aspects of bacterial genetics.

V. Theory

Unit I

Comparative studies of prokaryotic and eukaryotic genome and their replication; structure, classification and replication of plasmids.

Unit II

Bacterial variations: Phenotypic and genotypic variations, Mutations and mutagenesis, Types of bacterial mutants, Detection of mutants and genemapping. Mechanism of gene transfer: Transduction, Transformation and conjugation. Types and mechanism of recombination: Reciprocal, Non-reciprocal and illegitimate recombination's.

Unit III

Mobile genetic elements, molecular mechanism of antibiotic resistance, regulation of gene expression.

- I. Course Title : Microbial Toxins**
II. Course Code : VMC 604
III. Credit Hours : 2+1

IV. Aim of the course

To learn about the structure, Mechanism of action, Methods of detection of various bacterial and fungal toxins.

V. Theory

Unit I

Classification of bacterial and fungal toxin on the basis of their structure and functions. The role of microbial toxins in the pathogenesis of diseases; biochemical and biological characteristics of toxins. Toxin producing Grams-positive and Grams-negative bacteria. Properties and clinical conditions produced by different bacterial and fungal toxins. Analytical methods for detection of bacterial and fungal toxins: Biological assays, Immunological assays, Nucleic acid-based methods.

Unit II

Application of microbial toxins and immunobiological studies of toxins.

VI. Practical

Detection and identification of Mycotoxigenic fungi and mycotoxins. Method of detection of bacterial endotoxin, Production of toxins in suitable media, Purification and characterization of toxins, Biological characterization in animal and in tissue culture. Toxin neutralization test.



- I. Course Title : Bacterial Pathogenesis**
II. Course Code : VMC 605
III. Credit Hours : 2+0
IV. Aim of the course

To learn the molecular mechanisms of bacterial pathogenesis.

V. Theory

Unit I

Molecular structure, Production and mode of action of bacterial virulence factors, Bacterial biofilms and advance studies on pathogenesis of bacterial diseases of various systems.

Unit II

Host-pathogen interaction, Animal models for bacterial pathogens.

- I. Course Title : Advances in Veterinary Virology**
II. Course Code : VMC 606
III. Credit Hours : 2+1
IV. Aim of the course

Advanced study of virus structure, Their nucleic acids and proteins; Latest trends in animal virus research.

V. Theory

Unit I

Biology of RNA and DNA virus replication. An introduction to bacteriophages and phage replication.

Unit II

Current concepts in animal virus research with respect to viral structure and architecture, viral virulence, viral pathogenesis, persistence and oncogenesis. Viruses as bio-terror agents and viruses for pest management (Bio-control).

Unit III

Antiviral drugs: Scope, Use and limitations, Existing antiviral drugs and their mechanism of action, Latest trends in antiviral drug development.

Unit IV

Preparation of plasmid backbone, Preparation of viral genes for cloning and cloning in viral genome backbone, Confirmation of cloned genes, Development of positive marker and negative markers, DIVA vaccine, Different types of viral vectors (vaccinia, adenoviral, retroviral vectors).

VI. Practical

Characterization of viral proteins and genome. Problem oriented practical assignments aimed at development of bioreagents and relevant diagnostic tests.

- I. Course Title : Molecular Viral Pathogenesis**
II. Course Code : VMC 607
III. Credit Hours : 2+1
IV. Aim of the course

To study molecular and genetic determinants of viral virulence and pathogenesis;



animal models for studying viral pathogenesis.

V. Theory

Unit I

Study of virus host interactions: Host specificity, Tissue tropism, Mechanism of virus spread in the body.

Unit II

Host immune responses to viral infections; Viral strategies to evade host immune responses. Viral interference and interferons.

Unit III

Pathogenesis of viral diseases of various systems, animal models for studying viral pathogenesis, molecular and genetic determinants of viral virulence, mechanisms of viral virulence.

Unit IV

Molecular and genetic determinants of viral persistence, viral oncogenesis, viral immunosuppression, and immunopathology.

VI. Practical

Pathotyping of animal viruses using Newcastle disease virus as model, Determination of immunosuppressive potential of animal viruses using infectious bursal disease virus/ Marek's disease virus/ chicken anaemia virus, Characterization of molecular determinants of viral virulence using variants, Recombinants and reassortants.

I. Course Title : Structure Function Relationship of DNA and RNA Viruses

II. Course Code : VMC 608

III. Credit Hours : 2+0

IV. Aim of the course

To understand the relationship between structure and function of DNA and RNA viruses of animals for the development of next generation viral vaccine and antivirals.

V. Theory

Unit I

Methods of studying virus structure and architecture, Methods of amplification of viral nucleicacids, Molecular characterization of viral protein and nucleic acids, Nucleotide sequencing and its analysis by software programmes.

Unit II

Detailed study of virus replication in various groups of animal viruses.

Unit III

Understanding the relationship between structure and function of animal DNA and RNA viruses, Development of modern vaccines and antivirals using the relationship between structure and function of animal DNA and RNA viruses.



- I. Course Title : Oncogenic Viruses**
II. Course Code : VMC 609
III. Credit Hours : 2+0

IV. Aim of the course

To study mechanisms of viral oncogenesis.

V. Theory

Unit I

General features of cell transformation and characterization of transformed cells. Oncogenic RNA and DNA viruses. Oncolytic viruses, viral and cellular oncogenes.

Unit II

Mechanisms of viral oncogenesis and diagnosis of viral oncogenesis.

- I. Course Title : Slow Viral Infections and Prions**
II. Course Code : VMC 610
III. Credit Hours : 1+0

IV. Aim of the course

To study slow viral infections, properties and replication of prions and diseases caused by them.

V. Theory

Unit I

Epidemiology, Pathogenesis, Diagnosis and control of slow viral infections.

Unit II

Properties, Replication and epidemiology of prions. Pathogenesis, immunity, Diagnosis and control of Scrapies, Bovine spongiform encephalopathy, Chronic wasting disease of deer, Transmissible mink encephalopathy. Recent trends in prion research.

- I. Course Title : Advances in Veterinary Immunology**
II. Course Code : VMC 611
III. Credit Hours : 2+1

IV. Aim of the course

To study recent advances in immunology.

V. Theory

Unit I

Cells and tissues of immune system: Significance of HSC I, Origin of myeloid cells; Lymphoid cells (T and B cells), NK cells, NKT cell, Apoptosis and its role in homeostatic mechanism. Ontogeny of the lymphoid tissue in mammals and birds. Cell adhesion molecules, Recirculation and trafficking, Cell homing receptor. Antigen presenting cells and their functions at cellular level.

Unit II

Cytokines, chemokines and cytokine receptors.

Unit III

Developmental biology of Immune cells: Early development of T and B cells and its differentiation, Maturation in primary lymphoid organ. B cell development and T cell development. Lineage commitment, Memory generation. Organization of expression of lymphocyte receptors gene, Multigenic organization of immunoglobulin gene and thymic selection of T cell repertoire. Concept of extrathymic origin of T cells. Effector and memory T and B cells.

Unit IV

Recombination events in T and B cell: Mechanism of recombination of immunoglobulin genes and T cell receptor genes.

Unit V

Activation of T and B cells: Clonal expansion. Role of T cell help in B cell response, affinity maturation of B cells and class switching and T cell activation.

Unit VI

MHC: MHC class-I and II structure and gene arrangement, polymorphism, antigen processing and presentation mechanism.

Unit VII

Antibody mediated and cell mediated effector functions. Cellular immune response: Effector mechanisms of CTL, NK cells and NK T cell activation. Regulation of immune response. Role of T reg-cells, immunological tolerance and graft rejection.

VI. Practical

Purification of immunoglobulin classes, Subclasses, Fragmentation of antibody by enzyme digestion to F(ab)₂ and Fc fragments, Affinity chromatography techniques. Separation of protein by SDS PAGE under reducing condition. Western blot experiment to detect the immunogenic protein, ELISPOT, cytotoxic T cell assay, morphological and functional assays of blood monocytes. FACS and MACS.

I. Course Title : Cytokines and Chemokines

II. Course Code : VMC 612

III. Credit Hours : 2+0

IV. Aim of the course

To study recent advances in cytokines and chemokines.

V. Theory

Unit I

Properties of cytokines. General structure and function of classification of cytokines family's, Cytokine secretion by Th1 and Th2 subsets. Cytokines cross regulation. Cytokine receptors: general structure of cytokine receptors, Immunoglobulin superfamily receptors, class 1 and class 2 cytokine receptor families. TNF receptor families and cytokine antagonists.

Unit II

Cytokine related diseases. Therapeutic uses of cytokines and their receptors. Chemokines: subgroups of chemokines and their structures and functions, chemokine receptor families.



Unit III

Immunomodulators: Types of immunomodulators and their mechanism of action. Adjuvants: classification, Mode of action, Adjuvants combination and safety. Cytokine as adjuvant, PLG and microparticle as adjuvant, TLR agonist as adjuvant. Antigen delivery system and mode of action. Immunostimulants: Bacterial product and synthetic Compound, Complex carbohydrates, Immune enhancing drugs, Vitamins and cytokines.

Unit IV

Immunosuppression, Neuroendocrine control of immunoregulation, Immunosuppressive agents and drugs, Corticosteroids, Cyclosporin's, Cyclophosphamide and other agents, Like irradiation and the mode of action.

- I. Course Title : Immunoregulation**
II. Course Code : VMC 613
III. Credit Hours : 1+0

IV. Aim of the course

To study recent advances in immunoregulation mechanisms.

V. Theory

Unit I

Molecular mediators of immune response: Lymphokines and monokines. Idiotypic networks. Epitope specific regulation. Th, Tc and Treg cells. MHC in immunoregulation, Immune response genes. Antigen specific suppressor molecules produced by T cells. Immunosuppressive agents and immune-stimulation. Immunoregulatory pathways.

- I. Course Title : Advances in Vaccinology**
II. Course Code : VMC 614
III. Credit Hours : 2+0

IV. Aim of the course

To learn about advances in vaccine research and modern approaches for the vaccine development.

V. Theory

Unit I

Different phases in vaccine development. Direct and indirect correlates of protection. Antigen identification and characterization employing emerging technologies such as microarrays, *in vivo* expression technology, Signature-tagged mutagenesis and phage display technology.

Unit II

Immuno-informatics applied to epitope mapping, T cell epitopes and identification of pathogenic epitopes. Novel vaccines: nucleic acids, Marker vaccines, Mucosal vaccines, Bacterial ghosts as vaccines and virus-like particles. Futuristic vaccines: anti-allergic, Anti-autoimmune diseases, De-addiction vaccines and transplant survival/ prolonging vaccines.



- I. Course Title : Current Topics in Infection and Immunity**
II. Course Code : VMC 615
III. Credit Hours : 2+0

IV. Aim of the course

Discussions on recent developments in the immunobiology of major viral, bacterial and fungal diseases of animals.

V. Theory

Unit I

Introduction and historical developments. Host-pathogen relationship.

Unit II

Effector mechanisms of specific and non-specific immunity to different groups of microbes.

Unit III

Immunobiology of major viral, Bacterial and fungal diseases of animals. Types of vaccines for infectious diseases; Current trends in vaccine development.

- I. Course Title : Veterinary Microbial Biotechnology**
II. Course Code : VMC 616
III. Credit Hours : 2+1

IV. Aim of the course

To understand as to how microbial processes and activities can be used for development of medically and industrially important products and processes.

V. Theory

Unit I

History of microbial biotechnology. Microbes in nature. Microbes as infectious agents of human and animals. Host-microbe relationships. Microbial metabolism and growth characteristics. Microbial genetics.

Unit II

Introduction to molecular biology of microorganisms: DNA, RNA and proteins structure and functions. DNA replication, RNA transcription, reverse transcription, protein translation and regulatory mechanisms. Bacterial extrachromosomal DNA elements.

Unit III

Genetic engineering: Restriction enzymes, DNA ligases, DNA polymerases, RNases and DNases and other enzymes. DNA sequencing. Plasmids and phage-derived vectors, Bacterial hosts for cloning and expression of transgenes. Genomic libraries and sequencing. Blotting of DNA, RNA and proteins. Polymerase chain reaction. An introduction to Microarrays and Metagenomics.

Unit IV

Expression of antigens and antibody fragments useful as diagnostic reagents and vaccines. PCR and blotting techniques in infectious disease diagnosis. Nucleic acid vaccines. Vectored viral and bacterial vaccines. Construction of defined mutants



and marker vaccines using genetic manipulation techniques. Manipulation of microbial processes for production of industrially useful substances.

VI. Practical

Extraction of nucleic acids from viruses and bacteria. Restriction endonuclease digestion of DNA and resolution in agarose gel electrophoresis. PCR amplification of DNA. RT-PCR of RNA. Insertion of DNA fragments into plasmid/ phagemid/ phage vectors. Construction of competent *E. coli* host cells. Transformation and transfection of competent *E. coli* cells. Screening of transformants and isolation of clones. Sequence analysis of clones/ PCR amplicons. Expression of genes of bacterial/ viral antigens. Use of PCR for infectious disease diagnosis.

I. Course Title : Special Problem

II. Course Code : VMC 690

III. Credit Hours : 1+0

IV. Aim of the course

To provide expertise in handling practical research problem(s).

V. Practical

Short research problem(s) involving contemporary issues and research techniques.



Course Outline-cum-Lecture Schedule for Doctoral Degree Programme

VMC 601: Advances in Veterinary Bacteriology 2+1

S.No.	Topic of Syllabus	Lecture/ Practical
Theory		
1.	Recent advances in bacterial taxonomy and phylogeny	3
2.	Advanced studies on bacterial cytology	2
3.	Molecular structure and function of bacterial cell surface Peptidoglycans	2
4.	Walls of Gram-positive and Gram-negative bacteria	2
5.	Cell surface appendages: Flagella and Fimbriae	3
6.	Role of bacteria cell envelope in pathogenicity and immunogenicity	4
7.	Biochemical activities	4
8.	Antigenic structure	4
9.	Bacterial secretory and excretory system	4
10.	Bacterial whole genome sequence analysis and its application	4
	Total	32
Practical		
1.	Isolation of bacterial LPS	1
2.	Isolation of bacterial OMP	1
3.	Isolation of bacterial Peptidoglycans	1
4.	Isolation of bacterial Capsule	1
5.	Isolation of bacterial Flagellar antigen	1
6.	Genotyping of bacteria	2
7.	Phage typing of bacteria	2
8.	Serotyping of bacteria	3
9.	Studies on host pathogen interactions	4
	Total	16

VMC 602: Advances in Veterinary Mycology 2+1

S.No.	Topic of Syllabus	Lecture/ Practical
Theory		
1.	Advanced studies on taxonomy of pathogenic fungi	2
2.	Advanced studies on genetics of pathogenic fungi	4
3.	Advanced studies on physiology of pathogenic fungi	4
4.	Advanced studies on antigenic characterization of pathogenic fungi	6
5.	Advanced studies on molecular approaches for identification of fungi	4
6.	Immunology and serology of mycoses	4
7.	Antifungal therapy	4
8.	Fungal vaccines	2
9.	Fungal viruses	2
	Total	32



S.No.	Topic of Syllabus	Lecture/ Practical
Practical		
1.	Morphological, biochemical and physiological studies of various fungi	6
2.	<i>In vivo</i> pathogenicity study	5
3.	Molecular detection and characterization of fungi	5
	Total	16

VMC 603: Bacterial Genetics 2+0

S.No.	Topic of Syllabus	Lecture
Theory		
1.	Comparative studies of prokaryotic and eukaryotic genome and their replication	3
2.	Structure, classification and replication of plasmids	3
3.	Bacterial variations: Phenotypic and genotypic variations	3
4.	Mutations and mutagenesis, types of bacterial mutants and detection of mutants	4
5.	Gene mapping	3
6.	Mechanism of gene transfer: transduction, transformation and conjugation	4
7.	Types and mechanism of recombination: Reciprocal, non-reciprocal and illegitimate recombination's	4
8.	Mobile genetic elements	3
9.	Molecular mechanism of antibiotic resistance	3
10.	Regulation of gene expression	2
	Total	32

VMC 604: Microbial Toxins 2+1

S.No.	Topic of Syllabus	Lectures/ Practicals
Theory		
1.	Classification of bacterial and fungal toxin on the basis of their structure and functions	4
2.	The role of microbial toxins in the pathogenesis of diseases	3
3.	Biochemical and biological characteristics of toxins	5
4.	Toxin producing Grams-positive and Grams-negative bacteria	2
5.	Properties and clinical conditions produced by different bacterial and fungal toxins	4
6.	Analytical methods for detection of bacterial and fungal toxins: Biological assays, immunological assays, Nucleic acid-based methods	8
7.	Application of microbial toxins	3
8.	Immuno-biological studies of toxins	3
	Total	32
Practical		
1.	Detection and identification of Mycotoxigenic fungi and mycotoxins	2
2.	Method of detection of bacterial endotoxin	3
3.	Production of toxins in suitable media	3
4.	Purification and characterization of toxins	3



S.No.	Topic of Syllabus	Lectures/ Practicals
5.	Biological characterization in animal and in tissue culture	3
6.	Toxin neutralization test	2
	Total	16

VMC 605: Bacterial Pathogenesis 2+0

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Molecular structure, production and mode of action of bacterial virulence factors	8
2.	Bacterial biofilms	4
3.	Advanced studies on pathogenesis of bacterial diseases of various systems	8
4.	Host-pathogen interaction	8
5.	Animal models for bacterial pathogens	4
	Total	32

VMC 606: Advances in Veterinary Virology 2+1

S.No.	Topic of Syllabus	Lectures/ Practicals
Theory		
1.	Biology of RNA and DNA virus replication	2
2.	An introduction to bacteriophages and phage replication	2
3.	Current concepts in animal virus research with respect to viral structure and architecture	3
4.	viral virulence, viral pathogenesis, persistence and oncogenesis	4
5.	Viruses as bio-terror agents and viruses for pest management (Bio-control)	2
6.	Antiviral drugs: Scope, use and limitations	3
7.	Existing antiviral drugs and their mechanism of action	2
8.	Latest trends in antiviral drug development	2
9.	Preparation of plasmid backbone, preparation of viral genes for cloning and cloning in viral genome backbone	3
10.	Confirmation of cloned genes	2
11.	Development of positive marker and negative markers	2
12.	DIVA vaccine	2
13.	Different types of viral vectors (vaccinia, adenoviral, retroviral vectors)	3
	Total	32
Practical		
1.	Characterization of viral proteins and genome	8
2.	Problem oriented practical assignments aimed at development of bioreagents and relevant diagnostic tests	8
	Total	16


VMC 607: Molecular Viral Pathogenesis 2+1

S.No.	Topic of Syllabus	Lectures/ Practicals
Theory		
1.	Study of virus host interactions: host specificity, tissue tropism and mechanism of virus spread in the body	3
2.	Host immune responses to viral infections	2
3.	Viral strategies to evade host immune responses	2
4.	Viral interference and interferons	2
5.	Pathogenesis of viral diseases of various systems	3
6.	Animal models for studying viral pathogenesis	3
7.	Molecular and genetic determinants of viral virulence	3
8.	Mechanisms of viral virulence	3
9.	Molecular and genetic determinants of viral persistence	3
10.	Viral oncogenesis	4
11.	Viral immunosuppression and immunopathology	4
	Total	32
Practical		
1.	Pathotyping of animal viruses using Newcastle disease virus as model	4
2.	Determination of immunosuppressive potential of animal viruses using infectious bursal disease virus/ Marek's disease virus/ chicken anaemia virus	8
3.	Characterization of molecular determinants of viral virulence using variants, recombinants and reassortants	4
	Total	16

VMC 608: Structure Function Relationship of DNA and RNA Viruses 2+0

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Methods of studying virus structure and architecture	3
2.	Methods of amplification of viral nucleicacids	2
3.	Molecular characterization of viral protein and nucleic acids	3
4.	Nucleotide sequencing and its analysis by software programmes	6
5.	Detailed study of virus replication in various groups of animal viruses	6
6.	Understanding the relationship between structure and function of animal DNA and RNA viruses	6
7.	Development of modern vaccines and antivirals using the relationship between structure and function of animal DNA and RNA viruses	6
	Total	32

VMC 609: Oncogenic Viruses 2+0

S.No.	Topic of Syllabus	Practical
Theory		
1.	General features of cell transformation and characterization of transformed cells	4
2.	Oncogenic RNA and DNA viruses	4



S.No.	Topic of Syllabus	Practical
3.	Oncolytic viruses	5
4.	Viral and cellular oncogenes	5
5.	Mechanisms of viral oncogenesis	8
6.	Diagnosis of viral oncogenesis	6
	Total	32

VMC 610: Slow Viral Infections and Prions 1+0

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Epidemiology of slow viral infections	1
2.	Pathogenesis of slow viral infections	1
3.	Diagnosis and control of slow viral infections	2
4.	Properties, replication and epidemiology of prions	2
5.	Scrapies	2
6.	Bovine spongiform encephalopathy	2
7.	Chronic wasting disease of deer	2
8.	Transmissible mink encephalopathy	2
9.	Recent trends in prion research	2
	Total	16

VMC 611: Advances in Veterinary Immunology 2+1

S.No.	Topic of Syllabus	Lectures/ Practicals
Theory		
1.	Significance of HSC 1 and Origin of myeloid cells	1
2.	Lymphoid cells (T and B cells), NK cells and NKT cell	1
3.	Apoptosis and its role in homeostatic mechanism	1
4.	Ontogeny of the lymphoid tissue in mammals and birds	1
5.	Cell adhesion molecules, recirculation and trafficking, cell homing receptor	2
6.	Antigen presenting cells and their functions at cellular level	1
7.	Cytokines, chemokines and cytokine receptors	2
8.	Early development of T and B cells and its differentiation and maturation in primary lymphoid organ	1
9.	B cell development and T cell development	2
10.	Lineage commitment and memory generation	2
11.	Organization of expression of lymphocyte receptors gene	2
12.	Multiagenic organization of immunoglobulin gene	1
13.	Thymic selection of T cell repertoire.	1
14.	Concept of extrathymic origin of T cells	1
15.	Effector and memory T and B cells	1
16.	Mechanism of recombination of immunoglobulin genes and T cell receptor genes	2
17.	Clonal expansion	1
18.	Role of T cell help in B cell response	1
19.	Affinity maturation of B cells and class switching and T cell activation	1



S.No.	Topic of Syllabus	Lectures/ Practicals
20.	MHC class-I and II structure and gene arrangement, polymorphism, antigen processing and presentation mechanism	2
21.	Effector mechanisms of CTL, NK cells and NK T cell activation	2
22.	Regulation of immune response	2
23.	Role of T reg-cells, immunological tolerance and graft rejection	1
	Total	32
Practical		
1.	Purification of immunoglobulin classes, subclasses, fragmentation of antibody by enzyme digestion to F (ab) ₂ and Fc fragments, affinity chromatography techniques	2
2.	Separation of protein by SDS PAGE under reducing condition	2
3.	Western blot experiment to detect the immunogenic protein	2
4.	ELISPOT	2
5.	Cytotoxic T cell assay	2
6.	Morphological and functional assays of blood monocytes	2
7.	FACS	2
8.	MACS	2
	Total	16

VMC 612: Cytokines and Chemokines 2+ 0

S.No.	Topic of Syllabus	Lectures
Theory		
1	Properties of cytokines	2
2	General structure and function of classification of cytokines family's, cytokine secretion by Th1 and Th2 subsets	3
3	Cytokines cross regulation	2
4	Cytokine receptors: general structure of cytokine receptors, immunoglobulin superfamily receptors, class 1 and class 2 cytokine receptor families	3
5	TNF receptor families and cytokine antagonists	2
6	Cytokine related diseases	2
7	Therapeutic uses of cytokines and their receptors	2
8	Chemokines: subgroups of chemokines and their structures and functions, chemokine receptor families	3
9	Types of immunomodulators and their mechanism of action	2
10	Adjuvants: classification, mode of action, adjuvants combination and safety	2
11	Cytokine as adjuvant, PLG and microparticle as adjuvant, TLR agonist as adjuvant	2
12	Antigen delivery system and mode of action Immunostimulants: bacterial product and synthetic compound, complex carbohydrates, immune enhancing drugs, vitamins and cytokines	3
13	Immunosuppression, Neuroendocrine control of immunoregulation, Immunosuppressive agents and drugs, corticosteroids, cyclosporin's, cyclophosphamide and other agents, like irradiation and the mode of action	3
	Total	32

**VMC 613: Immunoregulation 1+0**

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Molecular mediators of immune response: lymphokines and monokines	2
2.	Idiotypic networks	2
3.	Epitope specific regulation	2
4.	Th, Tc and Treg cells	2
5.	MHC in immunoregulation, immune response genes	2
6.	Antigen specific suppressor molecules produced by T cells	2
7.	Immunosuppressive agents and immune-stimulation	2
8.	Immunoregulatory pathways	2
	Total	16

VMC 614: Advances in Vaccinology 2+0

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Different phases in vaccine development	4
2.	Direct and indirect correlates of protection	2
3.	Antigen identification and characterization employing emerging technologies such as microarrays, in vivo expression technology, signature-tagged mutagenesis and phage display technology	6
4.	Immuno-informatics applied to epitope mapping, T cell epitopes and identification of pathogenic epitopes	8
5.	Nucleic acids, marker vaccines, mucosal vaccines, bacterial ghosts as vaccines and virus-like particles	6
6.	Futuristic vaccines: anti-allergic, anti-autoimmune diseases, de-addiction vaccines and transplant survival/ prolonging vaccines	6
	Total	32

VMC 615: Current topics in Infection and Immunity 2+0

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Introduction and historical developments	5
2.	Host-pathogen relationship	6
3.	Effector mechanisms of specific and non-specific immunity to different groups of microbes	6
4.	Immunobiology of major viral, bacterial and fungal diseases of animals	6
5.	Types of vaccines for infectious diseases	5
6.	Current trends in vaccine development	6
	Total	32


VMC 616: Veterinary Microbial Biotechnology 2+1

S.No.	Topic of Syllabus	Lectures/ Practicals
Theory		
1.	History of microbial biotechnology	1
2.	Microbes in nature	1
3.	Microbes as infectious agents of human and animals	1
4.	Host-microbe relationships	1
5.	Microbial metabolism and growth characteristics	1
6.	Microbial genetics	1
7.	Introduction to molecular biology of microorganisms: DNA, RNA and proteins structure and functions	2
8.	DNA replication, RNA transcription, reverse transcription, protein translation and regulatory mechanisms	2
9.	Bacterial extrachromosomal DNA elements	1
10.	Genetic engineering: restriction enzymes, DNA ligases, DNA polymerases, RNases and DNases and other enzymes	2
11.	DNA sequencing	2
12.	Plasmids and phage-derived vectors, bacterial hosts for cloning and expression of transgenes	2
13.	Genomic libraries and sequencing	1
14.	Blotting of DNA, RNA and proteins	2
15.	Polymerase chain reaction	1
16.	An introduction to Microarrays and Metagenomics	1
17.	Expression of antigens and antibody fragments useful as diagnostic reagents and vaccines	2
18.	PCR and blotting techniques in infectious disease diagnosis	2
19.	Nucleic acid vaccines	1
20.	Vectored viral and bacterial vaccines	1
21.	Construction of defined mutants and marker vaccines using genetic manipulation techniques	2
22.	Manipulation of microbial processes for production of industrially useful substances	2
	Total	32
Practical		
1.	Extraction of nucleic acids from viruses and bacteria	2
2.	Restriction endonuclease digestion of DNA and resolution in agarose gel electrophoresis	1
3.	PCR amplification of DNA	1
4.	RT-PCR of RNA	1
5.	Insertion of DNA fragments into plasmid/ phagemid/ phage vectors	2
6.	Construction of competent E. coli host cells	2
7.	Transformation and transfection of competent E. colicells	1
8.	Screening of transformants and isolation of clones	1
9.	Sequence analysis of clones/ PCR amplicons	2
10.	Expression of genes of bacterial/ viral antigens	2
11.	Use of PCR for infectious disease diagnosis	1
	Total	16

**VMC 690: Special Problem 0+1****Practical**

Short research problem(s) involving contemporary issues and research techniques. Planning a short research problem or working on a published research paper or new developments.

Suggested Reading

- AM Lesk. 2002. *Introduction to Bioinformatics*. Oxford University press.
- Abbas AH, Lichtman and S. Pillai. 2017. *Cellular and Molecular Immunology: Functions and Disorders of the Immune System*, 7th Ed., Elsevier.
- B Detrick and RG Hamilton and JH Schmitz. 2016. *Manual of Molecular and Clinical Laboratory Immunology*. 8th Ed. American Society for Microbiology.
- B Markey, F Leonard, M Archambault, A Cullinane and D Maguire. 2013. *Clinical Veterinary Microbiology* 2nd Ed. MOSBY- Elsevier.
- BD Singh. 2012. *Biotechnology: Expanding Horizons*, 4thEd.Kalyani Pub.
- C Hirsh, NJ MacLachlan and RL Walker. 2004. *Veterinary Microbiology*, 2ndEdn., Wiley-Blackwell Pub.
- CC Kibbler, R Barton, Neil AR Gow, S Howell, DM MacCallum and RJ Manuel. 2018. *Oxford Textbook of Medical Mycology*, 1st Ed., Oxford University Press.
- CM Fraser, T Read and KE Nelson. 2010. *Microbial Genomes (Infectious Disease)*. 1st Edition, Humana Press.
- D Balasubramanian, CFA Bryce, K Jayaraman, J Green and K Dharmalingam. 2004. *Concepts in Biotechnology*, Revised edition, Universities Press Pub.
- DW Mount. 2001. *Bioinformatics: Sequence and genome analysis*. Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.
- FA Murphy, EPJ Gibbs, MK Holzmek and MJ Studdert. 1999. *Veterinary Virology*. 3rd Ed. Academic Press.
- GJ Tortora, BR Funke, CL Case, D Weber and W Bair. 2018. *Microbiology: An Introduction*, 13th Ed., Pearson Pub.
- GM Callahan and RM Yates. 2014. *Basic Veterinary Immunology*. 1stEdn., University Press of Colorado.
- JB Carter and VA Saunders. 2013. *Virology: Principles and Applications*, 2nd Ed., John Wiley and Sons Pub.
- J Glenn Songer and KW Post. 2004. *Veterinary Microbiology: Bacterial and Fungal Agents of Animal Diseases*. 1st Ed., Saunders Pub.
- J Punt, S Stranford, P Jones and J Owen. 2019. *Kuby Immunology*, 8th Ed., W.H. Freeman Pub.
- J Willey, K Sandman and D Wood. 2019. *Prescott's Microbiology*, 11thEdn., McGraw-Hill Education Pub.
- J Mestecky, W Strober, MW Russell, H Cheroutre, BN Lambrecht and BL Kelsall. 2015. *Mucosal Immunology* 4th Edn., Academic Press.
- JE Coligan, AM Kruisbeek, DH Margulies, EM Shevach and W Strober. 2003. *Current Protocols in Immunology*. 3rd Edn. John Wiley and Sons.
- L Gyles, JF Prescott, J Glenn Songer and CO Thoen. 2010. *Pathogenesis of Bacterial Infections in Animals*, 4thEdn., Wiley-Blackwell Pub.
- MJ Dey and RM Schultz. 2014. *Veterinary Immunology: Principles and Practice*, 2nd Edn., CRC Press/ Taylor and Francis.
- MM Levine, JB Kaper, R Rappuoli, MA Liu and MF Good. 2004. *New Generation Vaccines*. 3rd Ed. Marcel-Dekker.
- NJ Maclachlan and EJ Dubovi. 2016. *Fenner's Veterinary Virology*. 5thEdn., Academic Press.
- PJ Quinn, BK Markey, FC Leonard, P Hartigan, S Fanning and ES Fitzpatrick. 2011. *Veterinary Microbiology and Microbial Disease*, 2nd Ed., Wiley-Blackwell Pub.
- PJ Delves, SJ Martin, DR Burton and IM Roitt. 2017. *Roitt's Essential Immunology* 13th Edition, Wiley Blackwell.



- R Tizard. 2017. *Veterinary Immunology*, 10thEdn., Saunders Publ.
- S Giguère, JF Prescott and PM Dowling. 2013. *Antimicrobial Therapy in Veterinary Medicine*, 5th Ed., John Wiley and Sons, Inc.
- SJ Flint, V Racaniello, G Rall and A Skalka. 2015. *Principles of Virology*, 4th Edition (2 volume set). ASM press
- S Jameel and L Villarreal. 2000. *Advances in Animal Virology*. Science Pub.
- Samanta. 2015. *Veterinary Mycology*. Springer, India, Private Ltd Pub.
- WJW Morrow, NA Sheikh, CS Schmidt and D Huw Davies. 2012. *Vaccinology: Principles and Practice* 1 edition Wiley-Blackwell.
- TA Brown. 2016. *Gene Cloning and DNA Analysis*. 7th Edition., Wiley Blackwell
- WJ Dodds and R Schulz. 1999. *Veterinary Vaccines and Diagnostics*. Vol. 41 (Advances in Veterinary Medicine) 1st Ed. Academic Press.
- For Ph.D. Courses: Selected articles and reviews from journals

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Veterinary Para-Clinical Subjects

– Veterinary Pathology



Course Title with Credit Load M.V.Sc. in Veterinary Pathology

Course Code	Course Title	Credit Hours
VPL 501	General Pathology*	2+1
VPL 502	Techniques in Pathology*	0+2
VPL 503	Animal Oncology	1+1
VPL 504	Clinical Pathology*	1+1
VPL 505	Necropsy Procedures and Interpretations*	1+1
VPL 506	Necropsy Conference*	0+1
VPL 507	Systemic Pathology*	2+1
VPL 508	Pathology of Infectious Diseases of Domestic Animals*	2+1
VPL 509	Toxicopathology	2+1
VPL 510	Avian Pathology*	2+1
VPL 511	Pathology of Wild/ Zoo and Aquatic Animal Diseases	2+1
VPL 512	Pathology of Laboratory Animal Diseases	2+1
VPL 591	Master's Seminar*	1+0
VPL 599	Master's Research	30

*Core Courses

Course Contents

M.V.Sc. in Veterinary Pathology

- I. Course Title** : General Pathology
II. Course Code : VPL 501
III. Credit Hours : 2+1

IV. Aim of the course

To acquaint the students with different types of degenerations, cell injuries caused by different types of irritants and inflammation.

V. Theory

Unit I

Introduction and principles of Pathology including genetic basis of disease; Cellular responses to injury: Causes and mechanisms of reversible and irreversible cell injury; Morphologic characteristics, Significance and fate of various intracellular (lipids, glycogen, proteins) and extracellular (hyaline material, amyloid, fibrinoid change, gout) accumulations/ degenerations, Endogenous and exogenous pigmentations, Cell death (necrosis, apoptosis and gangrene), Pathologic calcifications and cellular adaptive changes.

Unit II

Inflammation and repair: Introduction to inflammation, Acute inflammation-cellular and molecular events including mediators and heat shock proteins of acute inflammation; Cellular components, Morphologic classification and outcomes of acute inflammation, Chronic inflammation-causes, Morphologic features and cellular components of chronic inflammation, Healing and repair, Systemic effects of inflammation.

Unit III

Disturbances in circulation: Causes, mechanisms, Morphologic features, Significance and fate of hyperemia, Oedema, Haemorrhage, Thrombosis, Embolism, Ischaemia, infarction and shock.

Unit IV

Immune mediated reactions: Introduction to autoimmunity and immune mediated diseases, mechanisms of hypersensitivity reactions.

VI. Practical

- To study the morphologic descriptions of lesions and nomenclature of a morphologic diagnosis based on gross and/ or microscopic lesions of variety of conditions (degenerations, infiltrations, pigmentations, necrosis, circulatory and growth disturbances and different types of inflammation) in the preserved specimens/ slides. Demonstration of post-mortem changes.
- Continuous assessment of students for their skills in the diagnosis of gross lesions during post-mortem examination of different tissues of domestic animals.



Preparation of histopathology slides on the selected cases followed by interaction in the student seminars/ group discussions.

VII. Suggested Reading

- McGavin MD and Zachary JF. 2017. *Pathologic Basis of Veterinary Diseases*. 6th Ed. Elsevier.
- Vegad JL. 2007. *Text Book of Veterinary General Pathology*. 2nd Ed. International Book Distr.

I. Course Title : Techniques in Pathology

II. Course Code : VPL 502

III. Credit Hours : 0+2

IV. Aim of the course

To acquaint the students with different techniques used frequently in Veterinary Pathology.

V. Practical

- Basic histopathological techniques-Collection of tissues, fixation, processing, section cutting and H and E staining of tissue sections. Collection and fixation of tissues for scanning electron microscopy, transmission electron microscopy, histochemical, toxicological, bacteriological and virological examinations. Application of micrometry and special staining techniques. Demonstration of different inclusions, bacteria and fungi in tissues.
- Principles of dark field, phase contrast and fluorescent microscopy; introduction to scanning electron microscopy and transmission electron microscopy.
- Histochemical techniques for demonstration of fat, glycogen, connective tissue, mucopolysaccharides and common enzymes, pigments and minerals Cryosectioning and application of immunohistochemical techniques—immunoperoxidase and immunofluorescence.
- Principles and applications of PCR and its variants.
- Museum specimen preparation and maintenance.

VI. Suggested Reading

- Culling CFA. 1969. *Handbook of Histological Techniques*. Butterworths.
- Lillie RD. 1965. *Histopathologic Techniques and Practical Histo-chemistry*. 3rd Ed. McGraw-Hill.
- Culling CFA. 2013. *Handbook of Histopathological and Histochemical Techniques: Including Museum Techniques* PDF, eBook (<http://mbooknom.men/go/best.php?id=B01DRY52U8>)

I. Course Title : Animal Oncology

II. Course Code : VPL-503

III. Credit Hours : 1+1

IV. Aim of the course

To acquaint the students with different types of neoplasms of domestic animals, their nature, cause, pathology and diagnosis.

V. Theory

Unit I

Tumour-Etiology, Carcinogens and oncogenesis, Nomenclature and classification, characteristics of benign and malignant tumours, Molecular mechanisms, Pathways of spread of tumors and tumor immunology

**Unit II**

Effects of tumour, Grading, Staging and laboratory diagnosis of tumours. Animal tumour models—experimental induction of neoplasms

Unit III

Pathology of different types of epithelial and connective tissue tumours with their characteristic identification features and epidemiology. Commonly encountered tumours of respiratory, haemopoietic, integumentary, musculoskeletal, gastrointestinal, hepatobiliary, uro-genital, nervous, ocular, ear and endocrine system.

VI. Practical

- Cytological diagnosis of tumours via impression smears and Fine Needle Aspiration Cytology.
- To study the gross and microscopic changes in different types of neoplasms.

VII. Suggested Reading

- Meuten DJ. 2016. *Tumors in Domestic Animals*. 5th Ed. Wiley-Blackwell

I. Course Title : Clinical Pathology

II. Course Code : VPL 504

III. Credit Hours : 1+1

IV. Aim of the course

To acquaint the students with clinical alterations in blood, urine, CSF and other body fluids due to different diseases.

V. Theory**Unit I**

Study of changes in blood/ plasma/ serum including biochemical profile for organ function tests, Cytological examination and examination of urine, Faeces, Cerebrospinal fluid and biopsy specimens and their interpretation.

VI. Practical

Analysis of clinical samples (blood/ serum/ plasma, urine, faeces, Biopsy samples (exfoliative/ FNAC) including biochemical profile for organ function tests in different disease conditions in animals/ poultry and their interpretations.

VII. Suggested Reading

- Amy C. Valenciano, Rick L. Cowell. 2013. *Cowell and Tyler's Diagnostic Cytology and Hematology of the Dog and Cat*, 4th Ed, Elsevier
- Benzamin MM. 1985. *Outline of Veterinary Clinical Pathology*. 3rd Ed. Ludhiana, Kalyani Publishers.
- Coles EH. 1986. *Veterinary Clinical Pathology*. 4th Ed, WB Saunders.
- Douglas J., Weiss, K and Jane Wardrop. 2010. *Schalm's Veterinary Haematology*, Wiley.

I. Course Title : Necropsy Procedures and Interpretations

II. Course Code : VPL 505

III. Credit Hours : 1+1

IV. Aim of the course

To acquaint the students with necropsy procedures in large and small animals and



study of PM lesions in different diseases and to educate the students about common veterolegal problems and technically simple and legal writing of PM reports.

V. Theory

Unit I

General knowledge about the laws relating to veterinary practice, professional discipline and professional etiquettes.

Unit II

Regulations dealing with diseases of animals in India regarding epidemiology, quarantine certificate, issue of soundness certificate, etc.

Unit III

Different manners/ modes of death such as criminal assault, Cruelty to animals, malicious poisoning, Snake bite, Death due to drowning, Lightning strokes during thunderstorms; Veterolegal wounds like electrocution, Gunshot wounds, Automobile accidents, and violent death; Legal implications in animals in above conditions, doping in horses, etc.

VI. Practical

- Detailed necropsy examination of various species of large and small animals including poultry, laboratory animals and wildlife. Systematic examination of brain, lungs, heart, endocrine glands, lymph nodes, liver, gastro-intestinal tract, urinary and genital systems for gross pathological and histopathological studies and correlation of the observations to diagnose the disease conditions.
- Necropsy case presentation and report writing/ protocol preparation. Collection, preservation and dispatch of morbid materials for diagnosis of viral, bacterial, protozoan, parasitic diseases, toxic/ poisoning and for histochemistry/ histopathology.

VII. Suggested Reading

- Albert C Straffuss. 1988. *Necropsy: Procedures and Basic Diagnostic Methods for Practicing Veterinarians*, Charles C. Thomas Publisher Springfield
- Benjamin Lucio-Martinez and Jodi A Korich. 2010. *Illustrated guide to Poultry Necropsy and diagnosis*, Cornell University (<https://www.slideshare.net/heshamkotb/illustrated-guide-to-poultry-necropsy-and-diagnosis>)
- D Gopala Krishna Rao. 2005. *Textbook on necropsy and histopathological techniques*, 1st Ed. Academia
- Donald B Feldman and John Curtis Seely. 1988. *Necropsy Guide: Rodents and the Rabbit*, 1st Ed. CRC Press
- Gahlot AK, Sharma SN and Tanwar RA. 2003. *Veterinary Jurisprudence*. 5th Ed. NBS Publishers, Bikaner.
- John M King, David C Dodd and Lois Roth. 2006. *The Necropsy Book*, Fifth Edition, C L Davis Foundation
- Jones TC and Gleiser CA. 1954. *Veterinary Necropsy Procedures*. JB Lippincott
- Lincoln PJ and Thomson J. 1998. *Forensic DNA Profiling Protocols*. Humana Press.
- Majó Masferrer, Natàlia, Dolz Pascual, Roser and Shivaprasad HL. 2011. *Atlas of Avian Necropsy: Macroscopic Diagnosis Sampling*, SERVET Publishers
- Rudin N and Inman K. 2002. *An Introduction to Forensic DNA Analysis*. CRC Press



- I. Course Title : Necropsy Conference**
II. Course Code : VPL 506
III. Credit Hours : 0+1

IV. Aim of the course

To promote self learning of the students in different necropsy procedures of animals including poultry and description of post-mortem lesions in different diseases/ disease conditions.

V. Practical

- Continuous assessment of students on detailed necropsy examination of various species of large and small animals including poultry; Necropsy associated cytological examinations; Systematic examination of different organs for morphologic description of gross lesions; gross photography; Collection of tissues for histopathology and based on nature of gross lesions, if possible further collection for investigation of viral/ bacterial/ protozoan/ fungal/ parasitic diseases/ toxic or poisoning, etc.
- Morphologic description of microscopic lesions; microscopic photography; correlation of gross and microscopic observations with the results of other parallel investigations to diagnose the disease conditions; presentation of select case(s) in the monthly seminars followed by report writing and final morphologic/ etiologic diagnosis, classification and preservation of microscopic slides.

VI. Suggested Reading

- Albert C Straffuss. 1988. *Necropsy: Procedures and Basic Diagnostic Methods for Practicing Veterinarians*, Charles C. Thomas Publisher Springfield.
- Benjamin Lucio-Martinez and Jodi A Korich. 2010. *Illustrated guide to Poultry Necropsy and diagnosis*, Cornell University (<https://www.slideshare.net/heshamkotb/illustrated-guide-to-poultry-necropsy-and-diagnosis>)
- D Gopala Krishna Rao. 2005. *Textbook on necropsy and histopathological techniques*, 1st Ed. Academia.
- Donald B Feldman, John Curtis Seely. 1988. *Necropsy Guide: Rodents and the Rabbit*, 1st Ed. CRC Press.
- Jones TC and Gleiser CA. 1954. *Veterinary Necropsy Procedures*. JB Lippincott.
- John M King, David C Dodd and Lois Roth. 2006. *The Necropsy Book*, Fifth Edition, C L Davis Foundation.
- Majó Masferrer, Natàlia, Dolz Pascual, Roser and Shivaprasad HL. 2011. *Atlas of Avian Necropsy: Macroscopic Diagnosis Sampling*, SERVET Publishers.

- I. Course Title : Systemic Pathology**
II. Course Code : VPL 507
III. Credit Hours : 2+1

IV. Aim of the course

To teach the students about different disease conditions of haemopoietic, circulatory, respiratory, digestive, urinary and genital systems, nervous, musculoskeletal, endocrine glands and special senses.

V. Theory

Unit I

Advanced study of pathological conditions in relation to their etiology, Pathology



and pathogenesis including examples of specific infectious or non-infectious diseases affecting cardiovascular (heart, blood vessels and lymph vessels), Respiratory (nasal cavity, Larynx, Trachea, Bronchi, Lungs and pleura) and haemopoietic (bone marrow, blood, spleen, lymph node) systems.

Unit II

Advanced study of pathological conditions in relation to their etiology, Pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting different organs of digestive (buccal cavity, pharynx, oesophagus, stomach and intestines), Urinary (kidneys, ureter, urinary bladder and urethra) and genital (male and female organs including mammary gland) systems.

Unit III

Advanced study of pathological conditions in relation to their etiology, Pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting different organs of nervous (brain and spinal cord), endocrine (pituitary, thyroid, parathyroid, pancreas) musculo-skeletal systems (muscles and bones) and organs of special senses (eye, ear), skin and its appendages (hoof, tail).

VI. Practical

- To study the morphologic description of lesions and nomenclature of a morphologic diagnosis based on gross and/ or microscopic lesions in variety of organs in the preserved specimens/ slides.
- Continuous assessment of students for their skills in the morphologic description of lesions and nomenclature of a morphologic diagnosis based on gross and/ or microscopic lesions in variety of organs during post-mortem examination of domestic animals followed by interaction in the student seminars/ group discussions.

VII. Suggested Reading

- Grant Maxie. 2015. Jubb, Kennedy & Palmer's *Pathology of Domestic Animals*, 6th Ed. Saunders Ltd.
- Vegad JL and Madhu Swamy. 2010. *A text book of Veterinary Systemic Pathology*, 2nd Ed. Publisher IDBC, Lukhnow

I. Course Title : Pathology of Infectious Diseases of Domestic Animals

II. Course Code : VPL 508

III. Credit Hours : 2+1

IV. Aim of the course

To teach the students about important infectious disease conditions of domestic animals.

V. Theory

Unit I

Study of etiology, Pathology and pathogenesis of various viral diseases-Foot and mouth disease, Vesicular stomatitis, Vesicular exanthema, Vesicular disease, Rinderpest, Bovine viral diarrhoea-Mucosal disease, Bovine malignant catarrhal fever, Infectious bovine rhinotracheitis, Parainfluenza-3, Bovine respiratory syncytial virus infection, Pox diseases, Blue tongue, Contagious ecthyma, PPR, Rabies, Canine distemper, Parvovirus infections, Infectious canine hepatitis, Pseudorabies, Classical swine fever, Swine and Equine influenza, Equine infectious anaemia, African horse

sickness, Equine viral arteritis, Equine viral encephalomyelitis, Equine herpesvirus infections, Papillomatosis, Rift Valley fever, Japanese encephalitis, Ovine encephalomyelitis (Louping ill) and Prion diseases.

Unit II

Study of etiology, pathology and pathogenesis of various bacterial diseases-Tuberculosis, Johne's disease, Actinobacillosis, Actinomycosis, Brucellosis, Listeriosis, Pasteurellosis, Leptospirosis, Anthrax, Clostridial group of diseases, Streptococcal and Staphylococcal infections, Campylobacter infections, Swine erysipelas, Glasser's disease, Foot rot, Colibacillosis and Salmonellosis, Glanders, Melioidosis, Nocardiosis, Cutaneous streptothricosis, Corynebacterium infections, Chlamydial and Mycoplasma infections.

Unit III

Study of etiology, Pathology and pathogenesis of various fungal, Rickettsial and parasitic diseases-Aspergillosis, Blastomycosis, Coccidioidomycosis, Histoplasmosis, Epizootic lymphangitis, Rhinosporidiosis, Sporotrichosis, Candidiasis, Cryptococcosis, Dermatomycoses; Diseases due to commonly occurring mycotoxins; Important rickettsial diseases-Q-fever, Heart water disease, Ehrlichiosis, Anaplasmosis, Haemobartonellosis; Important protozoan diseases-Coccidiosis, Toxoplasmosis, Babesiosis, Theilariosis, Cryptosporidiosis, Trypanosomiasis and Pathology of important diseases caused by helminths.

VI. Practical

Morphologic description of lesions based on gross and/ or microscopic lesions and the study of their correlation with a specific disease in the preserved specimens/ slides.

VII. Suggested Reading

- Jones TC, Hunt RD & King NW. 1997. *Veterinary Pathology*. Blackwell Publishing.
- Grant Maxie. 2015. Jubb, Kennedy & Palmer's *Pathology of Domestic Animals*, 6th Ed. Saunders Ltd.
- Gary Procop and Bobbi Pritt. 2014. *Pathology of Infectious Diseases*, 1st Ed. Saunders

I. Course Title : Toxicopathology

II. Course Code : VPL 509

III. Credit Hours : 2+1

IV. Aim of the course

To teach student about toxicity in livestock due to plants and extraneous poisons.

V. Theory

Unit I

Introduction, classification and mode of action of different poisons.

Unit II

Study of pathogenesis, symptoms, gross and microscopic pathology of diseases caused by toxic plants, Organic and inorganic poisons commonly taken or administered maliciously to different species of domestic animals.

Unit III

Various regulatory bodies and regulatory processes, Protocols in conducting toxicopathological trials; Chronology for conducting preclinical toxicology. OECD-



Good Laboratory Practices, Toxicopathological profile including battery of tests for pharmaceutical/ toxic agents.

Unit IV

In-vitro and *In vivo* models for toxicity studies and evaluation parameters.

VI. Practical

- To study gross and histopathological alterations as a result of ingestion of toxic plants and extraneous poisons in domestic animals.
- Assignments on commonly occurring toxic plants of the region; Diagnosis of commonly taken or maliciously administered poisonous substances.

VII. Suggested Reading

- Jones TC, Hunt RD and King NW. 1997. *Veterinary Pathology*. Blackwell Publishing.

I. Course Title : Avian Pathology

II. Course Code : VPL 510

III. Credit Hours : 2+1

IV. Aim of the course

To teach the students about the different disease conditions of poultry.

V. Theory

Unit I

Avian inflammation and immunology, Study of etio-pathology, symptoms, transmission, and diagnosis of infectious diseases of chickens, turkeys, ducks and other birds caused by Bacteria: *Salmonella*, *Escherichia coli* and Clostridial infections, Infectious coryza, Fowl cholera, Tuberculosis and Spirochaetosis; Chlamydial and Mycoplasmal infections; Viruses: Ranikhet disease, Infectious bursal disease, Infectious bronchitis, Infectious laryngotracheitis, Marek's disease, Leukosarcoma group of diseases, Reticuloendotheliosis, Fowl pox, Avian influenza, Avian encephalomyelitis, Inclusion body hepatitis, Hydropericardium syndrome, Egg drop syndrome-76, Chicken infectious anaemia, Avian nephritis, Reovirus infections- Viral arthritis and Infectious stunting syndrome, Duck plague, Duck viral hepatitis, Coronaviral enteritis and Haemorrhagic enteritis of turkeys: Fungi and mycotoxins; Parasites-Coccidiosis, Histomoniasis, Round worm and Tape worm infections; Ecto-parasites of birds.

Unit II

Study of etio-pathology, clinical symptoms, and diagnosis of nutritional deficiencies - Vitamin and Mineral deficiencies; Metabolic diseases-Ascites, Gout, Fatty liver and kidney syndrome, Fatty liver haemorrhagic syndrome, Cage layer fatigue, etc.; Miscellaneous conditions of poultry-Heat stress, Blue comb, Breast blister, Bumble foot, Cannibalism, False layer, Internal layer, Pendulous crop, Round heart disease etc.

Unit III

Emerging and re-emerging diseases of poultry: Introduction to an emerging and a re-emerging pathogen, mechanisms of poultry pathogen's emergence, co-evolution of poultry pathogens with their vaccines and medications, common diseases of poultry susceptible to point mutations and their pathology.

VI. Practical

- Necropsy examination of the different species of poultry; morphologic description of gross and/ or microscopic lesions in the preserved specimens/ slides.
- Continuous assessment of students for their skills in the diagnosis of gross lesions in different organs of various systems during post-mortem examination of poultry. Preparation of histopathology slides on the select cases followed by interaction in the student seminars/ group discussions.

VII. Suggested Reading

- Saif YM, Barnes FJ, Glisson JR, Fadly AM, Mc Dougald LR & Swayne D. 2008. *Diseases of Poultry*. 12th Ed. Blackwell Publishing.
- Randall CJ. 1984. *A Colour Atlas of Diseases of the Domestic Fowl and Turkey*, Mosby International.
- Majó Masferrer, Natàlia, Dolz Pascual, Roser and Shivaprasad HL. 2011. *Atlas of Avian Necropsy: Macroscopic Diagnosis Sampling*, SERVET Publishers.
- Benjamin Lucio-Martinez and Jodi A Korich. 2010. *Illustrated guide to Poultry Necropsy and diagnosis*, Cornell University (<https://www.slideshare.net/heshamkotb/illustrated-guide-to-poultry-necropsy-and-diagnosis>)

I. Course Title : Pathology of Wild/ Zoo and Aquatic Animal Diseases

II. Course Code : VPL 511

III. Credit Hours : 2+1

IV. Aim of the course

To teach the pathology and diagnosis of different disease conditions of wild and aquatic animals particularly fish.

V. Theory

Unit I: Wild/ Zoo Animal diseases

Etiology, transmission, gross and microscopic pathology of some commonly occurring infectious diseases of wild animals: West Nile fever, Rabies, Foot and mouth disease, Pox, Kyasanaur forest disease, Infectious hepatitis virus, Infectious feline peritonitis, Anthrax, Tuberculosis, Colibacillosis, Clostridial infections Trypanosomosis, Babesiosis, Theileriosis; Etiology, gross and microscopic pathology of commonly occurring non-infectious diseases of Wild/ Zoo animals.

Unit II: Infectious diseases of fish

Study of etiology, gross and microscopic pathology of Bacterial diseases- Bacterial cold water disease, Bacterial fin disease, Gill rot, Furunculosis, Aeromonas septicemia, Epizootic ulcerative syndrome, Yersiniosis, Pseudomoniasis, Alteromoniasis, Pasteurellosis, Enteric septicemia of catfish, Edwardsiellosis, Vibrinosis, Streptococcosis, Bacterial kidney disease, Mycobacteriosis, Nocardiosis, Epitheliocystis: Salmonid rickettsialsepticaemia, Columnaris disease; Viral diseases-Spring viremia of carp, Infectious pancreatic necrosis, Viral hemorrhagic septicaemia, Koi herpes virus disease, Infectious spleen and kidney necrosis, Carp pox, Virus nervous necrosis, Lymphocystis disease, Infectious salmon anemia, Salmon alpha virus infections, Infectious hematopoietic necrosis, Herpes viral hematopoietic necrosis, Chinese grass carp reovirusdisease, Viral hemorrhagic necrosis, Epizootic hemorrhagic necrosis; Fungal diseases- Saprolegniasis, Branchiomycosis (Gill rot), Ichthyosporidiosis, Exophiala infection, Aphanomyces and Fusarium infection; Parasitic and Protozoal diseases-Ich



or White spot disease, Costiasis, Trichodiniasis, Velvet disease, Coral fish disease, Epistylis, Red sore disease, Glossatella, Myxosporidiosis, Whirling disease, Microsporidiosis (Glugea, Pleistophora, Loma), Coccidiosis, Proliferative kidney disease, Cryptosporidiosis.

Unit III: Other diseases of Fish

Nutritional diseases-Nutritional deficiency of protein, lipid, carbohydrate, vitamins and minerals; Neoplastic conditions- Melanoma in Platyfish/ Swordtail hybrids, Hepatoma and hepatocellular carcinoma in rainbow trout, Stomatopapilloma of eels (Cauliflower disease), Papilloma of the brown bullhead, Lip Fibroma (Fibropapilloma) of Angel fish, Dermal fibrosarcomas of walleye pike, Lymphosarcoma of pike, Schwannoma/ Neurofibromas of the bicoloured damselfish; Environmental stress-Gas bubble disease, Acidosis/ Alkalosis, Thermal shock, Sun burn disease, Anoxia, Increased in dissolved CO₂ or H₂S or Ammonia concentration in water, Increased in turbidity of pond water, Algal toxicosis disease.

VI. Practical

Post-mortem examination of wild animals including wild birds. Study of gross and microscopic lesions of important infectious and non-infectious diseases of fish and wild animals

VII. Suggested Reading

- Arora BM. 1984. *Wildlife Diseases in India*. Periodical Expert Book Agency.
- Fowler ME. 1978. *Zoo and Wild Animal Medicine*. WB Saunders.
- Roberts RJ. 1979. *Fish Pathology*. Bailliere Tindall, London

I. Course Title : Pathology of Laboratory Animal Diseases

II. Course Code : VPL 512

III. Credit Hours : 2+1

IV. Aim of the course

To teach the students about pathology and diagnosis of different disease conditions of laboratory animals.

V. Theory

Unit I

Etiology, transmission, gross and microscopic pathology of some commonly occurring diseases of Rabbits: Pasteurellosis, Bordetellosis, Colibacillosis, Tyzzer's disease, Staphylococcal infections, Venereal spirochetosis, (rabbit syphilis, cuniculosis), Proliferative ileotyphilitis, Salmonellosis, Tularemia, Clostridium infections, Myxomatosis, Rabbit fibroma/ Shope fibroma, Rabbit papillomatosis, Viral hemorrhagic disease, Coccidiosis, Enephalotozoonoses, Baylisascarisprocyonis, Cestode, Mites, Fleas and lice, miscellaneous and neoplastic diseases of rabbits.

Unit II

Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Rats: Bacterial diseases-Staphylococcal dermatitis, Pasteurellosis, Streptococcal diseases, Helicobacter infection, CAR bacillus, Mycoplasma pulmonis, Pseudotuberculosis (corynebacteriosis), Tyzzer's disease, Salmonellosis, Rat bite fever; Viral diseases- Rat theilo virus (RTV-1), Parvovirus, coronavirus, pneumonia virus of mice, Hantaan virus, Sendai virus, Reovirus-3, Protozoan diseases

(Trichomonads, *Chilomastixbettencorti*, *Spironucleusmuris*, *Giardia muris*, Rat sarcodines, Rat enteric coccidian), Arthropods (Mesostigmated mites, lice of rats), Helminths (rat pinworms, Hymenolepid tapeworm, Cestodes with a rat intermediate host, rat threadworms); fungal disease (*Pneumocystis carinii*), other miscellaneous and neoplastic diseases

Unit III

Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Mice: Bacterial diseases- *Helicobacter* infection, Pasteurellosis, Staphylococcal furunculosis, *Mycoplasma pulmonis*, Cilia associated respiratory bacillus, *Corynebacterium bovis*, *Pseudomonas aeruginosa*, *Citrobacter rodentium*, Tyzzer's disease, Salmonellosis; Viral diseases- Mouse norovirus, Mouse hepatitis virus, Mouse encephalomyelitis virus, Epizootic diarrhoea of infant mice, Parvovirus, Murine cytomegalovirus, Mouse adenovirus, Ectromelia virus, Lymphocytic choriomengitis virus, Pneumonia virus of mice, Lactate dehydrogenase elevating virus, Sendai virus, Mouse thymic virus, Mouse polyoma viruses, Reo-3 virus; Parasitic diseases-Pin worms, Fur mites of mice, Mange mites, Mesostigmatid mites, Lice of mice, Trichomonads, *Chilomastixbettencorti*, *Spironucleusmuris*, *Giardia muris*, Mouse sarcodines, Mouse enteric coccidian, Mouse parental coccidian, Mouse sporozoans, Hymenolepid tapeworms, Encysted tape worm; Fungal disease (*Pneumocystis pneumonia*) and other miscellaneous and neoplastic diseases

Unit IV

Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Guinea pigs: Bacterial diseases- Antibiotic-induced enterotoxemia/haemorrhagic typhlitis, *Bordetella pneumonia*, Streptococcal pneumonia, Cervical lymphadenitis, Pododermatitis, Mastitis, Tyzzer's disease, Salmonellosis; Viral diseases- Guinea pig cytomegalovirus, Adenovirus, Parainfluenza virus, Corona-like virus, Lymphocytic choriomeningitis virus; Parasitic diseases- Coccidia, Fur mites, Helminthes, Lice of guinea pigs, Mange mites, Cryptosporidiosis, Microsporidium parasites and other miscellaneous conditions

Unit V

Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Hamsters, Gerbills and primates

VI. Practical

Post-mortem examination of laboratory animals. Study of gross and microscopic lesions of important infectious and non-infectious diseases of laboratory animals

VII. Suggested Reading

- Beninchka K, Garner FM and Jones TC. 1978. *Pathology of Laboratory Animals*. Vols. I, II. Springer Verlag.



Course Outline-cum-Lecture Schedule for Master Degree Programme

I. Course Title : General Pathology

II. Course Code : VPL 501

III. Credit hours : 2+1

IV. Aim of the course

To acquaint the students with different types of degenerations, cell injuries caused by different types of irritants and inflammation

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Introduction and principles of Pathology including genetic basis of disease	3
2.	Cellular responses to injury: Causes and mechanisms of reversible and irreversible cell injury; morphologic characteristics, significance and fate of various intracellular (lipids, glycogen, proteins) and extracellular (hyaline material, amyloid, fibrinoid change, gout) accumulations/ degenerations, endogenous and exogenous pigmentations, cell death (necrosis and apoptosis), pathologic calcifications and cellular adaptive changes	9
3.	Inflammation and repair: Introduction to inflammation, acute inflammation-cellular and molecular events including mediators and heat shock proteins of acute inflammation; cellular components, morphologic classification and outcomes of acute inflammation	5
4.	Chronic inflammation-causes, morphologic features and cellular components of chronic inflammation, healing and repair, systemic effects of inflammation	5
5.	Disturbances in circulation: Causes, mechanisms, morphologic features, significance and fate of hyperemia, oedema, haemorrhage, thrombosis, embolism, ischaemia, infarction and shock	6
6.	Immune mediated reactions: Introduction to autoimmunity and immune mediated diseases, mechanisms of hypersensitivity reactions.	4
Practical		
1.	To study the morphologic descriptions of lesions and nomenclature of a morphologic diagnosis based on gross and/ or microscopic lesions of variety of conditions (degenerations, infiltrations, pigmentations, necrosis, circulatory and growth disturbances and different types of inflammation) in the preserved specimens/ slides.	6
2.	Demonstration of post-mortem changes.	2
3.	Continuous assessment of students for their skills in the diagnosis of gross lesions during post-mortem examination of different tissues of domestic animals.	4



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
4.	Preparation of histopathology slides on the select cases followed by interaction in the student seminars/ group discussions.	4

I. Course Title : Techniques in Pathology

II. Course Code : VPL 502

III. Credit hours : 0+2

IV. Aim of the course

To acquaint the students with different techniques used frequently in Veterinary Pathology

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
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Practical

- | | | |
|----|---|----|
| 1. | Basic histopathological techniques-Collection of tissues, fixation, processing, section cutting and H and E staining of tissue sections. Collection and fixation of tissues for scanning electron microscopy, transmission electron microscopy, histochemical, toxicological, bacteriological and virological examinations. Application of micrometry and special staining techniques. Demonstration of different inclusions, bacteria and fungi in tissues | 10 |
| 2. | Principles of dark field, phase contrast and fluorescent microscopy; introduction to scanning electron microscopy and transmission electron microscopy | 5 |
| 3. | Histochemical techniques for demonstration of fat, glycogen, connective tissue, mucopolysaccharides and common enzymes, pigments and minerals | 7 |
| 4. | Cryosectioning and application of immunohistochemical techniques-immunoperoxidase and immunofluorescence | 3 |
| 5. | Principles and applications of PCR and its variants | 2 |
| 6. | Museum specimen preparation and maintenance | 5 |
-

I. Course Title : Animal Oncology

II. Course Code : VPL 503

III. Credit hours : 1+1

IV. Aim of the course

To acquaint the students with different types of neoplasms of domestic animals, their nature, cause, pathology and diagnosis.



Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Tumour-Etiology, carcinogens and oncogenesis, nomenclature and classification, characteristics of benign and malignant tumours, molecular mechanisms, pathways of spread of tumors and tumor immunology	4
2.	Effects of tumour, grading and staging and laboratory diagnosis of tumours. Animal tumour models–experimental induction of neoplasms	4
3.	Pathology of different types of epithelial and connective tissue tumours with their characteristic identification features and epidemiology	2
4.	Tumours of respiratory, haemopoietic, integumentary, musculoskeletal, gastrointestinal, hepatobiliary, uro-genital, nervous, ocular, ear and endocrine system	6
Practical		
1.	Cytological diagnosis of tumours via impression smears and Fine Needle Aspiration Cytology.	8
2.	To study the gross and microscopic changes in different types of neoplasms.	8

I. Course Title : Clinical Pathology

II. Course Code : VPL 504

III. Credit hours : 1 + 1

IV. Aim of the course

To acquaint the students with clinical alterations in blood, urine, CSF and other body fluids due to different diseases.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Study of changes in blood/ plasma/ serum including biochemical profile for organ function tests	8
2.	Cytological examination and examination of urine, faeces, cerebrospinal fluid and biopsy specimens and their interpretation	8
Practical		
1.	Analysis of clinical samples (blood/ serum/ plasma) and their interpretations	4
2.	Analysis of clinical samples (urine) and their interpretations	2
3.	Analysis of clinical samples (faeces) and their interpretations	2
4.	Analysis of biopsy samples (exfoliative/ FNAC) and their interpretations	4
5.	Analysis of biochemical profile for organ function tests in different disease conditions in animals	4



- I. Course Title : Necropsy Procedures and Interpretations**
II. Course Code : VPL 505
III. Credit hours : 0+1

IV. Aim of the course

To acquaint the students with necropsy procedures in large and small animals and study of PM lesions in different diseases.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Practical		
1.	Detailed necropsy examination of various species of large and small animals including poultry, laboratory animals and wildlife.	4
2.	Systematic examination of brain, lungs, heart, endocrine glands, lymph nodes, liver, gastro-intestinal tract, urinary and genital systems for gross pathological and histopathological studies and correlation of the observations to diagnose the disease conditions.	8
3.	Necropsy case presentation and report writing/ protocol preparation. Collection, preservation and dispatch of morbid materials for diagnosis of viral, bacterial, protozoan, parasitic diseases, toxic/ poisoning and for histochemistry/ histopathology.	4

- I. Course Title : Necropsy Conference**
II. Course Code : VPL 506
III. Credit hours : 0 + 1

IV. Aim of the course

To promote self-learning of the students in different necropsy procedures of animals including poultry and description of post-mortem lesions in different diseases/ disease conditions.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Practical		
1.	Continuous assessment of students on detailed necropsy examination of various species of large and small animals including poultry; necropsy associated cytological examinations; systematic examination of different organs for morphologic description of gross lesions; gross photography; collection of tissues for histopathology and based on nature of gross lesions, if possible further collection for investigation of viral/ bacterial/ protozoan/ fungal/ parasitic diseases/ toxic or poisoning, etc.	8
2.	Morphologic description of microscopic lesions; microscopic photography; correlation of gross and microscopic observations with the results of other parallel investigations to diagnose the disease conditions; presentation of select case(s) in the monthly	



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
	seminars followed by report writing and final morphologic/ etiologic diagnosis, classification and preservation of microscopic slides.	8

- I. Course Title : Systemic Pathology**
II. Course Code : VPL 507
III. Credit hours : 2 + 1

IV. Aim of the course

To teach the students about different disease conditions of haemopoietic, circulatory, respiratory, digestive, urinary and genital systems, nervous, musculoskeletal, endocrine glands and special senses.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Advanced study of pathological conditions in relation to their etiology, pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting cardiovascular (heart, blood vessels and lymph vessels) and respiratory (nasal cavity, larynx, trachea, bronchi, lungs and pleura).	8
2.	Advanced study of pathological conditions in relation to their etiology, pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting digestive (buccal cavity, pharynx, oesophagus, stomach and intestines) and haemopoietic (bone marrow, blood, spleen, lymph node) systems.	8
3.	Advanced study of pathological conditions in relation to their etiology, pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting urinary (kidneys, ureter, urinary bladder and urethra) and genital (male and female organs including mammary gland) systems.	8
4.	Advanced study of pathological conditions in relation to their etiology, pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting nervous (brain and spinal cord), endocrine (pituitary, thyroid, parathyroid, pancreas) musculo-skeletal systems (muscles and bones) and organs of special senses (eye, ear), skin and its appendages (hoof, tail).	8
Practical		
1.	To study the morphologic description of lesions and nomenclature of a morphologic diagnosis based on gross and/ or microscopic lesions in variety of organs in the preserved specimens/ slides.	8
2.	Continuous assessment of students for their skills in the morphologic description of lesions and nomenclature of a morphologic diagnosis based on gross and/ or microscopic lesions in variety of organs during post-mortem examination of domestic animals followed by interaction in the student seminars/ group discussions.	8



- I. Course Title : Pathology of infectious diseases of domestic animals**
II. Course Code : VPL 508
III. Credit hours : 2 + 1

IV. Aim of the course

To teach the students about important infectious disease conditions of domestic animals.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Study of etiology, pathology and pathogenesis of various viral diseases- Foot and mouth disease, Vesicular stomatitis, Vesicular exanthema, Vesicular disease, Rinderpest, Bovine viral diarrhoea-Mucosal disease, Bovine malignant catarrhal fever, Infectious bovine rhinotracheitis, Parainfluenza-3, Bovine respiratory syncytial virus infection, Pox diseases, Blue tongue, Contagious ecthyma, PPR	7
2.	Study of etiology, pathology and pathogenesis of various viral diseases- Rabies, Canine distemper, Parvovirus infections, Infectious canine hepatitis, Pseudorabies, Classical swine fever, Swine and Equine influenza, Equine infectious anaemia, African horse sickness, Equine viral arteritis, Equine viral encephalomyelitis, Equine herpesvirus infections, Papillomatosis, Rift Valley fever, Japanese encephalitis, Ovine encephalomyelitis (Louping ill) and Prion diseases.	5
3.	Study of etiology, pathology and pathogenesis of various bacterial diseases- Tuberculosis, Johne's disease, Actinobacillosis, Actinomycosis, Brucellosis, Listeriosis, Pasteurellosis, Leptospirosis, Anthrax, Clostridial group of diseases, Streptococcal and Staphylococcal infections.	5
4.	Study of etiology, pathology and pathogenesis of various bacterial diseases- Campylobacter infections, Swine erysipelas, Glasser's disease, Foot rot, Colibacillosis and Salmonellosis, Glanders, Melioidosis, Nocardiosis, Cutaneous streptothricosis, Corynebacterium infections, Chlamydial and Mycoplasma infections.	5
5.	Study of etiology, pathology and pathogenesis of various fungal diseases-Aspergillosis, Blastomycosis, Coccidioidomycosis, Histoplasmosis, Epizootic lymphangitis, Rhinosporidiosis, Sporotrichosis, Candidiasis, Cryptococcosis, Dermatomycoses; Diseases due to commonly occurring mycotoxins	5
6.	Important rickettsial diseases- Q-fever, Heart water disease, Ehrlichiosis, Anaplasmosis, Haemobartonellosis; Important protozoan diseases-Coccidiosis, Toxoplasmosis, Babesiosis, Theilariosis, Cryptosporidiosis, Trypanosomiasis and Pathology of important diseases caused by helminthes	5
Practical		
1.	Morphologic description of lesions based on gross and/ or microscopic lesions and the study of their correlation with a specific disease in the preserved specimens/ slides.	16



- I. Course Title : Toxicopathology**
II. Course Code : VPL 509
III. Credit Hours : 2 + 1

IV. Aim of the course

To teach student about toxicity in livestock due to plants and extraneous poisons.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Introduction, classification and mode of action of different poisons.	4
2.	Study of pathogenesis, symptoms, gross and microscopic pathology of diseases caused by toxic plants, organic and inorganic poisons commonly taken or administered maliciously to different species of domestic animals	12
3.	Various regulatory bodies and regulatory processes, porticos in conducting toxicopathological trials. Chronology for conducting preclinical toxicology. OECD-Good Laboratory Practices, toxicopathological profile including battery of tests for pharmaceutical/toxic agents	8
4.	<i>In-vitro</i> and <i>in-vivo</i> models for toxicity studies and evaluation parameters	8
Practical		
1.	To study gross and histopathological alterations as a result of ingestion of toxic plants and extraneous poisons in domestic animals.	8
2.	Assignments on commonly occurring toxic plants of the region; Diagnosis of commonly taken or maliciously administered poisonous substances.	8

- I. Course Title : Avian Pathology**
II. Course Code : VPL 510
III. Credit hours : 2 + 1

IV. Aim of the course

To teach the students about the different disease conditions of poultry.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Avian inflammation and immunology, Study of etio-pathology, symptoms, transmission, and diagnosis of infectious diseases of chickens, turkeys, ducks and other birds caused by Viruses: Ranikhet disease, Infectious bursal disease, Infectious bronchitis, Infectious laryngotracheitis, Marek's disease, Leukosarcoma group of diseases, Reticuloendotheliosis, Fowl pox, Avian influenza, Avian encephalomyelitis, Inclusion body hepatitis, Hydropericardium syndrome, Egg drop syndrome-76, Chicken infectious anaemia, Avian nephritis,	



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
	Reovirus infections- Viral arthritis and Infectious stunting syndrome, Duck plague, Duck viral hepatitis, Coronaviral enteritis and Haemorrhagic enteritis of turkeys	12
2.	Study of etio-pathology, symptoms, transmission, and diagnosis of infectious diseases of chickens, turkeys, ducks and other birds caused by Bacteria: <i>Salmonella</i> , <i>Escherichia coli</i> and Clostridial infections, Infectious coryza, Fowl cholera, Tuberculosis and Spirochaetosis; Chlamydial and Mycoplasmal infections; Fungi and mycotoxins; Parasites-Coccidiosis, Histomoniasis, Round worm and Tape worm infections; Ecto-parasites of birds	10
3.	Study of etio-pathology, clinical symptoms, and diagnosis of nutritional deficiencies -Vitamin and Mineral deficiencies; Metabolic diseases-Ascites, Gout, Fatty liver and kidney syndrome, Fatty liver haemorrhagic syndrome, Cage layer fatigue, etc.; Miscellaneous conditions of poultry-Heat stress, Blue comb, Breast blister, Bumble foot, Cannibalism, False layer, Internal layer, Pendulous crop, Round heart disease, etc.	6
4.	Emerging and re-emerging diseases of poultry: Introduction to an emerging and a re-emerging pathogen, mechanisms of poultry pathogen's emergence, co-evolution of poultry pathogens with their vaccines and medications, common diseases of poultry susceptible to point mutations and their pathology	4
Practical		
1.	Necropsy examination of the different species of poultry; morphologic description of gross and/ or microscopic lesions in the preserved specimens/ slides.	8
2.	Continuous assessment of students for their skills in the diagnosis of gross lesions in different organs of various systems during post-mortem examination of poultry. Preparation of histopathology slides on the select cases followed by interaction in the student seminars/ group discussions.	8

I Course Title : Pathology of Wild/ Zoo and Aquatic Animal Diseases

II. Course Code : VPL 511

III. Credit hours : 2 + 1

IV. Aim of the course

To teach the pathology and diagnosis of different disease conditions of wild and aquatic animals particularly fish

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Wild/ Zoo Animal diseases: Etiology, transmission, gross and microscopic pathology of commonly occurring infectious diseases of wild animals: West Nile fever, Rabies, Foot and mouth disease, Pox,	



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
	Kyasanaur forest disease, Infectious hepatitis virus, Infectious feline peritonitis, Anthrax, Tuberculosis, Colibacillosis, Clostridial infections Trypanosomosis, Babesiosis, Theileriosis; Etiology, gross and microscopic pathology of commonly occurring non-infectious diseases of Wild/ Zoo animals.	7
2.	Infectious diseases of Fish: Study of etiology, gross and microscopic pathology of Viral diseases-Spring viremia of carp, Infectious pancreatic necrosis, Viral hemorrhagic septicaemia, Koi herpes virus disease, Infectious spleen and kidney necrosis, Carp pox, Virus nervous necrosis, Lymphocystis disease, Infectious salmon anemia, Salmon alpha virus infections, Infectious hematopoietic necrosis, Herpes viral hematopoeitic necrosis, Chinese grass carp reovirus disease, Viral hemorrhagic necrosis, Epizootic hemorrhagic necrosis; Fungal diseases- Saprolegniasis, Branchiomycosis (Gill rot), Ichthyosporidiosis, Exophiala infection, Aphanomyces and Fusarium infection.	7
3.	Infectious diseases of Fish: Study of etiology, gross and microscopic pathology of Bacterial diseases- Bacterial cold water disease, Bacterial fin disease, Gill rot, Furunculosis, Aeromonas septicemia, Epizootic ulcerative syndrome, Yersiniosis, Pseudomoniasis, Alteromoniasis, Pasteurellosis, Enteric septicemia of catfish, Edwardsiellosis, Vibriosis, Streptococcosis, Bacterial kidney disease, Mycobacteriosis, Nocardiosis, Epitheliocystis: Salmonidrickettsialsepticaemia, Columnaris disease; Parasitic and Protozoal diseases-Ich or White spot disease, Costiasis, Trichodiniasis, Velvet disease, Coral fish disease, Epistylis, Red sore disease, Glossatella, Myxosporidiosis, Whirling disease, Microsporidiosis (Glugea, Pleistophora, Loma), Coccidiosis, Proliferative kidney disease, Cryptosporidiosis.	6
4.	Other diseases of Fish: Nutritional diseases- Neoplastic conditions- Melanoma in Platyfish/ Swordtail hybrids, Hepatoma and hepatocellular carcinoma in rainbow trout, Stomatopapilloma of eels (Cauliflower disease), Papilloma of the brown bullhead, Lip Fibroma (Fibropapilloma) of Angel fish, Dermal fibrosarcomas of walleye pike, Lymphosarcoma of pike, Schwannoma/ Neurofibromas of the bicoloured damselfish.	6
5.	Other diseases of Fish: Nutritional diseases- Nutritional deficiency of protein, lipid, carbohydrate, vitamins and minerals; Environmental stress- Gas bubble disease, Acidosis/ Alkalosis, Thermal shock, Sun burn disease, Anoxia, Increased in dissolved CO ₂ or H ₂ S or Ammonia concentration in water, Increased in turbidity of pond water, Algal toxicosis disease.	6
Practical		
1.	Post-mortem examination of wild animals including wild birds. Study of gross and microscopic lesions of important infectious and non-infectious diseases of fish and wild animals.	16



- I. Course Title : Pathology of Laboratory Animal Diseases**
II. Course Code : VPL 512
III. Credit hours : 2 + 1

IV. Aim of the course

To teach the students about pathology and diagnosis of different disease conditions of laboratory animals.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Etiology, transmission, gross and microscopic pathology of some commonly occurring diseases of Rabbits: Pasteurellosis, Bordetellosis, Colibacillosis, Tyzzer's disease, Staphylococcal infections, Venereal spirochetosis, (rabbit syphilis, cuniculosis), Proliferative ileotyphilitis, Salmonellosis, Tularemia, Clostridium infections, Myxomatosis, Rabbit fibroma/ Shope fibroma, Rabbit papillomatosis, Viral hemorrhagic disease, Coccidiosis, Enephalotozoonoses, Baylisascarisprocyonis, Cestode, Mites, Fleas and lice, miscellaneous and neoplastic diseases of rabbits	5
2.	Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Rats: Bacterial diseases-Staphylococcal dermatitis, Pasteurellosis, Streptococcal diseases, Helicobacter infection, CAR bacillus, Mycoplasma pulmonis, Pseudotuberculosis (corynobacteriosis), Tyzzer's disease, Salmonellosis, Rat bite fever; Protozoan diseases (Trichomonads, <i>Chilomastix bettencorti</i> , <i>Spiroucleus muris</i> , <i>Giardia muris</i> , Rat sarcodines, Rat enteric coccidian), Arthropods (Mesostigmated mites, lice of rats), Helminths (rat pinworms, Hymenolepid tapeworm, Cestodes with a rat intermediate host, rat threadworms).	5
3.	Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Rats: Viral diseases- Rat theilo virus (RTV-1), Parvovirus, coronavirus, pneumonia virus of mice, Hantaan virus, Sendai virus, Reovirus-3 fungal disease (<i>Pneumocystis carinii</i>), other miscellaneous and neoplastic diseases	5
4.	Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Mice: Bacterial diseases- Helicobacter infection, Pasteurellosis, Staphylococcal furunculosis, <i>Mycoplasma pulmonis</i> , Cilia associated respiratory bacillus, <i>Corynebacterium bovis</i> , <i>Pseudomonas aeruginosa</i> , <i>Citrobacter rodentium</i> , Tyzzer's disease, Salmonellosis; Parasitic diseases-Pin worms, Fur mites of mice, Mange mites, Mesostigmatid mites, Lice of mice, Trichomonads, <i>Chilomastix bettencorti</i> , <i>Spiroucleus muris</i> , <i>Giardia muris</i> , Mouse sarcodines, Mouse enteric coccidian, Mouse parentral coccidian, Mouse sporozoans, Hymenolepid tapeworms, Encysted tape worm	5
5.	Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Mice: Viral diseases- Mouse norovirus, Mouse hepatitis virus, Mouse encephalomyelitis virus, Epizootic diarrhoea of infant mice, Parvovirus, Murine cytomegalovirus, Mouse adenovirus, Ectromelia virus, Lymphocytic choriomengitis virus, Pneumonia virus of mice, Lactate dehydrogenase elevating virus,	



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
	Sendai virus, Mouse thymic virus, Mouse polyoma viruses, Reo-3 virus; Fungal disease (<i>Pneumocystis</i> pneumonia) and other miscellaneous and neoplastic diseases	5
6.	Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Guinea pigs: Bacterial diseases- Antibiotic-induced enterotoxemia/ haemorrhagic typhlitis, <i>Bordetella</i> pneumonia, Streptococcal pneumonia, Cervical lymphadenitis, Pododermatitis, Mastitis, Tyzzer's disease, Salmonellosis; Viral diseases- Guinea pig cytomegalovirus, Adenovirus, Parainfluenza virus, Corona-like virus, Lymphocytic choriomeningitis virus; Parasitic diseases- Coccidia, Fur mites, Helminthes, Lice of guinea pigs, Mange mites, Cryptosporidiosis, Microsporidium parasites and other miscellaneous conditions	5
7.	Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Hamsters, Gerbills and primates	2
Practical		
1.	Post-mortem examination of laboratory animals. Study of gross and microscopic lesions of important infectious and non-infectious diseases of laboratory animals.	16



Course Title with Credit Load

Ph.D. in Veterinary Pathology (VPL)

Course Code	Course Title	Credit Hours
VPL 601	Molecular and Ultrastructural Basis of Cell Injury*	2+1
VPL 602	Molecular Basis of Inflammation	1+1
VPL 603	Molecular Basis of Neoplasia	1+1
VPL 604	Immunopathology*	2+1
VPL 605	Advances in Diagnostic Pathology	1+2
VPL 606	Pathology of Nutritional and Metabolic Disturbances	2+1
VPL 607	Pathology of Important Emerging and Re-Emerging Diseases of Pets and Livestock	2+1
VPL 608	Research Methodology in Pathology*	1+0
VPL 609	Necropsy Conference I*	0+1
VPL 690	Special Problem	0+1
VPL 691	Doctoral Seminar-I*	1+0
VPL 692	Doctoral Seminar-II*	1+0
VPL 699	Doctoral Research	75

*Core courses



Course Contents

Ph.D. in Veterinary Pathology (VPL)

- I. Course Title** : Molecular and Ultrastructural Basis of Cell Injury
II. Course Code : VPL 601
III. Credit Hours : 2+1

IV. Aim of the course

To teach the students about different molecular including ultrastructural changes in diseases conditions.

V. Theory

Unit I

Study of cells- cell morphology, interpretation of normal and abnormal cells.

Unit II

Overview of Cell injury, Targets of cell injury-Cell membranes, Aerobic respiration, structural proteins and enzymes and genetic apparatus of the cell; Mechanisms of cell injury-hypoxia, Injury by free radicals, Chemical injury, Infectious agents, other forms of cell injury-immune mediated reactions, Genetic derangements; Mechanisms of cell membrane damage; Mechanisms of DNA damage-base loss, Base modification, chemical modification, Replication errors, Inter-strand cross-links, DNA-protein cross-links, Strand breaks. Molecular and immunopathological changes associated with different types of cell injuries.

Unit III

Morphology of Reversible and irreversible cell injury with particular emphasis on ultra structural changes in the cells and organelles: Morphology of cell death-necrosis, Apoptosis and autolysis, Mechanism of apoptosis, Intracellular and extracellular accumulations, Pigment and tissue deposits, Consequences of cell injury Cellular adaptations-hyperplasia, Hypertrophy, Atrophy, Metaplasia and dysplasia.

Unit IV

Mechanism of other types of cell death, viz., Pyroptosis, Ferroptosis, Autophagy, ETOSIS, etc.

VI. Practical

Collection and preparation of specimens for electron microscopic studies. Interpretation of ultra-structural changes and their correlation with gross and histopathological findings

VII. Suggested Reading

- Selected articles from journals.



- I. Course Title : Molecular Basis of Inflammation**
II. Course Code : VPL 602
III. Credit Hours : 1+1

IV. Aim of the course

To teach the students about molecular mechanisms of inflammations.

V. Theory

Unit I

Cellular, molecular and immunopathological changes associated with different types of inflammation. Acute inflammation, Vascular events of acute inflammation, Cellular events in acute inflammation, Leucocyte-endothelial interactions, Leucocyte adhesion molecules, Endothelial adhesion molecule receptors, Leucocyte chemotactic factors, Microbicidal activity of leucocytes, Leucocyte activation.

Unit II

Plasma derived mediators of inflammation-Complement system, Kinin system, Coagulation system and Fibrinolytic system; Cell derived mediators of inflammation-vasoactive amines, lipid mediators, cytokines, chemokines, oxygen radicals and nitric oxide, Cellular components of inflammation, types of exudative inflammation.

Unit III

Chronic inflammation and its types, Elements of chronic inflammation, Healing and repair, Wound healing mediators and their functions, Repair of bone, Repair of nervous tissue and myocardium.

VI. Practical

Molecular alterations and their correlation with gross and microscopic inflammatory changes

VII. Suggested Reading

- Selected articles from journals.

- I. Course Title : Molecular Basis of Neoplasia**
II. Course Code : VPL 603
III. Credit Hours : 1+1

IV. Aim of the course

To teach the students about molecular mechanisms of neoplasia and diagnostic techniques.

V. Theory

Unit I

Tumour characteristics, differentiation and proliferation, molecular basis of cancer, tumour stromal interaction, molecular mechanisms of invasion and metastasis of tumours, molecular changes underlying tumour progression and heterogeneity, tumour biology and growth.

Unit II

Tumour genetics, immunohistochemical/ including markers associated tumour diagnosis.



Unit III

Application of cytological, histopathological, immunohistochemical and molecular techniques in diagnosis and prognosis of various tumour conditions.

VI. Suggested Reading

- Selected articles from journals.

I. Course Title : Immunopathology

II. Course Code : VPL 604

III. Credit Hours : 2+1

IV. Aim of the course

To teach the students about immune mediated and autoimmune diseases of animals.

V. Theory

Unit I

Principles of immunopathology, Etiopathology of hypersensitivity reactions and immune complex diseases; Autoimmunity, mechanisms of autoimmunity, Genetic, microbial and environmental factors in autoimmunity.

Unit II

Study of etiology, pathology and pathogenesis of commonly encountered Immunoproliferative disorders (Multiple myeloma, lymphoma, leukemia), Hypersensitivity diseases, Autoimmune diseases and immune deficiencies in domestic animals.

VI. Practical

Immune complexes-quantification and determination by various techniques, Enumeration of various populations of lymphocytes by different techniques, Determination of C3 levels, Autoimmune reaction by demonstrating auto-antibodies, Gross and microscopic pathology of hypersensitivity reactions (class IV and others).

VII. Suggested Reading

- Selected articles from journals.

I. Course Title : Advances in Diagnostic Pathology

II. Course Code : VPL 605

III. Credit Hours : 1+2

IV. Aim of the course

To teach the students about current diagnostic techniques for diagnosis of different diseases.

V. Theory

Unit I

Principles and applications of Scanning electron microscopy, Transmission electron microscopy, Laser scanning confocal microscopy, Telemicroscopy-Virtual slide microscopy.

Unit II

Current techniques for diagnosis of animal diseases namely ELISA, PCR and its



variants, Flow cytometry (FCM), *In-situ* hybridization, Bio chip techniques (DNA chip, Protein microarray, Tissue microarray), Chromatography, Spectrophotometry and Immunodiffusion technique, Biopsy techniques, Use of laboratory animals, etc.

Unit III

In-vitro cell culture techniques (commonly used cell lines, chicken embryo), cytopathic effect of different viruses and their interpretations.

VI. Practical

Principles and practice of advance techniques for the diagnosis of animal diseases.

VII. Suggested Reading

- Selected articles from journals.

I. Course Title : Pathology of Nutritional and Metabolic Disorders

II. Course Code : VPL 606

III. Credit Hours : 2+1

IV. Aim of the course

To teach the students about nutritional and metabolic disorder of animals.

V. Theory

Unit I

Pathogenesis, gross and microscopic pathology of nutritional imbalances, viz., carbohydrate, protein, fats, vitamins and macro and microelements.

Unit II

Pathogenesis, gross and microscopic pathology of different metabolic diseases namely Milk fever, Ketosis, Pregnancy toxemia, Tetany, Azoturia, Equine hyperlipidemia, downer's cow and rheumatism like syndrome and post parturient hemoglobinuria in domestic animals and diabetes mellitus in dogs.

VI. Practical

Estimation of certain minerals in sera of natural and experimentally induced deficiencies in domestic animals. To study the haematological, gross and microscopic pathological alterations caused by nutritional and metabolic disorders.

VII. Suggested Reading

- Selected articles from journals.

I. Course Title : Pathology of Important Emerging and Re-Emerging Diseases

II. Course Code : VPL-607

III. Credit Hours : 2+1

IV. Aim of the course

To teach the students about important emerging, re-emerging, exotic and transboundary diseases of pets and livestock.

V. Theory

Unit I

Advances in pathogenesis and pathology including molecular basis of important viral infections namely Foot and mouth disease, Vesicular stomatitis, Vesicular



exanthema, Rinderpest, Bovine malignant catarrhal fever, Infectious bovine rhinotracheitis, Parainfluenza-3, Bovine respiratory syncytial virus infection, Blue tongue, Contagious ecthyma, Pox diseases, Peste des petits ruminants, Rabies, Canine distemper, parvovirus infections, Infectious canine hepatitis, Pseudorabies, Hog cholera/ swine fever, swine influenza, Rift valley fever, Scrapie, Bovine spongiform encephalopathy, Japanese encephalitis, Diseases caused by Nipah virus, Kyasanaur forest disease, West Nile fever, Hendravirus, Ebola virus, Crimean-Congo haemorrhagic fever, Chikungunya virus, Ganjam virus, Marburg virus, etc.

Unit II

Advances in pathogenesis and pathology including molecular basis of important bacterial infections namely Tuberculosis, Johnne's disease, Actinobacillosis, Actinomycosis, Brucellosis, Listeriosis, Pasteurellosis, Leptospirosis, Anthrax, Clostridial group of diseases, Swine erysipelas, Glasser's disease, Colibacillosis and Salmonellosis, *Corynebactrium* infections, Chlamydial and Mycoplasmal infections.

Unit III

Advances in pathogenesis and pathology including molecular basis of important fungal infections namely Aspergillosis, Blastomycosis, Coccidioidomycosis, Histoplasmosis, Rhinosporidiosis, Sporotrichosis, Candidiasis, Cryptococcosis, Dermatomycoses, diseases due to commonly occurring mycotoxins-Aflatoxins, Ochratoxin, Zearalenone, T-2 toxins, Rubratoxin, Fumonisin, Moniliformin, etc.

VI. Practical

Study of clinical and gross alterations and histopathology of some important emerging and enzootic diseases.

VII. Suggested Reading

- Selected articles from Journals.

I. Course Title : Research Methodology in Pathology

II. Course Code : VPL 608

III. Credit Hours : 1+0

IV. Aim of the course

To provide exposure to the students on different methodologies indispensable in Pathology research through available scientific literature in world class journals.

V. Theory

Unit I

Literature based study: Use of various experimentation techniques in pathology research, Animal experimentation techniques, Planning and design of various types of experiments through study of literature for selection of appropriate methodology and evaluation parameters including scoring system, Data evaluation methods, etc.

Unit II

Introduction to OECD-GLP guidelines, Reference studies through literature for safety evaluation of drug/ plant/ plant molecules using *In-vitro* and *In vivo* techniques, Determination and calculation of LD₅₀, ID₅₀, MIC, MTD, etc., use of modern molecular techniques in experimental pathology research.

VI. Suggested Reading

- Selected articles from journals.

I. Course Title : Necropsy Conference-I

II. Course Code : VPL-609

III. Credit Hours : 0+1

IV. Aim of the course

To promote self learning of the students in different necropsy procedures of animals including poultry and description of post-mortem lesions in different diseases/ disease conditions.

V. Practical

- Continuous assessment of students on detailed necropsy examination of various species of large and small animals including poultry; necropsy associated cytological examinations; systematic examination of different organs for morphologic description of gross lesions; gross photography; collection of tissues for histopathology and based on nature of gross lesions, if possible further collection for investigation of viral/ bacterial/ protozoan/ fungal/ parasitic diseases/ toxic or poisoning, etc.
- Morphologic description of microscopic lesions; microscopic photography; correlation of gross and microscopic observations with the results of other parallel investigations to diagnose the disease conditions; presentation of select case(s) in the monthly seminars followed by report writing and final morphologic/ etiologic diagnosis, classification and preservation of microscopic slides.

VI. Suggested Reading

- D Gopala Krishna Rao. 2005. *Textbook on necropsy and histopathological techniques*, 1st Ed. Academia.
- Donald B Feldman, John Curtis Seely. 1988. *Necropsy Guide: Rodents and the Rabbit*, 1st Ed. CRC Press.
- Albert C Strafuss. 1988. *Necropsy: Procedures and Basic Diagnostic Methods for Practicing Veterinarians*, Charles C. Thomas Publisher Springfield.
- Jones TC and Gleiser CA. 1954. *Veterinary Necropsy Procedures*. JB Lippincott.
- John M King, David C Dodd and Lois Roth. 2006. *The Necropsy Book*, Fifth Edition, C L Davis Foundation.
- Majó Masferrer, Natàlia, Dolz Pascual, Roser and Shivaprasad HL. 2011. *Atlas of Avian Necropsy: Macroscopic Diagnosis Sampling*, SERVET Publishers.
- Benjamin Lucio-Martinez and Jodi A Korich. 2010. *Illustrated guide to Poultry Necropsy and diagnosis*, Cornell University (<https://www.slideshare.net/heshamkotb/illustrated-guide-to-poultry-necropsy-and-diagnosis>).

I. Course Title : Special Problem

II. Course Code : VPL 690

III. Credit Hours : 0+1

IV. Aim of the course

To provide expertise in handling practical research problems.

V. Practical

Short research problem(s) involving contemporary issues and research techniques.



VI. List of some selected Journals

- *American Journal of Veterinary Medical Association*
- *Annals of Nutrition and Metabolism*
- *Annual Review of Nutrition*
- *Avian Diseases*
- *Avian Pathology*
- *Cancer Research*
- *Cellular and Molecular Biology*
- *Current Contents*
- *European Journal of Nutrition*
- *Genomics, Proteomics and Bioinformatics*
- *Indian Journal of Animal Sciences*
- *Indian Journal of Poultry Science*
- *Indian Journal of Veterinary Pathology*
- *Indian Veterinary Journal*
- *Journal of Applied Toxicology*
- *Journal of Comparative Pathology*
- *Journal of Ethnopharmacology*
- *Journal of Immunology and Immunopathology*
- *Journal of Pathology*
- *Journal of Research in Veterinary Science*
- *Phytomedicine*
- *Toxicology Letters*
- *Toxicon*
- *Trends in Immunology*
- *Veterinary Bulletin*
- *Veterinary Immunology and Immunopathology*
- *Veterinary Pathology*

e-Resources

- www.iavp.org (Indian Journal of Veterinary Pathology)
- www.vetpathology.org (Veterinary Pathology)
- www.tandf.co.uk (Avian Pathology)
- www.avdi.allenpress.com (Avian Diseases)
- www.elsevier.com/locate/vetimm (Veterinary Immunology and Immunopathology).

Course Outline-cum-Lecture Schedule for Doctoral Degree Programme

- I. Course Title** : Molecular and Ultra structural Basis of Cell Injury
II. Course Code : VPL 601
III. Credit Hours : 2 + 1

IV. Aim of the course

To teach the students about different molecular including ultrastructural changes in diseases conditions.

Lecture/ Practical schedule

Sr. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Study of cells- cell morphology, interpretation of normal and abnormal cells	6
2.	Overview of Cell injury, Targets of cell injury-Cell membranes, aerobic respiration, structural proteins and enzymes and genetic apparatus of the cell; mechanisms of cell injury-hypoxia, injury by free radicals, chemical injury, infectious agents, other forms of cell injury-immune mediated reactions, genetic derangements; mechanisms of cell membrane damage; mechanisms of DNA damage-base loss, base modification, chemical modification, replication errors, inter-strand cross-links, DNA-protein cross-links, strand breaks. Molecular and immunopathological changes associated with different types of cell injuries	10
3.	Morphology of Reversible and irreversible cell injury with particular emphasis on ultra structural changes in the cells and organelles: Morphology of cell death-necrosis, apoptosis and autolysis, mechanism of apoptosis, intracellular and extracellular accumulations, pigment and tissue deposits, consequences of cell injury	10
4.	Cellular adaptations-hyperplasia, hypertrophy, atrophy, metaplasia and dysplasia	4
5.	Mechanism of other types of cell death, viz., pyroptosis, ferroptosis, autophagy, ETOSIS, etc.	2
Practical		
1.	Collection and preparation of specimens for electron microscopic studies. Interpretation of ultra-structural changes and their correlation with gross and histopathological findings	16



- I. Course Title : Molecular Basis of Inflammation**
II. Course Code : VPL 602
III. Credit Hours : 1 + 1

IV. Aim of the course

To teach the students about molecular mechanisms of inflammations.

Lecture/ Practical schedule

Sr. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Cellular, molecular and immunopathological changes associated with different types of inflammation. Acute inflammation, Vascular events of acute inflammation, Cellular events in acute inflammation, Leucocyte-endothelial interactions, Leucocyte adhesion molecules, Endothelial adhesion molecule receptors, Leucocyte chemotactic factors, Microbicidal activity of leucocytes, Leucocyte activation.	6
2.	Plasma derived mediators of inflammation-Complement system, Kinin system, Coagulation system and Fibrinolytic system; Cell derived mediators of inflammation-vasoactive amines, lipid mediators, cytokines, chemokines, oxygen radicals and nitric oxide, Cellular components of inflammation, types of exudative inflammation.	6
3.	Chronic inflammation and its types, Elements of chronic inflammation, Healing and repair, Wound healing mediators and their functions, Repair of bone, Repair of nervous tissue and myocardium.	4
Practical		
1.	Molecular alterations and their correlation with gross and microscopic inflammatory changes.	16

- I. Course Title : Molecular Basis of Neoplasia**
II. Course Code : VPL 603
III. Credit Hours : 1 + 1

IV. Aim of the course

To teach the students about molecular mechanisms of neoplasia and diagnostic technique.

Lecture/ Practical schedule

Sr. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Tumour characteristics, differentiation and proliferation, molecular basis of cancer, tumour stromal interaction, molecular mechanisms of invasion and metastasis of tumours, molecular changes underlying tumour progression and heterogeneity, tumour biology and growth.	8



Sr. No.	Name of Topic	No. of Tentative Lectures/ Practicals
2.	Tumour genetics, immunohistochemical/ including markers associated tumour diagnosis.	8
Practical		
1.	Application of cytological, histopathological, immunohistochemical and molecular techniques in diagnosis and prognosis of various tumour conditions.	16

I. Course Title : Immunopathology

II. Course Code : VPL 604

III. Credit Hours : 2 + 1

IV. Aim of the course

To teach the students about immune mediated and autoimmune diseases of animals.

Lecture/ Practical schedule

Sr. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Principles of immunopathology, Etiopathology of hypersensitivity reactions and immune complex diseases; Autoimmunity, mechanisms of autoimmunity, Genetic, microbial and environmental factors in autoimmunity.	16
2.	Study of etiology, pathology and pathogenesis of commonly encountered Immunoproliferative disorders (Multiple myeloma, lymphoma, leukemia), hypersensitivity diseases, autoimmune diseases and immune deficiencies in domestic animals.	16
Practical		
1.	Immune complexes-quantification and determination by various techniques, enumeration of various populations of lymphocytes by different techniques, determination of C3 levels.	8
2.	Autoimmune reaction by demonstrating auto-antibodies, gross and microscopic pathology of hypersensitivity reactions (class IV and others).	8

I. Course Title : Advances in Diagnostic Pathology

II. Course Code : VPL 605

III. Credit Hours : 1 + 2

IV. Aim of the course

To teach the students about current diagnostic techniques for diagnosis of different diseases.



Lecture/ Practical schedule

Sr. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Principles and applications of Scanning electron microscopy, Transmission electron microscopy, Laser scanning confocal microscopy, Telemicroscopy-Virtual slide microscopy	4
2.	Current techniques for diagnosis of animal diseases namely ELISA, PCR and its variants, Flow cytometry (FCM), <i>In-situ</i> hybridization, Bio-chip techniques (DNA chip, Protein microarray, Tissue microarray), Chromatography, Spectrophotometry and Immunodiffusion technique, Biopsy techniques, Use of laboratory animals, etc.	8
3.	<i>In-vitro</i> cell culture techniques (commonly used cell lines, chicken embryo), cytopathic effect of different viruses and their interpretations	4
Practical		
1.	Principles and practice of advance techniques for the diagnosis of animal diseases	32

I. Course Title : Pathology of Nutritional and Metabolic Disorders

II. Course Code : VPL 606

III. Credit Hours : 2 + 1

IV. Aim of the course

To teach the students about nutritional and metabolic disorder of animals.

Lecture/ Practical schedule

Sr. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Pathogenesis, gross and microscopic pathology of nutritional imbalances, viz., carbohydrate, protein, fats, vitamins and macro and microelements	16
2.	Pathogenesis, gross and microscopic pathology of different metabolic diseases namely milk fever, ketosis, pregnancy toxemia, tetany, azoturia, equine hyperlipidemia, downer's cow and rheumatism like syndrome and post parturient hemoglobinuria in domestic animals and diabetes mellitus in dogs	16
Practical		
1.	Estimation of certain minerals in sera of natural and experimentally induced deficiencies in domestic animals	8
2.	To study the haematological, gross and microscopic pathological alterations caused by nutritional and metabolic disorders	8



- I. Course Title : Pathology of Important Emerging and Re-Emerging diseases**
- II. Course Code : VPL 607**
- III. Credit Hours : 2 + 1**
- IV. Aim of the course**

To teach the students about important emerging, re-emerging, exotic and transboundary diseases of pets and livestock.

Lecture/ Practical schedule

Sr. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Advances in pathogenesis and pathology including molecular basis of important viral infections namely Foot and mouth disease, Vesicular stomatitis, Vesicular exanthema, Rinderpest, Bovine malignant catarrhal fever, Infectious bovine rhinotracheitis, Parainfluenza-3, Bovine respiratory syncytial virus infection, Blue tongue, Contagious ecthyma, Pox diseases, Peste des petits ruminants, Rabies, Canine distemper, parvovirus infections, Infectious canine hepatitis, Pseudorabies	8
2.	Advances in pathogenesis and pathology including molecular basis of important viral infections namely Hog cholera/ swine fever, swine influenza, Rift valley fever, Scrapie, Bovine spongiform encephalopathy, Japanese encephalitis, Diseases caused by Nipah virus, Kyasanaur forest disease, West Nile fever, Hendravirus, Ebola virus, Crimean-Congo haemorrhagic fever, Chikungunya virus, Ganjam virus, Marburg virus, etc.	8
3.	Advances in pathogenesis and pathology including molecular basis of important bacterial infections namely Tuberculosis, Johne's disease, Actinobacillosis, Actinomycosis, Brucellosis, Listeriosis, Pasteurellosis, Leptospirosis, Anthrax, Clostridial group of diseases, Swine erysipelas, Glasser's disease, Colibacillosis and Salmonellosis, Corynebacterium infections, Chlamydial and Mycoplasmal infections	8
4.	Advances in pathogenesis and pathology including molecular basis of important fungal infections namely Aspergillosis, Blastomycosis, Coccidioidomycosis, Histoplasmosis, Rhinosporidiosis, Sporotrichosis, Candidiasis, Cryptococcosis, Dermatomycoses, diseases due to commonly occurring mycotoxins-Aflatoxins, Ochratoxin, Zearalenone, T-2 toxins, Rubratoxin, Fumonisin, Moniliformin, etc.	8
Practical		
1.	Study of clinical and gross alterations and histopathology of some important emerging and enzootic diseases.	16

- I. Course Title : Research Methodology in Pathology**
- II. Course Code : VPL 608**
- III. Credit Hours : 1+0**
- IV. Aim of the course**

To provide exposure to the students on different methodologies indispensable in Pathology research through available scientific literature in world class journals



Lecture/ Practical schedule

Sr. No.	Name of Topic	No. of Tentative Lectures/ Practicals
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Theory

- | | | |
|----|---|---|
| 1. | Literature based study: Use of various experimentation techniques in pathology research, animal experimentation techniques, Planning and design of various types of experiments through study of literature for selection of appropriate methodology and evaluation parameters including scoring system, data evaluation methods, etc. | 8 |
| 2. | Introduction to OECD-GLP guidelines, Reference studies through literature for safety evaluation of drug/ plant/ plant molecules using <i>In-vitro</i> and <i>In vivo</i> techniques, Determination and calculation of LD ₅₀ , ID ₅₀ , MIC, MTD, etc., use of modern molecular techniques in experimental pathology research | 8 |

I. Course Title : Necropsy Conference I

II. Course Code : VPL 609

III. Credit Hours : 0 + 1

IV. Aim of the course

To promote self-learning of the students in different necropsy procedures of animals including poultry and description of post-mortem lesions in different diseases/ disease conditions.

Lecture/ Practical schedule

Sr. No.	Name of Topic	No. of Tentative Lectures/ Practicals
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Practical

- | | | |
|----|--|---|
| 1. | Continuous assessment of students on detailed necropsy examination of various species of large and small animals including poultry; necropsy associated cytological examinations; systematic examination of different organs for morphologic description of gross lesions; gross photography; collection of tissues for histopathology and based on nature of gross lesions, if possible further collection for investigation of viral/ bacterial/ protozoan/ fungal/ parasitic diseases/ toxic or poisoning, etc. | 8 |
| 2. | Morphologic description of microscopic lesions; microscopic photography; correlation of gross and microscopic observations with the results of other parallel investigations to diagnose the disease conditions; presentation of select case(s) in the monthly seminars followed by report writing and final morphologic/ etiologic diagnosis, classification and preservation of microscopic slides | 8 |

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Veterinary Para-Clinical Subjects

– Veterinary Parasitology



Course Title with Credit Load M.V.Sc. in Veterinary Parasitology

Course Code	Course Title	Credit Hours
VPA 501	Platyhelminthes-I*	1+1
VPA 502	Platyhelminthes-II*	1+1
VPA 503	Nemathelminthes and Acanthocephala*	2+1
VPA 504	Arthropod Parasites*	2+1
VPA 505	Parasitic Protozoa*	2+1
VPA 506	Diagnostic Parasitology	0+2
VPA 507	Clinical Parasitology	1+1
VPA 508	Management of Parasitic Diseases	1+1
VPA 509	Immunoparasitology	2+1
VPA 510	Parasitic Zoonoses	2+0
VPA 511	Parasites of Wildlife	1+1
VPA 591	Master's Seminar*	1+0
VPA 599	Master Research	30

*Core Courses

Course Contents

M.V.Sc. in Veterinary Parasitology

I. Course Title : Platyhelminthes-I

II. Course Code : VPA 501

III. Credit Hours : 1+1

IV. Aim of the course

To study the morphology, biology, pathogenesis and control measures for trematode parasites of veterinary importance.

V. Theory

Unit I

Introduction, classification, general account and economic importance of trematodes.

Unit II

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, Treatment and control measures of trematodes belonging to families: Dicrocoeliidae, Opisthorchiidae and Fasciolidae.

Unit III

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of trematodes belonging to families: Echinostomatidae, Heterophyidae, Plagiorchiidae, Troglotrematidae, Prosthogonimidae, Nanophyetidae and Paragonimidae.

Unit IV

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of trematodes belonging to families: Notocotylidae, Brachylemidae, Cyclocoelidae, Paramphistomatidae and Schistosomatidae.

Unit V

Classification, characters of snails and control strategies of molluscs of veterinary importance.

VI. Practical

- Collection, preservation/ processing and identification of trematode parasites; their eggs and intermediate hosts.
- Observation on parasitic stages in host tissues and associated pathological lesions.
- Identification of molluscs of veterinary importance and examination of molluscs for various developmental stages of trematode parasites.

I. Course Title : Platyhelminthes-II

II. Course Code : VPA 502

III. Credit Hours : 1+1

IV. Aim of the course

To study the morphology, biology, pathogenesis and control measures for cestode



parasites of veterinary importance.

Unit I

Introduction, classification, general account and economic importance of cestodes

Unit II

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of cestodes belonging to families: Diphylobothriidae, Mesocestoididae and Taeniidae.

Unit III

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of cestodes belonging to families: Davaineidae, Hymenolepididae, Dipylidiidae and Dilepididae.

Unit IV

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, Treatment and control measures of cestodes belonging to families: Anoplocephalidae and Thysanosomidae.

V. Practical

Collection, preservation/ processing and identification of cestode parasites; their eggs, larval stages and intermediate hosts. Parasitic stages in host tissues and associated pathological lesions.

I. Course Title : Nematelminthes and Acanthocephala

II. Course Code : VPA 503

III. Credit Hours : 2+1

IV. Aim of the course

To study the morphology, biology, pathogenesis, diagnosis and control of nematodes and thorny-headed worms of veterinary importance.

V. Theory

Unit I

Introduction, classification, general account and economic importance of nematodes and thorny-headed worms.

Unit II

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of nematodes belonging to families: Ascarididae, Anisakidae, Oxyuridae, Heterakidae and Subuluridae.

Unit III

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment, and control measures of nematodes belonging to families: Rhabditidae, Strongyloididae and Strongylidae.

Unit IV

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment, and control measures of nematodes belonging to families: Trichonematidae, Amidostomidae, Stephanuridae, Syngamidae and Ancylostomatidae.

**Unit V**

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of nematodes belonging to families: Filaroididae, Trichostrongylidae, Ollulanidae, Dictyocaulidae and Metastrongylidae.

Unit VI

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of nematodes belonging to families: Spiruridae, Thelaziidae, Acuariidae, Tetrameridae, Physalopteridae, Gnathostomatidae, Filariidae, Setariidae, Onchocercidae and Dracunculidae.

Unit VII

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of nematodes belonging to families: Trichinellidae, Trichuridae, Capillariidae and Dioctophymatidae.

Unit VIII

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of thorny headed worms belonging to families: Polymorphidae, Oligacanthorhynchidae and Gnathobdellidae.

V. Practical

Collection, preservation/ processing and identification of nematode parasites and thorny headed worms; their eggs and larvae and associated pathological lesions.

I. Course Title : Arthropod Parasites

II. Course Code : VPA 504

III. Credit Hours : 2+1

IV. Aim of the course

To study the morphology, biology, vector potential of the arthropods of veterinary importance and their control measures

V. Theory**Unit I**

Introduction, Classification, Harmful effects and Economic importance of arthropod parasites.

Unit II

Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Vector potentiality, Economic significance and control of arthropods belonging to the families: Culicidae, Ceratopogonidae, Simuliidae and Psychodidae.

Unit III

Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Vector potentiality, Economic significance and control of arthropods belonging to the families: Tabanidae, Gasterophilidae, Muscidae, Cuterebridae and Glossinidae.

Unit IV

Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Vector potentiality, Economic significance and control of arthropods belonging to the families: Oestridae, Sarcophagidae, Calliphoridae and Hippoboscidae. Importance



of blow flies in forensic entomology and treatment of wounds.

Unit V

Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Economic significance and control of arthropods belonging to the families: Pediculidae, Haematopinidae, Linognathidae, Menoponidae, Philopteridae and Trichodectidae.

Unit VI

Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Economic significance and control of arthropods belonging to the Orders- Siphonaptera and Hemiptera, Cimicidae and Reduviidae.

Unit VII

Distribution, Life cycle, Seasonal pattern, Vector potentiality, Pathogenesis economic significance and control of acarines belonging to the families: Argasidae and Ixodidae.

Unit VIII

Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Economic significance and control of acarines belonging to the families: Sarcoptidae, Psoroptidae, Demodicidae, Trombiculidae, Dermanyssidae. Cytoditidae and Linguatulidae.

Unit IX

Chemical, Biological, Immunological control measures and integrated pest management. Detection and mechanisms of acaricidal resistance.

V. Practical

Collection, preservation/ processing, identification, differentiation of arthropod parasites and their developmental stages; associated lesions and skin scraping examination.

I. Course Title : Parasitic Protozoa

II. Course Code : VPA 505

III. Credit Hours : 2 + 1

IV. Aim of the course

To study the morphology, Life cycle, Pathogenesis, Diagnosis and control of protozoan parasites of veterinary importance.

V. Theory

Unit I

Introduction, classification, general account and economic importance of protozoan parasites.

Unit II

Morphology, Epidemiology, Pathogenesis, Clinical signs, Diagnosis, and control measures of protozoan parasites belonging to the families: Trypanosomatidae, Monocercomonadidae, Trichomonadidae, Hexamitidae and Endamoebidae.

Unit III

Morphology, Epidemiology, Pathogenesis, Clinical signs, Diagnosis and control measures of protozoan parasites belonging to the families: Eimeriidae, Cryptosporidiidae and Sarcocystidae.

**Unit IV**

Morphology, Epidemiology, Pathogenesis, Clinical signs, Diagnosis, Treatment and control measures of protozoan parasites belonging to the families: Plasmodiidae, Babesiidae, Theileriidae, Haemogregarinidae and Balantidiidae.

Unit V

Morphology, Epidemiology, Pathogenesis, Clinical signs, Diagnosis and control measures of Rickettsiales in relation to haemoprotozoans.

VI. Practical

Collection, Preservation/ Processing, Identification of parasitic protozoa in clinical material and host tissues. Special techniques for certain protozoans such as coccidia and Cryptosporidia.

I. Course Title : Diagnostic Parasitology

II. Course Code : VPA 506

III. Credit Hours : 0+2

IV. Aim of the course

To learn the techniques associated with isolation, Identification and preservation of the endo and ectoparasites of veterinary importance and their vectors.

V. Practical

Microscopy and micrometry, Preparation of Romanowsky stains. Collection, preservation, Processing and examination of faecal and blood samples; Lymph node biopsy, Skin scrapings, Nasal washings, Sputum, genital discharges/ washings and urine samples from animals for parasitological examinations. Quantitative faecal examination, Maintenance of fly and tick colonies in laboratory for experimental purposes and testing of drugs; tick dissection for vector potential. Collection of aquatic snails from field and their examination for the presence of different parasitic stages. Collection, fixation, staining, whole mounts and identification of parasites. Culturing techniques for important parasites, pasture larval count, worm count and assessment of worm burden.

Remote Sensing (RS) and Geographic Information System (GIS) as tools for mapping parasitic diseases.

I. Course Title : Clinical Parasitology

II. Course Code : VPA 507

III. Credit Hours : 1+1

IV. Aim of the course

Collection, preservation and examination of clinical material for parasitological investigations and interpretations.

V. Theory**Unit I**

Collection, preservation and dispatch of clinical material to laboratory for diagnosis

Unit II

History, clinical signs, gross and microscopic examination of diagnostic material.



Unit III

Animal sub-inoculation technique; blood and lymph node biopsy smear examination; histopathology of affected organs.

VI. Practical

Identification, observation of parasitic stages in host tissues, excretions, secretions and associated pathological lesions. Special techniques for haemoparasites and coccidians.

I. Course Title : Management of Parasitic Diseases

II. Course Code : VPA 508

III. Credit Hours : 1+1

IV. Aim of the course

To study the integrated approach for the control of helminths, arthropods and protozoan parasites of veterinary importance.

V. Theory

Unit I

Conventional and novel methods for control of helminth infections in livestock – anthelmintics, their mode of action, characteristic of an ideal anthelmintic drug, Anthelmintic resistance, Spectrum of activity, Delivery devices and integrated control method. Immunological control, Deworming schedule, Snail and other intermediate host control. Ethno veterinary practices.

Unit II

Conventional and novel methods of control of protozoan parasites–antiprotozoal drugs, Their mode of action, Integrated control method including immunological control.

Unit III

Conventional and novel methods of control with insecticides/ acaricides. Methods of application, their mode of action, insecticide resistance, biological control, integrated control method, genetic control and immunological control.

VI. Practical

In vivo and *in-vitro* detection of efficacy of control agents and resistance to anthelmintics, anticoccidials, insecticides and acaricides.

I. Course Title : Immunoparasitology

II. Course Code : VPA 509

III. Credit Hours : 2+1

IV. Aim of the course

To study the host immune response against endo and ectoparasites of veterinary importance with special reference to immunoprophylaxis and immunodiagnosis.

V. Theory

Unit I

Introduction, types of parasite-specific antigens and their characterization.

**Unit II**

Types of immunity in parasitic infections.

Unit III

Invasive and evasive mechanisms, immunomodulators and their uses.

Unit IV

Immune responses in helminths, arthropods and protozoa of veterinary importance.

Unit V

Immunological control against parasitic diseases.

VI. Practical

Preparation of various antigens (somatic, excretory-secretory) and their fractionation and characterization and demonstration of various immunodiagnostic methods for the diagnosis of parasitic infections.

I. Course Title : Parasitic Zoonoses

II. Course Code : VPA 510

III. Credit Hours : 2+0

IV. Aim of the course

To study important parasites of zoonotic significance.

Unit I

Introduction to the concept of Zoonotic infections, Definitions, Various classifications of zoonoses, Host-parasite relationships, Modes of infections and factors influencing prevalence of zoonoses.

Unit II

A detailed study of Transmission, Epidemiology, Diagnosis and Control of common protozoa of zoonotic importance.

Unit III

A detailed study of Transmission, Epidemiology, Diagnosis and Control of common helminths of zoonotic importance.

Unit IV

A detailed study of Transmission, Epidemiology, Diagnosis and Control of common arthropods of zoonotic importance.

I. Course Title : Parasites of Wildlife

II. Course Code : VPA 511

III. Credit Hours : 1+1

IV. Aim of the course

To study the biology and control measures for major parasitic diseases of zoo and wild animals.

V. Theory**Unit I**

A detailed study of protozoa of zoo and wild animals with particular emphasis on



morphological features, Geographical distribution Epidemiology, Diagnosis and management.

Unit II

A detailed study of arthropod parasites of zoo and wild animals with particular emphasis on morphological features, Geographical distribution, Epidemiology, diagnosis and management.

Unit III

A detailed study of helminth parasites of zoo and wild animals with particular emphasis on morphological features, Geographical distribution, Epidemiology, diagnosis and management.

VI. Practical

Methods for investigating parasitic diseases of captive and wild animals. Collection and identification of parasites. Visits to zoos and biological parks/ sanctuaries for collection of samples.

Course Outline-cum-Lecture Schedule for Master Degree Programme

- I. Course Title** : Platyhelminthes-I
II. Course Code : VPA 501
III. Credit Hours : 1+1

IV. Aim of the course

To study the morphology, biology, pathogenesis and control measures for trematode parasites of veterinary importance

Lecture	Topic
Theory	
1-2	Introduction, history, classification, general account and economic importance of trematodes
3-4	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Dicrocoeliidae and Opisthorchiidae
5-6	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Strigeidae and Fasciolidae
7-8	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Echinostomatidae, Heterophyidae, Plagiorchiidae and Troglotrematidae
9-10	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Prosthogonimidae, Nanophyetidae and Paragonimidae
11-12	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Notocotylidae, Brachylemidae, and Paramphistomatidae
13-14	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Cyclocoelidae and Schistosomatidae
15-16	Classification and characters of snails and Control strategies of molluscs of veterinary importance
Practicals	
1-5	Collection, preservation/ processing and identification of trematode parasites; their eggs and intermediate hosts
6-11	Observation on parasitic stages in host tissues and associated pathological lesions caused by trematodes
12-16	Identification of molluscs of veterinary importance and examination of molluscs for various developmental stages of trematode parasites.



- I. Course Title : Platyhelminthes-II**
II. Course Code : VPA 502
III. Credit Hours : 1+1

IV. Aim of the course

To study the morphology, biology, pathogenesis and control measures for cestode parasites of veterinary importance

Lecture	Topic
Theory	
1-2	Introduction, history, classification, general account and economic importance of cestodes
3-4	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to family: Diphyllbothriidae
5	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to family: Mesocostoididae
6-8	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to family: Taeniidae
9-10	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to families: Davaineidae and Hymenolepididae
11-12	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to families: Dipylidiidae and Dilepididae
13-14	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to family: Anoplocephalidae
15-16	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to family: Thysanosomidae
Practicals	
1-8	Collection, preservation/ processing and identification of cestode parasites; their eggs, larval stages and intermediate hosts.
9-16	Observation on parasitic stages in host tissues and associated pathological lesions

- I. Course Title : Nematelminthes and Acanthocephala**
II. Course Code : VPA 503
III. Credit Hours : 2+1

IV. Aim of the course

To study the morphology, biology, pathogenesis and control measures of nematodes and thorny-headed worms of veterinary importance

Lecture	Topic
1-2	Introduction, history, classification, general account and economic importance of nematodes and thorny-headed worms
2-4	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to family: Ascarididae
5-6	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Anisakidae and Oxyuridae
7-8	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Heterakidae and Subuluridae



Lecture	Topic
9-10	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Rhabditidae and Strongyloididae
11-12	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to family: Strongylidae.
13-14	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Trichonematidae and Amidostomidae
15-16	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Stephanuridae and Syngamidae
17-18	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to family: Ancylostomatidae.
19-20	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Filaroididae and Trichostrongylidae
21-22	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Ollulanidae, Dictyocaulidae and Metastrongylidae
23-24	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Spiruridae, Thelaziidae, Acuariidae, Tetrameridae, Physalopteridae, and Gnathostomatidae
25-26	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Filariidae, Setariidae, Onchocercidae and Dracunculidae.
27-28	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Trichinellidae and Trichuridae
29-30	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Capillariidae and Dioctophymatidae
31-32	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Polymorphidae, Oligacanthorhynchidae and Gnathobdellidae.

Practicals

- 1-16 Collection, preservation/ processing and identification of nematode parasites and thorny headed worms; their eggs and larvae and associated pathological lesions.

I. Course Title : Arthropod Parasites

II. Course Code : VPA 504

III. Credit Hours : 2 + 1

IV. Aim of the course

To study the morphology, biology, vector potential of the arthropods of veterinary importance and their control measures.

Lecture	Topic
1-2	Introduction, classification harmful effects and economic importance of arthropod parasites.



Lecture	Topic
3-4	Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the family: Culicidae
5-6	Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the family: Ceratopogonidae
7-8	Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the families: Simuliidae and Psychodidae.
8-9	Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the families: Tabanidae and Gasterophilidae
10-11	Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the families: Muscidae, and Glossinidae
12-14	Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the families: Oestridae, Sarcophagidae, Calliphoridae and Hippoboscidae. Importance of blow flies in forensic entomology and treatment of wounds
15-18	Distribution, morphology, life cycle, seasonal pattern, pathogenesis, economic significance and control of arthropods belonging to the families: Pediculidae, Haematopinidae, Linognathidae, Menoponidae, Philopteridae and Trichodectidae
19-20	Distribution, morphology, life cycle, seasonal pattern, pathogenesis, economic significance and control of arthropods belonging to the order: Siphonaptera and families: Cimicidae and Reduviidae
21-25	Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the families: Argasidae and Ixodidae
26-30	Distribution, morphology, life cycle, seasonal pattern, pathogenesis, economic significance and control of acarines belonging to the families: Sarcoptidae, Psoroptidae, Demodicidae, Trombiculidae, Dermanyssidae. Cytoditidae and Linguatulidae.
31-32	Chemical, biological, immunological control measures and integrated pest management. Detection and mechanisms of acaricidal resistance

Practicals

1-16	Collection, preservation/ processing, identification, differentiation of arthropod parasites and their developmental stages; associated lesions and skin scraping examination
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I. Course Title : Parasitic Protozoa

II. Course Code : VPA 505

III. Credit Hours : 2+1

IV. Aim of the course

To study the morphology, life cycle, pathogenesis, diagnosis and control of protozoan parasites of veterinary importance.

Lecture	Theory
1-3	Introduction, History, Classification and General account and economic importance of protozoan parasites.



Lecture	Topic
4-7	Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Trypanosomatidae
8-10	Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Monocercomonadidae and Trichomonadidae
11-12	Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Hexamitidae and Endamoebidae
13-14	Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Endamoebidae
15-16	Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Eimeriidae.
17-18	Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Cryptosporidiidae.
19-22	Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Sarcocystidae.
23	Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Plasmodiidae.
24-26	Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Babesiidae.
27-28	Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Theileriidae.
29-30	Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Haemogregarinidae and Balantidiidae
31-32	Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of Rickettsiales like <i>Anaplasma</i> , <i>Ehrlichia</i> , <i>Haemobartonella</i> and others.
Practicals	
1-4	Collection, preservation/ processing, identification of protozoan parasites based on faecal examination.
5-8	Collection, preservation/ processing, identification of protozoan parasites based on blood examination.
9-12	Observations on parasite stages in host tissues and the attendant pathological lesions.
13-16	Diagnosis of protozoan parasites of Veterinary importance.

I. Course Title : Diagnostic Parasitology

II. Course Code : VPA 506

III. Credit Hours : 0+2

Aim of the course

To learn the techniques associated with isolation, identification and preservation of the endo and ectoparasites of veterinary importance and their vectors.

Lecture	Topic
Practical	
1-2	Microscopy and micrometry, Preparation of Romanowsky stain.
3-8	Collection, preservation, processing and examination of faecal and blood samples; lymph node biopsy, skin scrapings, nasal washings sputum, genital discharges/ washings and urine samples from animals for parasitological examinations.



Lecture	Topic
9-12	Quantitative faecal examination.
13-16	Maintenance of fly and tick colonies in laboratory for experimental purposes and testing of drugs; tick dissection for vector potential.
17-20	Collection of aquatic snails from field and their examination for the presence of different parasitic stages.
21-24	Collection, fixation, staining, whole mounts and identification of parasites.
25-28	Culturing techniques for important parasites, pasture larval count, worm count and assessment of worm burden.
29-32	Remote Sensing (RS) and Geographic Information System (GIS) as tools for mapping parasitic diseases.

I. Course Title : Clinical Parasitology

II. Course Code : VPA 507

III. Credit Hours : 1+1

IV. Aim of the course

Collection of clinical material, examination/ investigation and its preservation for interpretations.

Lecture	Topic
Theory	
1-3	Unit I: Collection, preservation and dispatch of clinical material to laboratory for diagnosis.
4-8	Unit II: History, clinical signs, gross and microscopic examination of diagnostic material.
9-10	Unit III: Animal sub-inoculation tests.
11-13	Unit III: Blood and biopsy smear examination.
14-16	Unit III: Histopathology of affected organs.
Practical	
1-12	Identification, observation of parasitic stages in host tissues, excretions, secretions and associated pathological lesions.
7-12	Special techniques for <i>Cryptosporidium</i> oocysts in faecal samples. Sporulation of coccidial oocysts.

I. Course Title : Management of Parasitic Diseases

II. Course Code : VPA 508

III. Credit Hours : 1+1

IV. Aim of the course

To study the integrated approach for the control of helminths, arthropods and protozoan parasites of veterinary importance.

Lecture	Topic
Theory	
1-6	Unit I: Conventional and novel methods of control of helminth infection in livestock – anthelmintics, their mode of action, characteristic of an ideal anthelmintic drug, anthelmintic resistance, spectrum of activity, delivery devices, integrated



Lecture	Topic
	control method. Immunological control. Deworming schedule. Snail and other intermediate host control.
7-11	Unit II: Conventional and novel methods of control of protozoan parasites–antiprotozoal drugs, their mode of action, integrated control method including immunological control.
12-16	Unit III Conventional and novel methods of control with insecticides/ acaricides. Methods of application, their mode of action, insecticide resistance, biological control, integrated control method, genetic control and immunological control.
Practical	
1-6	<i>In vivo</i> detection of efficacy of and resistance to parasitocidal agents.
7-16	<i>In-vitro</i> detection of efficacy of and resistance to parasitocidal agents

I. Course Title : Immunoparasitology

II. Course Code : VPA 509

III. Credit Hours : 2+1

IV. Aim of the course

To study the host immune response against the endo and ectoparasites of veterinary importance with special reference to immunoprophylaxis and immunodiagnosis.

Lecture	Topic
Theory	
1-7	Unit I: Introduction, types of parasite-specific antigens and their characterization.
8-13	Unit II: Types of immunity in parasitic infections.
14-18	Unit III: Invasive and evasive mechanisms, immunomodulators and their uses.
19-27	Unit IV: Immune responses in helminths, arthropods and protozoa of veterinary importance.
28-32	Unit V: Immunological control against parasitic diseases
Practical	
1-9	Preparation of various antigens (somatic, excretory-secretory) and their fractionation and characterization and
10-16	Demonstration of various immunodiagnostic methods for the diagnosis of parasitic infections

I. Course Title : Parasitic Zoonoses

II. Course Code : VPA 510

III. Credit Hours : 2+0

IV. Aim of the course

To study important parasites of zoonotic significance.

Lecture	Topic
Theory	
1-3	Unit I: Introduction to the concept of zoonotic infections
4-6	Unit I: Definition and various classifications of zoonoses.



Lecture	Topic
7-10	Unit I: Host-parasite relationships, modes of infections, factors influencing prevalence of zoonoses.
11-18	Unit II: A detailed study of transmission, epidemiology, diagnosis and control of major protozoa of zoonotic importance.
19-25	Unit III: A detailed study of transmission, epidemiology, diagnosis and control of major helminths of zoonotic importance.
26-32	Unit IV: A detailed study of transmission, epidemiology, diagnosis and control of major arthropods of zoonotic importance.

I. Course Title : Parasites of Wildlife

II. Course Code : VPA 511

III. Credit Hours : 1+1

IV. Aim of the course

To study the biology and control measures for major parasitic diseases of zoo and wild animals.

Lecture	
Theory	
1-6	Unit I: A detailed study of protozoa of zoo and wild animals with particular emphasis on morphological features, geographical distribution epidemiology, diagnosis and management.
7-12	Unit II: A detailed study of arthropod parasites of zoo and wild animals with particular emphasis on morphological features, geographical distribution, epidemiology, diagnosis and management.
13-16	Unit III: A detailed study of helminth parasites of zoo and wild animals with particular emphasis on morphological features, geographical distribution, epidemiology, diagnosis and management
Practical	
1-6	Methods for investigating parasitic diseases of captive and wild animals.
7-16	Collection and identification of parasites. Visits to zoos and biological parks/sanctuaries for collection of samples.



Course Title with Credit Load

Ph.D. in Veterinary Parasitology

Course Code	Course Title	Credits Hours
VPA 601	Advances in Helminthology-I	2+1
VPA 602	Advances in Helminthology-II	2+1
VPA 603	Entomology and Acarology	2+1
VPA 604	Advances in Protozoology	2+1
VPA 605	Immunology of Parasitic Diseases*	1+2
VPA 606	Molecular Diagnostics and Vaccine Development in Parasitology*	2+1
VPA 607	Host Parasite Interactions	2+0
VPA 608	<i>In-vitro</i> Cultivation of Parasites	1+2
VPA 609	Emerging and Re-Emerging Parasitic Diseases	2+0
VPA 610	Biology and Ecology of Parasites	3+0
VPA 611	Molecular Veterinary Parasitology	2+0
VPA 612	Parasite Epidemiology *	2+0
VPA 690	Special Problem	0+1
VPA 691	Doctoral Seminar-I *	1+0
VPA 692	Doctoral Seminar-II*	1+0
VPA 699	Doctoral Research	75

*Core courses



Course Contents

Ph.D. in Veterinary Parasitology

- I. Course Title** : Advances in Helminthology-I
II. Course Code : VPA 601
III. Credit Hours : 2+1

IV. Aim of the course

Developments in the area of molecular biology, pathogenesis, diagnosis and control of trematodes and cestodes.

V. Theory

Unit I

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of trematodes and their larval stages.

Unit II

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of cestodes and larval stages.

VI. Practical

Morphological, Pathological and Immunological studies of trematode and cestode parasites.

- I. Course Title** : Advances in Helminthology-II
II. Course Code : VPA 602
III. Credit Hours : 2+1

IV. Aim of the course

To study the recent developments in the area of molecular biology, pathogenesis, diagnosis of nematode parasites and thorny headed worms with an objective of better control.

V. Theory

Unit I

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of nematode parasites and their larval stages.

Unit II

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of thorny-headed worms.

VI. Practical

Morphological, Pathological and Immunological studies of various nematodes and thorny-headed worms.



- I. Course Title : Entomology and Acarology**
II. Course Code : VPA 603
III. Credit Hours : 2+1

IV. Aim of the course

To study the recent scientific developments on biology and control measures for arthropods of veterinary importance.

V. Theory

Unit I

Origin, Evolution, Regional/ Seasonal distribution and Forecasting of insect and acarine population.

Unit II

Population dynamics of insects and acarines in relation to biotic and abiotic factors

Unit III

Recent developments pertaining to insects of veterinary importance.

Unit IV

Recent developments pertaining to arachnids of veterinary importance.

Unit V

Chemical, Biological, Herbal and Immunological control measures and integrated pest management. Modulation of vector competence to transmit parasitic infections using molecular genetics by developing transgenic vectors.

VI. Practical

Collection and identification of arthropods; Demonstration of the infective stages in vectors. Immuno pathological changes produced in the host tissues due to the infestation of arthropods.

- I. Course Title : Advances in Protozoology**
II. Course Code : VPA 604
III. Credit Hours : 2+1

IV. Aim of the course

To study the recent developments in molecular biology, pathogenesis, diagnosis and control of protozoan parasites of veterinary importance

V. Theory

Unit I

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of intestinal protozoa.

Unit II

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of haemoprotozoans.

Unit III

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of tissue and other protozoa.



VI. Practical

Morphological, pathological and immunodiagnosis of protozoan diseases

I. Course Title : Immunology of Parasitic Diseases

II. Course Code : VPA 605

III. Credit Hours : 1+2

IV. Aim of the course

To study the immune mechanisms operating in different parasitic infections and to identify the immunodominant/ immunoprotective antigens for diagnosis and control of parasitic diseases.

Unit I

To study the salient features of immune responses in relation to trematode, cestode, nematode and protozoan infections in livestock. Immune responses to arthropod infestations.

Unit II

Principles and applications of immunodiagnostic methods for parasitic diseases.

Unit III

Standardization of immunodiagnostic methods for parasitic diseases.

Unit IV

Identification of candidate antigens for diagnosis and vaccine development.

V. Practical

Methods for purification of antigens, fractionation and characterization of antigens, identification of candidate antigens as drug targets, raising of hyperimmune sera, development and standardization of immunodiagnostic methods for the diagnosis and control of parasitic infections.

I. Course Title : Molecular Diagnostics and Vaccine Development for Parasitic Diseases

II. Course Code : VPA 606

III. Credit Hours : 2+1

IV. Aim of the course

To understand the principles of development of sensitive molecular tools for rapid and field oriented tests. Identification of diagnostic and vaccine targets for detection and control of parasites of livestock and pets.

V. Theory

Unit I

Introduction to molecular taxonomy of parasites.

Unit II

Genome organisation in parasites of veterinary importance. Structure and function of nucleic acids.

Unit III

Basic plan of gene cloning, and expression in heterologous host. Production of



recombinant protein and downstream processing for diagnostic/ prophylactic applications.

Unit IV

General concept of protein synthesis. Identification and molecular characterization of proteins of diagnostic/ prophylactic relevance of parasitic origin.

Unit V

Nucleic acid based techniques for genetic characterization and sensitive diagnosis of parasitic infections; PCR, LAMP, Nucleic acid hybridization technique, pyrosequencing, Real Time PCR, DNA Microarray, Microsatellite analysis, RNAi, Reverse Genetic Approaches and their applications.

Unit VI

Hybridoma technology. Principle of production of monoclonal antibody. The diagnostic application of monoclonal antibodies of parasitic infection.

Unit VII

DNA vaccine, Vector vaccine, Recombinant protein based vaccine, Subunit vaccine, Principle and Application.

VI. Practical

Identification, Characterization, and Purification of Recombinant Protein Antigens; SDS-PAGE and Western Blotting, Extraction and quantification of nucleic acid and PCR and related techniques.

I. Course Title : Host Parasite Interactions

II. Course Code : VPA 607

III. Credit Hours : 2+0

IV. Aim of the course

To study different level of host-parasite interactions/ association with an objective of efficient control.

V. Theory

Unit I

Introduction, Distribution of parasites on/ in the host, Morphological adaptation for better survival in/ on the host.

Unit II

Behavioural defences, Host immune responses and Genetic resistance to parasites.

Unit III

Establishment of parasites in immune competent, Susceptible, Intermediate and Abnormal hosts, Chronicity of parasitic infections, Immuno evasive strategies of the parasites and host-parasite equilibrium.

Unit IV

Pathological consequences of host parasite interactions in relation to malnutrition and micronutrient metabolism.



- I. Course Title** : *In-vitro* Cultivation of Parasites
II. Course Code : VPA 608
III. Credit Hours : 1+2

IV. Aim of the course

Development and standardization of *in-vitro* techniques for parasite cultivation.

V. Theory

Unit I

Introduction, problems and goals of *in-vitro* cultivation of parasites.

Unit II

In-vitro cultivation of genital, Intestinal flagellates and Intestinal ciliates.

Unit III

In-vitro cultivation of intestinal protozoa.

Unit IV

In-vitro cultivation of haemoprotozoa.

Unit V

In-vitro techniques, media and tissue culture for cultivation of helminths and their larval stages.

Unit VI

In-vitro mass rearing and colonization of ticks, flies and other insects.

VI. Practical

Preparation of media, sterilization methods and cultivation of different parasites.

- I. Course Title** : **Emerging and Re-Emerging Parasitic Diseases**
II. Course Code : VPA 609
III. Credit Hours : 2+0

IV. Aim of the course

To study the emerging and re- emerging parasitic diseases.

V. Theory

Unit I

Emerging and re-emerging helminthic diseases.

Unit II

Emerging and re-emerging protozoan diseases.

Unit III

Emerging and re-emerging vector- borne diseases.

- I. Course Title** : **Biology and Ecology of Parasites**
II. Course Code : VPA 610
III. Credit Hours : 3+0

IV. Aim of the course

Study of the bionomics and ecology of the parasites.

V. Theory

Unit I

Ultrastructure, Physiology, Biochemistry and Bionomics of trematodes and cestodes of veterinary importance.

Unit II

Ultrastructure, Physiology, Biochemistry and Bionomics of nematodes of veterinary importance.

Unit III

Ultrastructure, Physiology, Biochemistry and Bionomics of important arthropod parasites.

Unit IV

Ultrastructure, Physiology, Biochemistry and Bionomics of important protozoan parasites.

Unit V

Ecology related definitions, Environmental changes and ecological disturbances due to natural phenomenon and human interventions (demographic, societal and agricultural changes global warming, floods, hurricanes and pollution.

Unit VI

Principles of Remote Sensing, GIS and their role in Veterinary Parasitology.

I. Course Title : Molecular Veterinary Parasitology

II. Course Code : VPA 611

III. Credit Hours : 2+0

IV. Aim of the course

To give an insight into molecular biology of parasites of veterinary importance, their transmission and control. Molecular, immunological and genetic aspects of common parasites of veterinary importance and vector-host-parasite interaction.

V. Theory

Unit I

Introduction to molecular biology of parasites-Biological molecules (carbohydrate, protein and nucleic acid)- Eukaryotic cell structure, cell membrane and organelles-kinetoplast, apicoplast, cilia, flagella biology-Eukaryotic cell metabolism and cell respiration-Oxidative phosphorylation-anaerobic metabolism in parasites-fatty acid metabolism of parasites-cellular reproduction mendelian genetics in parasites and vectors- Genome of parasites of veterinary importance, genome size- molecular taxonomy-DNA barcoding-phylogenetics.

Unit II

Genetic code- Gene expression-Transcription and Translation-post translational modifications- RNA interference in parasites-CRISPR/ Cas9 inparasites-metagenome-microbiome-transcriptome of parasites-transgenic and para transgenic approach in parasites-drug resistance mechanisms.

Unit III

Molecular biology of helminth parasites such as *Fasciola* spp, *Schistosoma* spp, *Taenia* spp, *Echinococcus* spp, *Toxocara* spp, *Haemonchus* spp., *Dictyocaulus* spp.



- I. Course Title** : Parasite Epidemiology
II. Course Code : VPA 612
III. Credit Hours : 2+0

IV. Aim of the course

To study the disease and transmission characteristics, descriptive epidemiology of infectious diseases.

V. Theory

Unit I: Introduction to epidemiological concepts

Definitions, aims and uses of epidemiological studies, Approaches of epidemiology (descriptive, analytical and experimental), Types of epidemiological studies along with their advantages and disadvantages, Features of parasitic disease epidemiology. Measures of disease frequency: Morbidity and mortality (Rate, Ratio, Proportional rate), Measures of morbidity (Cumulative incidence, Incidence rate, Attack rate, Prevalence-Point and Period) and mortality (Cumulative Mortality, Mortality rate, Death rate, Age/ Sex/ Breed death rate, Case fatality proportion, Cause specific death rate, etc.). The epidemiological triangle, iceberg concept, endemic stability, herd immunity concept, etc.

Unit II: Methods in epidemiology

Cross-sectional, case control and cohort studies. Techniques of epidemiological surveys.

Types of sampling- Non-probability sampling (target sampling, choice sampling, etc.), Probability sampling (Random samples, systemic sampling, stratified sampling, cluster sampling, etc.). Sample size calculation for different epidemiological and experimental studies.

Unit III: Advances in Epidemiological techniques

Sero-epidemiological methods used in important parasitic disease-Uses and limitations, Properties and Evaluation. Molecular epidemiology- Principles, laboratory methods, Bioinformatics in molecular epidemiology. Serological and molecular epidemiology of important parasites. Remote sensing and geographic information system- Scope and applications in Veterinary Parasitology.

Unit IV: Epidemiology of Important Parasitic Diseases

Epidemiological factors affecting distribution and transmission of important parasitic diseases of animals and birds- Agent Factors/ Disease Patterns, Environment and Disease Patterns, Social Factors and Disease Patterns, etc. Parasitic disease monitoring and evaluation, outbreak investigations and surveillance. Forecasting of parasitic diseases

VI. Suggested Reading

- Abubakar I, Stagg HR, Cohen T and Rodrigues LC. 2016. *Infectious Disease Epidemiology*, 1st Edn, Oxford University Press.
- Alan Gunn and Sarah Jane Pitt. 2012. *Parasitology: An integrated Approach*, 1st Edition, Wiley.
- Angela ER, Taylor and John R Baker. 1968. *In-vitro cultivation of parasites*, 1st Edition, Blackwell Scientific Pub.
- Atkinson CT, Thomas NJ and Hunter DB. 2009. *Parasitic diseases of wild birds*, 1st Edition, John Wiley and Sons, Inc

- Bhatia BB, Pathak KML and Juyal PD. 2014. *Textbook of Veterinary Parasitology*, 3rd Edition, Kalyani Publishers
- Boothroyd JC and Komuniecki R. 1995. *Molecular Approaches to Parasitology*. 1st Edition, Wiley-liss Publication, New York.
- Cohen S and Sadun EH. 1976. *Immunology of Parasitic Infections*, 1st Edition, Blackwell Scientific Publications
- David P Huges, Jacques Brodeur and Frederic Thomas. 2012. *Host manipulation by parasites*, Oxford University Press
- Elizabeth A Zeibeg. 2012. *Clinical Parasitology- A practical approach*. 2nd edition, Elsevier Health Sciences
- GW Krantz and DE Walter. 2009. *A manual of Acarology*, 3rd Edition, Texas Tech University Press
- Hendrix CM and Robinson E. 2017. *Diagnostic Parasitology for Veterinary Technicians*. 5th Edition. St. Louis, Missouri: Elsevier Inc
- Joanne P. 2009. *Advances in Parasitology Natural history of host- parasite interactions*- 1st edition, Vol 68 Academic Press
- Kennedy MW and Harnett W. 2001. *Parasitic nematodes: molecular biology, biochemistry, immunology*, 2nd Edition, CABI Publishing
- Kettle DS. 1995. *Medical and Veterinary Entomology*, 2nd Edition, CAB International
- Levine ND. 1999. *Veterinary Protozoology*, 1st edition, Wiley-Blackwell
- MA Taylor, RL Coop and RL Wall. 2015. *Veterinary Parasitology*, 3rd Edition, Wiley- Blackwell publishers.
- Marr JJ, Nilsen TW and Komuniecki RW. 2003. *Molecular Medical Parasitology*, 1st Edition, Elsevier
- Mehlhorn H. 2016. *Animal Parasites: Diagnosis, Treatment, Prevention*. 1st Edition, . Springer International Publishing
- Pittaway AR. 1991. *Arthropods of Medical and Veterinary Importance*, 1st Edition, CAB International
- Richard Wall and David Shearer. 1997. *Veterinary Entomology*, 1st Edition, Springer, Dordrecht
- Samuel W, Pybus M and Kocan A. 2001. *Parasitic Diseases of Wild Mammals*, 2nd Edition, Iowa State Univ. Press.
- Smyth JD. 1995. *Introduction to Animal Parasitology*, 3rd Edn., Cambridge University Press
- Soulsby EJL. 1982. *Helminths, Arthropods and Protozoa of Domesticated Animals* 7th Edition, Baillière Tindall, London
- Taylor MA, Coop RL and Wall RL. 2015. *Veterinary Parasitology*, 3rd Edn, Wiley- Blackwell Publishers
- Tibor Kassai. 1999. *Veterinary Helminthology*, 1st Edition, Butterworth-Heinemann publishers
- Urquhart GM, Armour J, Duncan JL, Dunn AM and Jennings FW. 1996. *Veterinary Parasitology*, 2nd Edition, Blackwell Science, London, UK
- Wakelin D. 1996. *Immunity to Parasites*. 2nd Edition, Cambridge University Press
- Walker A. 1994. *Arthropods of Humans and Domestic Animal: A Guide to Preliminary Identification*, 1st Edition, Springer Netherlands
- Zajac AM and Conboy GA. 2012. *Veterinary Clinical Parasitology*, 8th Edition, Wiley-Blackwell.
- Protozoological abstracts
- Advances in Parasitology
- Trends in Parasitology
- Experimental Parasitology
- Relevant Research/ Review articles



Course Outline-cum-Lecture Schedule Doctoral Degree Programme

- I. Course Title** : Advances in Helminthology-I
II. Course Code : VPA 601
III. Credit Hours : 2+1

IV. Aim of the course

Developments in the area of molecular biology, pathogenesis, diagnosis and control of trematodes and cestodes.

Lecture	Topics
Theory	
1-16	Unit I: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of trematodes and their larval stages.
17-32	Unit II: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of cestodes and larval stages.
Practicals	
1-9	Morphological, pathological and immunological studies of trematode parasites.
10-16	Morphological, pathological and immunological studies of cestode parasites.

- I. Course Title** : Advances in Helminthology-II
II. Course Code : VPA 602
III. Credit Hours : 2+1

IV. Aim of the course

To study the recent developments in the area of molecular biology, pathogenesis, diagnosis of nematode parasites and thorny headed worms with an objective of better control.

Lecture	Topics
Theory	
1-28	Unit I: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of nematode parasites and their larval stages.
30-32	Unit II: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of thorny-headed worms.
Practicals	
1-14	Morphological, pathological and immunological studies of various nematodes
15-16	Morphological, pathological and immunological studies of various thorny-headed worms



- I. Course Title : Advances in Entomology and Acarology**
II. Course Code : VPA 603
III. Credit Hours : (2+1)

IV. Aim of the course

To study the recent scientific developments on biology and control measures for arthropods of veterinary importance.

Lecture	Topics
Theory	
1-5	Unit I: Origin, evolution, regional/ seasonal distribution and forecasting of insect and acarine population
6-14	Unit II: Population dynamics of insects and acarines in relation to biotic and abiotic factors
15-21	Unit III: Recent developments pertaining to insects of veterinary importance.
22-27	Unit IV: Recent developments pertaining to arachnids of veterinary importance
28-32	Unit V: Chemical, biological, herbal and immunological control measures and integrated pest management. Modulation of vector competence to transmit parasitic infections using molecular genetics by developing transgenic vectors
Practicals	
1-11	Collection and identification of arthropods; demonstration of the infective stages in vectors
12-16	Immunopathological changes produced in the host tissues due to the infestation of arthropods

- I. Course Title : Advances in Protozoology**
II. Course Code : VPA 604
III. Credit Hours : (2+1)

IV. Aim of the course

To study the recent developments in molecular biology, pathogenesis, diagnosis and control of protozoan parasites of veterinary importance.

Lecture	Topics
Theory	
1-5	Unit I: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of intestinal protozoa
6-14	Unit II: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of haemoprotozoans
15-21	Unit III: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of tissue and other protozoa
Practicals	
1-16	Morphological, pathological and immunodiagnosis of protozoan diseases.

- I. Course Title : Immunology of Parasitic Diseases**
II. Course Code : VPA 605
III. Credit Hours : (1+2)

IV. Aim of the course

To study the immune mechanisms operating in different parasitic infections and



to identify the immunodominant/ immunoprotective antigens for diagnosis and control of parasitic diseases.

Lecture	Topics
Theory	
1-4	Unit I: To study the salient features of immune responses in relation to trematode, cestode, and nematode infections in livestock
5-7	Unit I: To study the salient features of immune responses to protozoan infections in livestock
8-9	Unit I: To study the salient features of immune responses to arthropod infestations
10-11	Unit II: Principles and applications of immunodiagnostic methods for parasitic diseases
12-13	Unit III: Standardization of immunodiagnostic methods for parasitic diseases
14-16	Unit IV: Identification of candidate antigens for diagnosis and vaccine development
Practicals	
1-16	Methods for purification of antigens, fractionation and characterization of antigens, identification of candidate antigens as drug targets,
17-20	Raising of hyperimmune sera
21-32	Development and standardization of immunodiagnostic methods for the diagnosis and control of parasitic infections

I. Course Title : Molecular Diagnostics and Vaccine Development for Parasitic Diseases

II. Course Code : VPA 606

III. Credit Hours : (2+1)

IV. Aim of the course

To understand the principles of development of sensitive molecular tools for rapid and field oriented tests. Identification of vaccine targets for control of parasites of livestock and pets.

Lecture	Topics
Theory	
1-3	Unit I: Introduction. Molecular taxonomy of parasites
4-8	Unit II: Genome organisation in parasites of veterinary importance. Structure and function of nucleic acids
9-14	Unit III: Basic plan of gene cloning, and expression in heterologous host. Production of recombinant protein and downstream processing for diagnostic/ prophylactic applications
15-17	Unit IV: General concept of protein synthesis. Identification and molecular characterization of proteins of diagnostic/ prophylactic relevance of parasitic origin
18-26	Unit V: Nucleic acid based techniques for genetic characterization and sensitive diagnosis of parasitic infections; PCR, LAMP, nucleic acid hybridization technique, pyrosequencing, real time PCR, DNA microarray, microsatellite analysis, RNAi, reverse genetic approaches and their applications, etc.
27-28	Unit VI: Hybridoma technology. Principle of production of monoclonal antibody. The diagnostic application of monoclonal antibodies of parasitic infection
29-32	Unit VII: DNA vaccine, vector vaccine, recombinant protein based vaccine, subunit vaccine, principle and application



Lecture	Topics
Practicals	
1-11	Identification, characterization, and purification of recombinant protein antigens; SDS-PAGE and western blotting,
12-16	Extraction and quantification of nucleic acid and PCR

I. Course Title : Host Parasite Interactions

II. Course Code : VPA 607

III. Credit Hours : (2+0)

IV. Aim of the course

To study different level of host-parasite interactions/ association with an objective of efficient control.

Lecture	Topics
Theory	
1-6	Unit I: Introduction, distribution of parasites on/ in the host, morphological adaptation for better survival in/ on the host
7-14	Unit II: Behavioural defences, host immune responses and genetic resistance to parasites
15-26	Unit III Establishment of parasites in immune competent, susceptible, intermediate and abnormal hosts, chronicity of parasitic infections, immunoevasive strategies of the parasites and host-parasite equilibrium
27-32	Unit IV: Pathological consequences of host parasite interactions in relation to malnutrition and micronutrient metabolism

I. Course Title : *In-vitro* Cultivation of Parasites

II. Course Code : VPA 608

III. Credit Hours : (1+2)

IV. Aim of the course

Development and standardization of *in-vitro* techniques for parasite cultivation.

Lecture	Topics
Theory	
1-2	Unit I: Introduction, problems and goals of <i>in-vitro</i> cultivation of parasites
3-6	Unit II: <i>In-vitro</i> cultivation of genital, intestinal flagellates and intestinal ciliates
7-9	Unit III: <i>In-vitro</i> cultivation of intestinal protozoa
10-11	Unit IV: <i>In-vitro</i> cultivation of haemoprotozoa
12-13	Unit V: <i>In-vitro</i> techniques, media and tissue culture for cultivation of helminths and their larval stages
14-16	Unit VI: <i>In-vitro</i> mass rearing and colonization of ticks, flies and other insects
Practicals	
1-7	Preparation of media, sterilization methods and cultivation of genital, intestinal flagellates and intestinal ciliates
8-16	Preparation of media, sterilization methods and cultivation of intestinal and haemoprotozoa protozoa



Lecture	Topics
17-24	Preparation of media, sterilization methods and cultivation of helminths and their larval stages
25-32	Preparation of media, sterilization methods and cultivation of ticks, flies and other insects

I. Course Title : Emerging and Re-Emerging Parasitic Diseases

II. Course Code : VPA 609

III. Credit Hours : (2+0)

IV. Aim of the course

To study the emerging and re-emerging parasitic diseases.

Lecture	Topics
Theory	
1-10	Unit I: Emerging and re-emerging helminthic diseases
11-21	Unit II: Emerging and re-emerging protozoan diseases
22-32	Unit III: Emerging and re-emerging vector-borne diseases

I. Course Title : Biology and Ecology of Parasites

II. Course Code : VPA 610

III. Credit Hours : (3+0)

IV. Aim of the course

Study of the bionomics and ecology of the parasites.

Lecture	Topics
Theory	
1-5	Unit I: Ultrastructure, physiology, biochemistry and bionomics of trematodes of veterinary importance
6-10	Unit I: Ultrastructure, physiology, biochemistry and bionomics of cestodes of veterinary importance
11-20	Unit II: Ultrastructure, physiology, biochemistry and bionomics of nematodes of veterinary importance
21-30	Unit III: Ultrastructure, physiology, biochemistry and bionomics of important arthropod parasites
31-40	Unit IV: Ultrastructure, physiology, biochemistry and bionomics of important protozoan parasites
41-45	Unit V: Ecology related definitions, Environmental changes and ecological disturbances due to natural phenomenon and human interventions (demographic, societal and agricultural changes global warming, floods, hurricanes and pollution)
46-48	Unit VI: Principles of Remote Sensing, GIS and their role in Veterinary Parasitology

I. Course Title : Molecular Veterinary Parasitology

II. Course Code : VPA 611

III. Credit Hours : (2+0)

IV. Aim of the course

To give a deep insight into molecular biology of parasites of veterinary importance,



their transmission and control. Molecular, immunological and genetic aspects of selected parasites of veterinary importance and vector-host-parasite interaction.

Lecture	Topics
Theory	
1-2	Unit I: Introduction to molecular biology of parasites-Biological molecules (carbohydrate, protein and nucleic acid)
3-6	Unit I: Eukaryotic cell structure, cell membrane and organelles- kinetoplast, apicoplast, cilia, flagella biology
7-11	Unit I: Eukaryotic cell metabolism and cell respiration-Oxidative phosphorylation-anaerobic metabolism in parasites-fatty acid metabolism of parasites-cellular reproduction mendelian genetics in parasites and vectors
12-16	Unit I: Genome of parasites of veterinary importance, genome size- molecular taxonomy-DNA barcoding-phylogenetics
17-22	Unit II: Genetic code- Gene expression-Transcription and Translation-post translational modifications- RNA interference in parasites-CRISPR/ Cas9 in parasites
23-27	Unit II: Metagenome-microbiome-transcriptome of parasites-transgenic and para transgenic approach in parasites-drug resistance mechanism and genetics
28-32	Unit III: Molecular biology of selected helminth parasites (<i>Fasciola</i> spp, <i>Schistosoma</i> spp, <i>Taenia</i> spp, <i>Echinococcus</i> spp, <i>Toxocara</i> spp, <i>Haemonchus</i> spp, <i>Dictyocaulus</i> spp etc)

I. Course Title : Parasite Epidemiology

II. Course Code : VPA 612

III. Credit Hours : (2+0)

IV. Aim of the course

To study the disease and transmission characteristics, descriptive epidemiology of infectious agents.

Lecture	Topics
Theory	
1-4	Unit I: Introduction to epidemiological concepts-Definitions, aims and uses of epidemiological studies, approaches of epidemiology (descriptive, analytical and experimental), types of epidemiological studies along with their advantages and disadvantages, features of parasitic disease epidemiology
5-8	Unit I: Introduction to epidemiological concepts- Measures of disease frequency: Morbidity and mortality (Rate, Ratio, Proportional rate), Measures of morbidity (Cumulative incidence, Incidence rate, Attack rate, Prevalence-Point and Period) and mortality (Cumulative Mortality, Mortality rate, Death rate, Age/ Sex/ Breed death rate, Case fatality proportion, Cause specific death rate, etc.). The epidemiological triangle, iceberg concept, endemic stability, herd immunity concept, etc.
9-12	Unit II: Methods in epidemiology Cross-sectional, case control and cohort studies. Techniques of epidemiological surveys Types of sampling- Non-probability sampling (target sampling, choice sampling, etc.), Probability sampling (Random samples, systemic sampling, stratified sampling. cluster sampling, etc.). Sample size calculation for different epidemiological and experimental studies



Lecture	Topics
13-16	Unit II: Methods in epidemiology Epidemiological Measures of Association-Strength of association (Relative risk, odds ratio), Effect of association (Attributable rate), effect/ importance of association
17-20	Unit III: Advances in Epidemiological techniques Sero-epidemiological methods used in important parasitic disease-Uses and limitations, properties and evaluation. Molecular epidemiology- Principles, laboratory methods, bioinformatics in molecular epidemiology
21-24	Unit III: Advances in Epidemiological techniques Serological and molecular epidemiology of important parasites. Remote sensing and geographic information system- Scope and applications in Veterinary Parasitology
25-28	Unit IV: Epidemiology of Important Parasitic Diseases Epidemiological factors affecting distribution and transmission of important parasitic diseases of animals and birds- Agent Factors/ Disease Patterns, Environment and Disease Patterns, Social Factors and Disease Patterns, etc.
29-32	Unit IV: Epidemiology of Important Parasitic Diseases Parasitic disease monitoring and evaluation, outbreak investigations and surveillance Forecasting of parasitic diseases

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Veterinary Para-Clinical Subjects

– Veterinary Public Health and Epidemiology



Course Title with Credit Load

M.V.Sc. in Veterinary Public Health and Epidemiology

Course Code	Course Title	Credit Hours
VPE 501	Concepts in Veterinary Public Health and One Health*	2+0
VPE 502	Zoonoses-I*	2+1
VPE 503	Zoonoses-II*	2+1
VPE 504	Principles of Epidemiology*	2+1
VPE 505	Hygiene and Safety of Foods of Animal and Aquatic Origin*	2+1
VPE 506	Food-borne Infections and Intoxications	2+1
VPE 507	Food Safety Standards, and Regulations	2+1
VPE 508	Environmental Hygiene and Safety	2+1
VPE 509	Applied Epidemiology	2+1
VPE 510	Biosecurity, Bioterrorism and Disaster Management	2+0
VPE 511	Laboratory Techniques in Veterinary Public Health*	0+3
VPE 591	Master's seminar*	0+1
VPE 599	Master's research	30

*Core courses

Course Contents

M.V.Sc. in Veterinary Public Health and Epidemiology

- I. Course Title** : Concepts in Veterinary Public Health and One Health
II. Course Code : VPE 501
III. Credit Hours : 2+0
IV. Aim of the course

To equip students with One Health concepts and advanced skills in public health aspects of infectious disease, intelligence, response, prevention and mitigation.

V. Theory

Unit I

VPH administration; organization, administration and implementation of VPH services/ programs; Structure and function of VPH agencies/ organizations of national and international importance. VPH team, administration and functions; responsibilities of veterinarians in public health team.

Unit II

Definition: One Health. Historical emergence of the concept. Scope, Objective and Area of activities of One Health. Strategic frame-work. Purpose for creation of Veterinary Public Health and Epidemiology –NET.

Unit III

Global burden of disease, Coordinated and systemic disease control response, Ecosystem, Urbanization intensive agriculture and animal husbandry practices, Host-pathogen interaction, Anti-microbial resistance and climate change.

VI. Suggested reading

- Calvin W Schwabe. 1984. *Veterinary Medicine and Human health*. Williams and Wilkins
- Sherikar AT, Bachhil VN and Thapliyal DC. 2013. *Text book of Elements of Veterinary Public Health*, ICAR, Govt. of India.
- Zinsstag J, Schelling E, Waltner-Toews D, Whittaker M and Tanner M. 2015. *One Health: the theory and practice of integrated health approaches*. CABI.

- I. Course Title** : Zoonoses-I
II. Course Code : VPE 502
III. Credit Hours : 2+1
IV. Aim of the course

To impart knowledge on Epidemiology, Etiology, Transmission pattern, Public health significance, Diagnosis and Management of important bacterial, Mycotic and Chlamydial zoonotic diseases.

V. Theory

Unit I

Definition and classification, Factors affecting the occurrence of zoonoses; Disease



management strategies, Disease burden on population and socioeconomic impacts.

Unit II

History, Etiology, Epidemiology, Diagnosis and management of important Bacterial zoonoses, viz., Anthrax, Brucellosis, Tuberculosis, Leptospirosis, Salmonellosis, Borreliosis, Cat scratch disease, Glanders, Lyme disease, Malidiosis, Streptococcosis, Plague, Rat bite fever, Tetanus, Tularemia, Yersiniosis, Staphylococcosis, Vibriosis, Listeriosis, Campylobacteriosis and others.

Unit III

History, Etiology, Epidemiology, Diagnosis and Management of important Mycotic zoonoses, viz., Dermatophytosis, Blastomycosis, Coccidioidomycosis, Cryptococcosis, Histoplasmosis, Aspergillosis, Candidiasis, Rhinosporidiosis, Sporotrichosis and others.

Unit IV

History, Etiology, Epidemiology, Diagnosis and Management of Chlamydiosis (Psittacosis and Ornithosis) and Prions diseases, viz., Creutzfeldt-Jakob Disease (CJD); Variant Creutzfeldt-Jakob Disease (vCJD), Kuru. Bovine Spongiform Encephalopathy (BSE), Chronic Wasting Disease (CWD) and Scrapie.

VI. Practical

Isolation and identification of important Bacterial, Mycotic and Chlamydial agents of public health significance from host, Vehicle and environment.

VII. Suggested reading

- Bauerfeind R, Graevenitz AV, Kimmig P, Schiefer HG, Schwarz T, Slenczka W and Zahner H. 2016. *Zoonoses: infectious diseases transmissible from animals and humans* (No. Ed. 4). American Society for Microbiology (ASM).
- Mahendra Pal. Zoonoses.
- Narayan KG *Epidemiology, Diagnosis and Management of Zoonoses*.
- Pedro N Acha and Boris Szyfres. *Zoonoses and Communicable Diseases Common to Man and Animals*.
- Seyedmousavi S, De Hoog GS, Guillot J and Verweij PE. 2018. *Emerging and Epizootic Fungal Infections in Animals*. Springereds.
- Thapliyal DC. 1999. *Diseases of animals transmissible to man*. 1st ed. International Book Distributing Company, Lucknow.
- *Zoonoses: Recognition Control and Prevention* (Martin E, Jones EH, Hubbard WT and Hagstard HV)

I. Course Title : Zoonoses-II

II. Course Code : VPE 503

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge on Epidemiology, Etiology, Transmission pattern, Public health significance, Diagnosis and Management of important Viral, Rickettsial and Parasitic zoonotic diseases.

V. Theory

Unit I

Disease burden, History, Etiology, Epidemiology, Transmission pattern, Diagnosis and management of important viral zoonoses, viz., Japanese encephalitis, Tick-

borne encephalitis, Encephalomyelitis, Rabies, Influenza, KFD, Rift valley fever, Chickungunya, FMD, and Enteroviruses.

Unit II

Disease burden, History, Etiology, Epidemiology, Transmission pattern, Diagnosis and management of important viral zoonoses, viz., Crimean-Congo haemorrhagic fever, Dengue, West-Nile fever, Yellow fever, Rift-valley fever, Equine encephalitis, Louping ill, Ebola, Marburg, Hantavirus, Zika, Hendra, Nipah and Corona viruses.

Unit III

Disease burden, History, Etiology, Epidemiology, Transmission pattern, Diagnosis and Management of important Rickettsial zoonoses, viz., Q fever, Typhus fever group.

Unit IV

Disease burden, Etiology, Host range, Epidemiology, Transmission pattern, Diagnosis and Management of important Parasitic zoonoses, viz., Hydatidosis, Taeniosis, Trichinosis, Fascioliosis, Fasciolopsiosis, Toxoplasmosis, Trypanosomosis, Cryptosporidiosis, Cysticercosis, Leishmaniosis, Sarcocystosis, Dracunculosis, Paragonimosis and Diphylobothriosis.

VI. Practical

Isolation and identification methods for important viral and parasitic agents of public health significance from host, vehicle and environment.

VII. Suggested Reading

- Bauerfeind R, Graevenitz AV, Kimmig P, Schiefer HG, Schwarz T, Slenczka W and Zahner H. 2016. *Zoonoses: infectious diseases transmissible from animals and humans* (No. Ed. 4). American Society for Microbiology (ASM).
- Mackie and Mc. Cartney. *Practical Medical Microbiology*.
- Parija SC. *Text book of Medical Parasitology*.
- Pedro N Acha and Boris Szyfres. *Zoonoses and Communicable Diseases Common to Man and Animals*.
- Soulsby JL *Helminthes, Arthropods and Protozoa of Domesticated Animals*.
- Steele JL. *CRC Handbook series in Zoonoses*.
- Thapliyal DC. 1999. *Diseases of animals transmissible to man*. 1st ed. International Book Distributing Company, Lucknow.

I. Course Title : Principles of Epidemiology

II. Course Code : VPE 504

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge on the principles and concepts employed for epidemiological investigation of the diseases.

V. Theory

Unit I

Historical perspective and scope of veterinary epidemiology. Theories of disease causation and advancement in the concepts of disease causation, Iceberg concept. Koch's postulates of disease causation. Epidemiological triangles, Disease causing wheels, webs and pies.



Unit II

Definitions: Epidemic, Endemic, Pandemic and Sporadic diseases. Qualitative and quantitative approaches to epidemiology. Measurement of disease. Endemic stability and herd immunity, Basic reproductive ratio, Trends and spatial distribution of disease, Epidemic curve and their utility.

Unit III

Transmission of disease and role of ecology in maintenance of disease agents. Type of epidemiological methods. Landscape and molecular methods used in the epidemiological investigation.

Unit IV

Epidemiological Studies-Observational (Case-control, cohort and cross-sectional studies) and experimental studies (field and clinical trials). Disease surveys, monitoring and surveillance. Epidemiological data bases.

Unit V

Definition, scope and limitation of serological epidemiology and interpretation of results. Characteristics of ideal serological test, multiple testing and evaluation of tests. Investigation of disease outbreaks. Strategies of disease control and eradication.

VI. Practical

Data collection from various sources, analysis and interpretation. Serum collection method demonstration. Analytical diagnostic and relative sensitivity and specificity calculation. use of software for data analysis.

VII. Suggested Reading

- Elliot P, Wakefield JC, Best NG and Briggs DJ. 2000. *Spatial Epidemiology: methods and applications*; Oxford University Press.
- Martin SW, Meek AH and Willeberg P. 1986. *Veterinary Epidemiology: Principles and methods*. IOWA State University Press/ Ames, Iowa. USA.
- Pfeiffer D. 1998. *Veterinary Epidemiology. An Introduction. Institute of Veterinary, Animal and Biomedical Sciences*. Massey University, Palmerston, New Zealand.
- Salman M. 2008. *Animal disease surveillance and survey systems: methods and applications*. John Wiley and Sonsed.
- Thrusfield M. 1995. *Veterinary Epidemiology*: Blackwell Science Ltd. Oxford, UK.

I. Course Title : Hygiene and Safety of foods of Animal and Aquatic origin

II. Course Code : VPE 505

III. Credit Hours : 2+1

IV. Aim of the course

To acquaint the students about principles of food hygiene and quality improvement practices.

V. Theory

Unit I

Principles of food hygiene in relation to foods of animal and aquatic origin. Importance of food hygiene in public health. Impact of environmental sanitation and other factors on food quality. General principles of prevention of food-borne illnesses, risk analysis.

Unit II

Importance and objectives of milk hygiene. Hygienic production, Handling, Transportation, Storage and marketing of milk. Mastitis. Milk spoilage and preservation. Milk-borne diseases of public health significance. Milk allergy-lactose intolerance. Residues of pesticide and antibiotics in milk and its impact on human health. Milk spoilage. Milk adulteration, synthetic milk. Milk plant hygiene and sanitation.

Unit III

Objectives and importance of meat hygiene. Hygienic practices at farm and during transportation of food animals including poultry. Hygienic meat production-an overview. Adulteration. Speciation, spoilage and preservation of meat. Meat-borne diseases of public health significance. Treatment and safe disposal of slaughterhouse by-products. Hygienic practices in abattoirs.

Unit IV

Fish, fisheries and ichthyology: an introduction. Environmental factors affecting aquatic food hygiene. Hygienic production, Handling, Preservation, Transportation and marketing of aquatic foods. Microbiology and Spoilage of aquatic foods. Safe disposal of fish byproducts. Fish-borne diseases of public health significance.

VI. Practical

Collection of meat/ milk/ egg/ fish samples for determination of physical as well as microbiological quality. Examination of meat/ milk samples for possible adulteration.

VII. Suggested reading

- FAO (Manual No. 79). *Manual on simple methods of Meat preservation*.
- Marriott NG, Schilling MW and Gravani RB. 2018. *Principles of Food sanitation*; Springer.
- Nollet LM and Toldrá F. 2016. *Safety Analysis of Foods of Animal origin*, CRC Press.ed.
- Norer R. 2016. *Genetic Technology and Food Safety*; Springer International Publishing.
- Wro and Bruno. *Fish Disease and Disorders – Viral Bacterial and Fungal Infections*.

I. Course Title : Food-borne Infections and Intoxications

II. Course Code : VPE 506

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge about illnesses arising due to consumption of contaminated foods.

V. Theory

Unit I

Definition: Food borne infection, Food intoxication, Bacterial toxins, Toxi-infection, etc. Classification, Epidemiology, Disease burden and Economics of food-borne diseases. Reservoirs of food-borne pathogens and its mode of transmission. Vehicles of pathogens. Measures employed for prevention and control of food-borne diseases. Food- poisoning outbreak investigation and management.

Unit II

Epidemiology, Economic, Diagnosis and Management of bacterial food-borne infections and intoxications due to *Salmonella*, *Campylobacter*, *Clostridium*,



Staphylococcus, Listeria monocytogenes, Vibrio parahaemolyticus, E.coli, Bacillus cereus, Shigella, Yersinia enterocolitica and others. Types of bacterial toxins and its manifestations.

Unit III

Epidemiology, Economics, Diagnosis and Management of food-borne Viral pathogens: Hepatitis viruses, Enteroviruses, Noroviruses, Rotaviruses and other. Food-borne parasitic and rickettsial infections.

Unit IV

Illness due to food additives, seafood toxins, mycotoxins, biocides, plant origin toxins, heavy metals, veterinary drugs, hormones, etc. in foods. Anti-microbial resistance (AMR) in food-borne pathogens-definition, current status, factors responsible, mechanism of resistance, mode of transmission and control.

VI. Practical

Food-borne disease outbreak investigation. Detection, characterization and quantitation of food-borne pathogens, toxins, antibiotics, pesticides and additives in foods.

VII. Suggested reading

- Cliver DO, Potter M and Riemann HP. 2011. *Food borne Infections and Intoxications*; Elsevier.
- D'Mello JPF. *Food Safety-Contaminants and Toxins*.
- Jay JM, Loessner MJ and Golden DA. 2008. *Modern food microbiology*; Springer Science and Business Media.
- Hubbert WT. *Food Safety and Quality Assurance-Foods of Animal Origin*.
- Vernam AH. 1991. *Food-borne pathogens*; Wolfe Publishing Ltd, London.

I. Course Title : Food Safety Standards and Regulations

II. Course Code : VPE 507

III. Credit Hours : 2+1

IV. Aim of the course

To acquaint the students with various parameters responsible for the production of hygienic and safe foods for human consumption.

V. Theory

Unit I

Indicators of food quality and spoilage (biological and others). Food plant hygiene and sanitation. Hurdle technique and its relevance. Microbiological criteria for food quality.

Unit II

Food standards- National, International, Private standards. GSP, GMP, HACCP and ISO 22000, etc. Genesis of food safety standards, Mechanism of food safety standards formulation, Agencies associated in food standard formulation, Role of WTO, FSSAI, BIS and others in standard formulation. National and international regulations and legislation enacted for quality food production.

Unit III

Food safety regulations in reference to the Pesticides, Veterinary drugs residues, Heavy metals, Hormones and others (MRLs, ADIs, etc.). Traceability system, Organic food production.



VI. Practical

Detection of Pesticides, Veterinary drug residues, Heavy metal in food samples. Visits to the various food processing units for examining the compliance of HACCP/ FSSAI regulations and other standards. Microbiological assessment of cleanliness of surface and equipment in abattoir/ meat/ milk plant

VII. Suggested Reading

- Fortin ND. 2016. *Food Regulation: law, science, policy, and practice*. John Wiley and Sons.
- Joint FAO. 2004. *Codex alimentarius: food hygiene basic texts* (No. Ed. 3). Food and Agriculture Organization of the United Nations.
- Josling TE, Roberts D and Orden D. 2004. *Food Regulation and Trade: toward a safe and open global system*; Peterson Institute Press.
- Van Der Meulen and Bernd. 2011. *Private Food Law: Governing food chains through contract law, self-regulation, private standards, audits and certification Schemes*. The Netherlands: Wageningen Academic Publishers.
- Vos E. 1999. *Institutional frameworks of community health and safety legislation: Committees, agencies, and private bodies*. Hart.

I. Course Title : Environmental Hygiene and Safety

II. Course Code : VPE 508

III. Credit Hours : 2+1

IV. Aim of the course

To impart education about environment, environmental pollutants and its manifestations on animal and human health.

V. Theory

Unit I

Introduction to environment, Environmental hygiene, Pollutants and its impact on animal/ human health. Green-house gasses and its effect. Microbial pollution. Environmental risk assessment and management.

Unit II

Nature and characteristics of various environmental pollutants. Pollutions of soil, air and water and its effects on health. Impact of noise pollution on health.

Unit III

Genetic risk from Environmental agents, Health problems due to nuclear energy, Microwave, Electro-magnetic and other radiation pollution, Environmental estrogens, Pesticides pollution. Industrial pollution as well as pollution due to plastic and petrochemical products.

Unit IV

Role of live-stock in environmental pollution, Dissemination of excreted pathogens, animal-waste and human risk, principles of safe disposal of bio-medical waste and recycling of wastes

Unit V

Contamination of environment with heavy metals, pesticides, veterinary drug residues and its impact on human health. National and international pollution control agencies and its role in management of environmental pollution. Regulations on control of environmental pollution.



VI. Practical

Determination of portability of drinking water, Estimation and detection of pathogenic microbes in water, air, soil, animal products, sewage, and animal waste; Visit of sewage and waste disposal plants/ sites.

VII. Suggested reading

- Fairman R, Mead CD and Williams WP. 1998. *Environmental risk assessment: approaches, experiences and information sources*.
- Frumkin H. 2016. *Environmental health: from global to local*. John Wiley and Sons.ed.
- Levy BS. 2006. *Occupational and environmental health: recognizing and preventing disease and injury*. Lippincott Williams and Wilkins. ed.
- Linkov I and Ramadan AB. 2004. *Comparative risk assessment and environmental decision making* (Vol. 38). Springer Science and Business Media.Ed.
- Ray M. *Environmental Pollution: Impact of technology on quality of life*.
- Richard B Philp. *Environmental Hazards and Human Health*

I. Course Title : Applied Epidemiology

II. Course Code : VPE 509

III. Credit Hours : 2+1

IV. Aim of the courses

To impart education on applied aspects of epidemiology.

V. Theory

Unit I

Introduction to applied epidemiology. Models, modelling and types of models. Epidemiological and economic models. Principles and classification of models. Deterministic and stochastic models. Empirical and explanatory models. Application of models in disease forecasting. Modelling in disease prevention and control.

Unit II

Disease occurrence, Ecology of disease, Monitoring and surveillance. Outbreak investigation protocol. Path, regression and discriminate analyses. Time series analysis and analysis of variance.

Unit III

Animal disease economics (cost-benefit analysis, internal rate of return, payback period, partial budgeting), decision analysis. Bayesian analysis. Monte-Carlo and Markovian processes and system evaluation. Uses of multivariate analysis.

Unit IV

Disease outbreaks, Participatory epidemiology, Disease reporting system, Tracing and notification. Disease control strategies, Risk assessment, Exotic diseases, Trans-boundary diseases, Vaccination.

Unit V

Definition; Disease intelligence. Tele-epidemiology. Remote sensing, Geographic information system, Disease surveillance and Early warning system.

VI. Practical

Survey, Sampling and Data presentation. Measurements of disease occurrence, Outbreak investigation and reporting. Use of epidemiological software.

VII. Suggested Reading

- Brownson RC and Petitti DB. 1998. *Applied Epidemiology: theory to practice*. Oxford University Press.
- Durr PA and Gatrell AC. 2004. *GIS and spatial analysis in veterinary science*. Cabi. Ed.
- Toma B, Dufour B, Sanaa M, Benet JJ, Moutou F, Louza A and Ellis P. 1999. *Applied Veterinary Epidemiology and the control of disease in populations*. 7 Avenue du Général de Gaulle.
- Twisk JW. 2013. *Applied longitudinal data analysis for epidemiology: a practical guide*. Cambridge university press.

I. Course Title : Bioterrorism and Disaster Management

II. Course Code : VPE 510

III. Credit Hours : 2+0

IV. Aim of the course

To equip the students with latest information of various types of disaster and its management, biological weapons used in bioterrorism, biological hazards and remedial measures, biomedical hazards and their prevention.

V. Theory

Unit I

Definition: Bioterrorism. Major agents used as biological weapons, Hazard analysis and combating bioterrorism. Bio-ethics and social ethics, Advisory role of veterinarians during such events.

Unit II

Definitions, Natural and man- made disaster, Impact analysis and classification of disaster scale, Essential preparations to manage disaster, Role of central, State and Local government bodies in disaster management, Role of veterinarians/ veterinary public health personnel during emergency/ Disaster and sequence of emergency medical services.

Unit III

Effect of natural disasters like floods, Prolonged draughts, Forest fires, Earthquakes, Tsunami and Tidal damages, Storms, etc. on human as well as animal population, post-disaster disease susceptibility and remedial measures.

Unit IV

Biosecurity– definition, importance, methods used for pathogen inventory, Food processing/ quarantine units/ animals/ poultry farms, etc. Biomedical hazards and biosafety in the laboratories. Occupational health risk and its management.

VI. Suggested Reading

- Antosia RE and Cahill JD. 2006. *Handbook of bioterrorism and disaster medicine*. Springer.ed.
- Hodgkinson PE and Stewart M. 1991. *Coping with catastrophe: A handbook of disaster management*. Taylor and Frances/ Routledge.
- Van De Walle B, Turoff M and Hiltz SR. 2014. *Information systems for emergency management*. Routledge.
- Van Oosterom P, Zlatanova S and Fendel E. 2006. *Geo-information for disaster management*. Springer Science and Business Media.Ed.



- I. Course Title : Laboratory Techniques in Veterinary Public Health**
II. Course Code : VPE 511
III. Credit Hours : 0+3

IV. Aim of the course

To impart practical exposure of laboratory techniques in Veterinary Public Health to the students.

V. Practical

Unit I

General practices: Use of PPE (Personal Protective Equipment) and biosafety cabinets, Preparation of glass-wares, cultural media, buffer solution, solutions of different molarity and other laboratory materials. Sampling methods for biological materials. Quality analysis of milk, meat, water and other food materials and others.

Unit II

Microbiological techniques: Plate counts, Enumeration and isolation of psychrophilic, Thermophilic and thermoduric organisms in food samples, Enumeration, isolation and identification of important food-borne pathogens, Detection of bacterial toxin involved in food-poisoning, Detection of viral pathogens in various samples. Isolation, identification and enumeration of yeast/ molds/ spores in food samples.

Unit III

Immunological/ Serological and electrophoretic techniques: AGPT, Precipitation tests, Agglutination test, Haem-agglutination test, Polyacrylamide gel electrophoresis, Counter immuno- gel electrophoresis, ELISA, FAT, Intra-dermal inoculation tests and others.

Unit IV

Detection and quantification of residues of pesticides and drugs using immunological and chromatographic methods.

Unit V

Methods for isolation and quantitation of genomic DNA/ RNA from bacterial and other biological specimens using Latest molecular techniques and others. Laboratory records and log books of equipment.

VI. Suggested Reading

- Bremner A and Jhonston M. *Poultry Meat Hygiene and Inspection*.
- Duncan JR and Prasse KW. 1986. *Veterinary Laboratory Medicine* (No. Ed. 2). Iowa State University Press.
- Garvin ML *Infectious Waste Management-A practical guide*.
- Gradwohls' *Clinical Lab Methods and Diagnosis*.
- Jerome KR. 2016. *Lennette's laboratory diagnosis of viral infections*. CRC (Sonnenwirth and Jarett) Press. ed.
- Prasad J and Neeraj. *Principles and Practice of Animal Health and Hygiene*.
- Rupprecht C and Nagarajan T. 2015. *Current laboratory techniques in rabies diagnosis, research and prevention* (Vol. 2). Academic Press.ed.

Course Outline-cum-Lecture Schedule for Master Degree Programme

I. Course Title	: Concepts in Veterinary Public Health and One Health
II. Course Code	: VPE 501
III. Credit Hours	: 2+0

Lecture(s)	Topic
Theory	
1-2	VPH administration: organization, administration and implementation of VPH services/ programs
3-4	Structure and function of VPH agencies/ organizations at national and international levels
5-6	VPH team; administration and functions; responsibilities of veterinarians in the public health team
7	One Health: Definition, historical emergence of the concept. Scope, objectives and activities of One Health
8-9	One Health Umbrella, stewardship of VPH for the implementation of one health activities
10	Strategic framework of One Health activities
11-12	One Health approaches for control of zoonoses and ensuring food safety
13	One Health approaches for combating antimicrobial resistance
14	One health policies, legislations and research
15-16	Transdisciplinary approach of eco-health concepts; one health integrating policy, science and practices
17	Genesis of veterinary public health and epidemiology as a discipline
18-19	Global burden of disease – need for inter-sectoral and inter-disciplinary collaboration
20-21	Coordinated and systemic disease control response
22	Ecosystems, urbanization, intensive agriculture and animal husbandry practices
23	Exploring host-pathogen interactions for better multi-sectoral responses at the human-animal-ecosystem interface addressing food safety, zoonoses, and other public health threats
24	Climate change and need for multi-sectoral and collateral/ multi-lateral collaborations
25	Sharing of epidemiological data and laboratory information on zoonoses and food safety problems across sectors
26	Integration of one health approaches for the promotion of ecosystem and wildlife health
27	Organizations and agencies working to mitigate health challenges based on 'One Health Approach'
28	One Health Initiative as a union of human and veterinary medicine
29	Local, regional, national and international One Health networks
30	One Health in the paradigm of preventive health care and herd health management
31-32	Case study that integrate veterinary public health with one health



I. Course Title : Zoonoses-I
II. Course Code : VPE 502
III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Definition and classification of zoonoses
2	Factors affecting occurrence of zoonoses
3	Disease management strategies
4	Zoonotic disease burden on population
5	Socioeconomic impact of zoonoses
6	Public health implications of bacterial zoonoses
7-9	History, etiology, epidemiology, diagnosis and management of anthrax, brucellosis and tuberculosis
10	History, etiology, epidemiology, diagnosis and management of leptospirosis
11-12	History, etiology, epidemiology, diagnosis and management of plague, rat bite fever, borreliosis and lyme disease
13-14	History, etiology, epidemiology, diagnosis and management of glanders, malidiosis, streptococcosis
15	History, etiology, epidemiology, diagnosis and management of salmonellosis
16	History, etiology, epidemiology, diagnosis and management of campylobacteriosis
17	History, etiology, epidemiology, diagnosis and management of yersiniosis and vibriosis
18-19	History, etiology, epidemiology, diagnosis and management of tetanus, listeriosis, staphylococcosis and tularemia, etc.
20	History, etiology, epidemiology, diagnosis and management of cat scratch disease,
21	History, etiology, epidemiology, diagnosis and management of mycotic zoonoses – General considerations
22-23	History, etiology, epidemiology, diagnosis and management of dermatophytosis, blastomycosis and coccidioidomycosis
24	History, etiology, epidemiology, diagnosis and management of cryptococcosis and histoplasmosis
25	History, etiology, epidemiology, diagnosis and management of aspergillosis and candidiasis
26	History, etiology, epidemiology, diagnosis and management of rhinosporidiosis, sporotrichosis and others
27	History, etiology, epidemiology, diagnosis and management of chlamydiosis (psittacosis and ornithosis)
28	History, etiology, epidemiology, diagnosis and management of prion diseases - Creutzfeldt-Jakob Disease (CJD) and variants
29-30	History, etiology, epidemiology, diagnosis and management of prion diseases - bovine spongiform encephalopathy (BSE), kuru, chronic wasting disease (CWD) and scrapie
31-32	Case studies pertaining to important zoonoses of India
Practical	
1.	Sampling and laboratory preparedness for handling zoonotic bacterial and fungal agents
2.	Isolation, identification and characterization of agents of <i>Bacillus anthracis</i> and zoonotic <i>Mycobacterium</i> species.
3.	Isolation, identification and characterization of zoonotic <i>Streptococcus</i> and <i>Staphylococcus</i> species.



Lecture(s)	Topic
4.	Isolation, identification and characterization of agents of <i>Clostridium tetani</i> and zoonotic <i>Listeria</i> species.
5.	Isolation, identification and characterization of zoonotic <i>Leptospira</i> and <i>Borrelia</i> species.
6.	Isolation, identification and characterization of <i>Burkholderia mallei</i> and <i>Burkholderia pseudomallei</i>
7.	Isolation, identification and characterization of zoonotic <i>Brucella</i> species
8.	Isolation, identification and characterization of food-borne and zoonotic <i>Salmonella</i> species including serotyping of isolates
9.	Isolation, identification and characterization of zoonotic <i>Yersinia</i> and <i>Vibrio</i> species
10.	Isolation, identification and characterization of zoonotic agents responsible for rat bite fever, cat scratch disease, tularemia, etc.
11.	Isolation and identification of zoonotic fungal agents of public health significance from the host, vehicle and environment associated with superficial mycozoonoses
12.	Isolation, identification and characterization of important mycotic agents of public health significance associated with systemic mycozoonoses – blastomycosis and coccidioidomycosis
13.	Isolation, identification and characterization of important mycotic agents of public health significance associated with systemic mycozoonoses – cryptococcosis and histoplasmosis
14.	Isolation, identification and characterization of important mycotic agents of public health significance associated with systemic mycozoonoses - aspergillosis, candidiasis, rhinosporidiosis and sporotrichosis
15.	Isolation, identification and characterization of important chlamydial agents of public health significance from host, vehicle and environment
16.	Laboratory detection of prion diseases

I. Course Title : Zoonoses-II

II. Course Code : VPE 503

III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1-3	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Japanese encephalitis, Tick-borne encephalitis and Encephalomyelitis
4-8	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Rabies, Influenza, KFD, Rift valley fever and Chikungunya
9	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of FMD and Enteroviruses
10	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Crimean-Congo haemorrhagic fever
11-12	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Dengue, West-Nile fever and Yellow fever
13	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Rift-valley fever, Louping ill
14	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of equine encephalitis
15-16	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis

Lecture(s)	Topic
17-18	and management of Ebola, Marburg and Hantavirus Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Hendra Nipah and Zika virus
19	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of corona viruses
20	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of important rickettsial zoonoses
21	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Q fever
22	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of typhus fever group
23-25	Disease burden, etiology, host range, epidemiology, transmission pattern, diagnosis and management of hydatidosis, taeniosis/ cysticercosis and Trichinosis
26	Disease burden, etiology, host range, epidemiology, transmission pattern, diagnosis and management of fasciolosis and fasciolopsiosis
27	Disease burden, etiology, host range, epidemiology, transmission pattern, diagnosis and management of Toxoplasmosis
28-29	Disease burden, etiology, host range, epidemiology transmission pattern, diagnosis and management of Trypanosomosis and Leishmaniosis
30	Disease burden, etiology, host range, epidemiology, transmission pattern, diagnosis and management of Cryptosporidiosis
31	Disease burden, etiology, host range, epidemiology, transmission pattern, diagnosis and management of Sarcocystosis and Dracunculiosis
32	Disease burden, etiology, host range, epidemiology, transmission pattern, diagnosis and management of Paragonimiosis and Diphylobothriosis
Practical	
1.	Detection and characterization of zoonotic viral and parasitic agents from host, vehicle, environment, etc. - Sampling and laboratory preparations
2.	Detection and characterization of Japanese encephalitis, chikungunya and dengue viruses
3.	Detection and characterization of encephalomyelitis, Rift valley fever, West-Nile fever, yellow fever, louping ill and equine encephalitis viruses
4.	Detection and characterization of rabies and influenza viruses
5.	Detection and characterization of FMD and entero-viruses
6.	Detection and characterization of KFD, tick-borne encephalitis and Crimean-Congo haemorrhagic fever viruses
7.	Detection and characterization of zoonotic Ebola, Marburg, Hanta, Zika, corona, Hendra and Nipah viruses
8.	Isolation, identification and characterization of agents responsible for Q fever, typhus fever and other rickettsial zoonoses
9.	Detection and characterization of agents responsible for hydatidosis, taeniosis/ cysticercosis and trichinellosis
10.	Detection and characterization of agents responsible for fasciolosis and fasciolopsiosis
11.	Detection and characterization of <i>Toxoplasma gondii</i>
12.	Detection and characterization of zoonotic <i>Trypanosoma</i> species
13.	Detection and characterization of zoonotic <i>Cryptosporidium</i> species of health significance
14.	Detection and characterization of zoonotic <i>Leishmania</i> species
15.	Detection and characterization of zoonotic <i>Sarcocystis</i> species
16.	Detection and characterization of zoonotic agents responsible for dracunculiosis, paragonimiosis and diphylobothriosis



I. Course Title : Principles of Epidemiology
II. Course Code : VPE 504
III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Historical perspective and scope of veterinary epidemiology
2	Disease causation -theories of disease causation, recent advancements and iceberg concept
3	Koch's postulates and Evan's rules
4	Epidemiological triangle
5	Epidemic, endemic, pandemic and sporadic diseases
6	Qualitative and quantitative approaches to epidemiology
7	Measurement of disease in populations
8	Endemic stability and herd immunity
9	Basic reproductive ratio
10	Trends in spatial and temporal distribution of disease
11	Epidemic curve and its applications
12	Transmission of disease
13	Role of ecology in maintenance of disease agents
14	Epidemiological methods
15	Landscape epidemiology
16	Molecular epidemiology
17	Epidemiological studies
18	Observational studies - case-control studies
19	Observational studies - cohort studies
20	Observational studies - cross-sectional studies
21	Experimental studies - field trials
22	Experimental studies - clinical trials
23	Disease surveys
24	Monitoring and surveillance
25	Epidemiological databases
26	Definition, scope and limitations of serological epidemiology and interpretation of results
27	Characteristics of ideal disease diagnostic tests
28	Multiple diagnostic testing
29	Evaluation of diagnostic tests
30	Investigation of disease outbreaks
31	Strategies of disease control
32	Disease eradication
Practical	
1.	Collection of data from various sources, analysis and interpretation
2.	Demonstration of sample (serum) collection
3.	Evaluation of diagnostic tests
4.	Analytical diagnostic and relative sensitivity and specificity calculation
5.	Use of software for data analysis
6.	Designing and interpretation of a case-control study
7.	Designing and interpretation of a cohort study
8.	Designing and interpretation of a cross-sectional study
9.	Designing and interpretation of a field trials
10.	Designing and interpretation of a clinical trials
11.	Determination of vaccines effectiveness
12.	Designing of a survey



Lecture(s)	Topic
13.	Spatio-temporal distribution of disease
14.	Outbreak investigation
15.	Case study on disease eradication
16.	Case study on disease monitoring and surveillance

I. Course Title : Hygiene and Safety of foods of Animal and Aquatic origin

II. Course Code : VPE 505

III. Credit Hours : 2+1

Lecture(s)	Topic
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Theory

- 1 Importance of food hygiene in relation to the public health
- 2 Principles of food hygiene in relation to foods of animal origin (including aquatic origin foods)
- 3 Environmental sanitation in food establishments
- 4 Food quality - perspectives
- 5 Prevention of foodborne illnesses - principles
- 6 Risk analysis
- 7 Milk hygiene - importance and objectives
- 8 Hygienic production, handling, transportation, storage and marketing of milk and milk products
- 9 Mastitis in dairy animals and its public health significance
- 10 Spoilage of milk
- 11 Preservation of milk
- 12 Milk-borne diseases of public health significance
- 13 Epidemiology of milk allergy and lactose intolerance
- 14 Public health impact pesticide residues in milk supply chain
- 15 Antimicrobial residues in milk supply chain and their public health impact
- 16 Adulteration of milk and dairy products
- 17 Public health implications of synthetic milk
- 18 Milk plant hygiene and sanitation
- 19 Meat hygiene - importance and objectives
- 20 Hygienic meat production including hygienic practices at abattoirs
- 21 Hygienic practices at farm and during transportation of food animals including poultry
- 22 Adulteration of meat and meat speciation
- 23 Spoilage of meat and meat products
- 24 Preservation of meat
- 25 Meat-borne diseases of public health significance
- 26 Safe disposal of slaughter house byproducts
- 27 Fish, fisheries and ichthyology
- 28 Environmental factors affecting aquatic food hygiene
- 29 Hygienic production, handling, preservation, transportation and marketing of aquatic foods
- 30 Microbial profile and spoilage of aquatic foods
- 31 Disposal of fishery waste
- 32 Fish-borne diseases of public health significance



Lecture(s)	Topic
Practical	
1.	Collection of samples of meat, milk, egg and fish for physicochemical and microbial analysis
2.	Analysis of foods of animal origin for physicochemical quality
3.	Analysis of foods of animal origin for microbial quality
4.	Detection of adulteration, debasement, substitution and admixing of animal origin foods and products
5.	Recent methods of speciation of meat
6.	Determination of spoilage in foods of animal origin
7.	Extension of shelf life of perishable foods of animal origin
8.	Detection of mastitis in dairy animals and linking it to consumer's health
9.	Study of supply chains of milk, meat, egg and fish
10.	Evaluation of food plant, equipment and the environment for compliance
11.	Microbial risk analysis
12.	Risk analysis for residues of public health significance in foods of animal origin
13.	Source tracing of foodborne outbreaks using molecular, bioinformatics or epidemiological tools
14.	Evaluation of fish and aquatic harvest for quality and safety
15.	Visit to milk/ meat/ egg/ fish processing unit for the demonstration of food quality and safety checkpoints
16.	Study of databases, information communication tools (ICT) and dedicated websites related to quality and safety of animal origin foods

I. Course Title : Food-borne Infections and Intoxications

II. Course Code : VPE 506

III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Definitions: Foodborne infections, Food intoxications, Toxi-infections, Bacterial toxins, etc.
2-3	Classification, epidemiology, disease burden and economics of foodborne diseases.
4	Fungal toxins
5	Plant, algal, and other toxins
6	Reservoirs of food-borne pathogens
7	Mode of transmission of food-borne pathogens
8	Vehicles of pathogens
9	Measures employed for prevention and control of food-borne diseases
10-11	Food- poisoning outbreak investigation
12	Management of food- poisoning outbreak
13-15	Epidemiology, economic, diagnosis and management of bacterial food-borne diseases
16-17	Foodborne disease due to <i>Salmonella</i> and <i>Campylobacter</i> species
18-19	Foodborne disease due to <i>Clostridium</i> , <i>Staphylococcus</i> , <i>Listeria</i> and <i>Bacillus</i> species
20-22	Foodborne diseases due to species of <i>Vibrio</i> , <i>Escherichia</i> , <i>Shigella</i> , <i>Yersinia</i> , etc.
23	Types of bacterial toxins and their manifestations
24-25	Epidemiology, economics, diagnosis and management of food-borne viral pathogens
26	Foodborne diseases due to hepatitis viruses and entero-viruses
27	Foodborne diseases due to noroviruses, rotaviruses, etc.
28	Food- borne rickettsial infections



Lecture(s)	Topic
29	Food- borne parasitic infections
30	Illness due to additives in foods, seafood toxins, mycotoxins, biocides and plant origin toxins
31	Illness due to food heavy metals, veterinary drugs, hormones, etc. in foods
32	Anti-microbial resistance (AMR) in food-borne pathogens-definition, current status, factors responsible, mechanism of resistance, mode of transmission and control

Practical

1. Food-borne disease outbreak investigation
2. Detection and characterization of food-borne bacterial pathogens in foods of animal origin
3. Detection and characterization of food-borne viral pathogens in foods of animal origin
4. Detection, quantification and characterization of microbial toxins in foods of animal origin
5. Detection of antimicrobial resistance in foodborne pathogens and their molecular and epidemiological characterization
6. Detection and characterization of rickettsial pathogens in foods of animal origin
7. Detection and characterization of parasites of public health in foods of animal origin
8. Detection, quantification and characterization of toxic compounds in the fish and aquatic food supply chain
9. Detection and quantification of antimicrobials in foods of animal origin
10. Detection and quantification of phytotoxins, biocides, etc. in foods of animal origin
11. Detection and quantification of pesticides residues in foods of animal origin
12. Detection and quantification of residues of metals and other environmental contaminants in foods of animal origin
13. Detection and quantification of additives in foods of animal origin
14. Detection and quantification of veterinary drugs in foods of animal origin
15. Case study on food-borne microbial disease relevant to the region
16. Case study on non-microbial hazard relevant to the region

I. Course Title : Food Safety Standards and Regulations

II. Course Code : VPE 507

III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Indicators of food quality and safety
2	Food spoilage (biological, chemical, etc.)
3	Food plant hygiene
4	Sanitation program for the food plant
5	Hurdle technique and its relevance
6	Microbiological food quality criteria
7-8	National and international food standards
9	Private food standards
10	Prerequisite programs for food safety - GAP, GMP, etc.
11	Application of ISO 9000 series to food establishments
12-13	HACCP, ISO 22000



Lecture(s)	Topic
14	Genesis of food safety standards
15	Mechanisms of food safety standard formulation
16	Agencies associated in food standard formulation
17	Role of WTO and FSSAI in standard formulation
18	Role of BIS and other agencies in standard formulation
19	Role of EIC/ EIA
20	National regulations and legislations related to quality food production
21	International regulations related to quality food production
22-26	Food safety regulations in reference to pesticides, veterinary drug, heavy metals, hormones and other residues (MRL, ADI, etc.)
27	Traceability system for foods of animal origin
28	Organic food production
29	Packaging of foods of animal origin – specifications and standards
30	Public health implications of <i>in-vitro</i> and cultured meats as well as meat obtained from genetically modified and unconventional animals
31	SWOT analysis of emerging and novel technologies related to the quality and safety of foods of animal origin
32	Case study related to food standards

Practical

1. Detection of pesticide residues in foods of animal origin
 2. Detection of veterinary drug residues in foods of animal origin
 3. Detection of heavy metal residues in foods of animal origin
 4. Estimation of MRL/ MPL
 5. Estimation of NOEL, ADI, etc.
 6. Microbiological assessment of cleanliness of food plant surface
 7. Microbiological assessment of equipment in abattoir/ meat/ milk plant
 8. Visit to food processing units for examining compliance of HACCP/ FSSAI regulations and other standards
 9. Demonstration of traceability system for foods of animal origin
 10. Demonstration of compliance of organic production of foods of animal origin
 11. Demonstration of registration and licensing of food business operator (FBO) under FSSAI regime
 12. Evaluation of detergents and sanitizers used in the food plant
 13. Inventory management and hygiene audit of food plant
 14. Occupational safety at food plant
 15. Case study on HACCP
 16. Case study on ISO 22000
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I. Course Title : Environmental Hygiene and Safety

II. Course Code : VPE 508

III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Introduction to the environment and environmental hygiene
2	Impact of environmental pollutants on animal and human health
3	Characteristics of various environmental pollutants
4	Nature and impact of microbial pollution
5	Nature and impact of pollution due to chemical pollutants



Lecture(s)	Topic
6	Environmental risk assessment (microbial and non-microbial hazards)
7	Pollutions of soil, air and water and their effects on human, animal and environmental health
8	Dissemination of pathogens and pollutants in the environment
9	Global warming, enhanced green-house effect and climate change- impact on human, animal and environmental health
10	Impact of noise pollution on human and animal health
11	Management of environmental pollution
12	Industrial pollution including impact of plastic and petrochemical products
13	Genetic risk associated with environmental pollutants
14	Health problems due to nuclear energy, microwave, electro-magnetic and other radiation pollutions
15	Pollution due to agrochemicals and pesticides
16-17	Contamination and impact of heavy metals and veterinary drug residues
18	Role of livestock in environmental pollution
19	Public health impact of animal-waste
20	Recycling of wastes
21	Principles of safe disposal of bio-medical waste
22	Food chain consequences of environmental pollutants, contaminants and toxicants
23	Implications of genetically modified organisms on the animal, human and environmental health - regulations and compliance
24	Management of environmental pollution – conventions, treaties, agreements, etc.
25-26	Role of national and international pollution control agencies in the management of environmental pollution.
27	Regulations pertaining to environmental pollution and its control
28	Hygiene and safety at specialized laboratories
29	Designing and maintenance of laboratories that handle high risk pathogens
30	Environmental risk assessment of hazards of regional/ national importance
31	Case studies involving livestock and the environment
32	Case studies indicating human health impact associated livestock

Practical

1. Determination of potability of the drinking water
2. Detection of pollutants in the water
3. Detection of pollutants in the air
4. Detection of pollutants in the soil
5. Detection of pollutants in the animal products
6. Detection of pollutants in the sewage
7. Detection of pollutants in the animal waste
8. Detection and quantification of environmental pollutants, toxicants and contaminants that affect animal, human and environmental health
9. Sustainable methods for animal waste disposal/ economic utilization arising from intensive animal husbandry
10. Cost-benefit analysis of environment friendly animal waste disposal approaches
11. Detection and quantification of genetically modified organisms
12. Structure and function of institutional biosafety committee (IBSC)
13. Environmental monitoring of pollutants – markers and methods
14. Preparation of feasibility report or projects pertaining to selected environmental pollutant(s) of regional importance
15. Visit to sewage/ waste recycling/ disposal plant/ processing unit
16. Case studies on risk mapping, environmental risk assessment, pollution mitigation, etc.



- I. Course Title : Applied Epidemiology**
II. Course Code : VPE 509
III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	An introduction to applied epidemiology
2	Models, modeling and types of model
3	Epidemiological and economic models
4	Principles and classification of models
5	Deterministic and stochastic models
6	Empirical and explanatory models
7	Application of models in disease forecasting
8	Modeling in disease prevention and control
9-10	Disease occurrence and ecology of disease
11	Monitoring and surveillance
12	Outbreak investigation protocol
13	Path, regression and discriminate analyses
14	Time series analysis
15	Statistical analysis of the data - Analysis of variance
16	Animal disease economics - cost-benefit analysis, internal rate of return payback period, etc.
17	Animal disease economics - partial budgeting
18	Animal disease economics - decision analysis
19	Bayesian analysis
20	Monte-Carlo and Markovian processes and system evaluation
21	Multivariate analysis
22	Disease outbreaks and participatory epidemiology
23	Disease reporting system - tracing and notification
24	Disease control strategies
25	Risk assessment
26	Exotic diseases and trans-boundary diseases
27	Vaccination for the prevention of diseases
28	Disease intelligence
29	Tele-epidemiology
30	Application of remote sensing technology
31	Geographic information system
32	Disease surveillance and early warning system
Practical	
1.	Survey of animal diseases
2.	Biostatistics for establishing disease causality, association and measurements
3.	Profanity and non-probability sampling methods
4.	Presentation of disease data
5.	Measurements of disease occurrence in populations
6.	Outbreak investigation
7.	Disease reporting systems
8.	Demonstration of epidemiological software
9.	Estimation of disease burden and economics of animal/ zoonotic diseases
10.	Modeling of animal diseases
11.	Demonstration of cartography and disease mapping using computer software
12.	Demonstration of global positioning system (GPS), remote sensing technology and geographic information system (GIS)



Lecture(s)	Topic
13.	Working modality on disease surveillance and monitoring
14.	Demonstration of disease early warning system
15.	Disease modeling
16.	Case study on disease reporting and notifiable disease

I. Course Title : Biosecurity, Bioterrorism and Disaster Management
II. Course Code : VPE 510
III. Credit Hours : 2+0

Lecture(s)	Topic
Theory	
1.	Introduction and definitions related to the bioterrorism
2.	Potential biological weapons
3.	Categorization agents of bioterrorism
4.	Hazard analysis in bioterrorism
5.	Strategies for combating bioterrorism
6.	Bio-ethics, social ethics and advisory role of veterinarians during the event of bioterrorism
7.	Disaster – Definitions, categorization (natural and man-made disasters)
8.	Impact analysis of disasters
9.	Classification of disaster scale
10.	Essential preparations for the management of disasters
11.	Role of central, state and local government bodies in disaster management
12.	Role of veterinarians/ veterinary public health personnel during emergency/ disasters
13.	Sequence of emergency services
14.	Effect of natural disasters on human and animal populations
15.	Nature and characteristics of disasters - floods, tsunami, tides, etc.
16.	Nature and characteristics of disasters - prolonged draughts, forest fires, etc.
17.	Nature and characteristics of disasters - earthquakes, storms, etc.
18.	Post-disaster disease susceptibility and remedial measures
19.	Biosecurity– definition, importance, methods, pathogen inventory, etc.
20.	Biosecurity at food processing establishments
21.	Biosecurity at livestock/ poultry farms
22.	Biosecurity at specialized animal facilities
23.	Quarantine measures for disease prevention – structure and functions
24.	Biomedical hazards at hospitals, laboratories and special animal handling units
25.	Laboratory biosafety – principles, requirements and applications
26.	Biosafety at the specialized laboratories
27.	Occupational health risk and its management
28.	National and international laboratory safety compliance
29.	Prediction, early warning or forecasting systems for disasters
30.	Case study related to bioterrorism
31.	Case study related to biosafety
32.	Case study related to disaster



I. Course Title	: Laboratory Techniques in Veterinary Public Health
II. Course Code	: VPE 511
III. Credit Hours	: 0+3

Class	Topic
Practical	
1	General laboratory practices – safety precautions, hazardous material disposal, maintenance and compliance with existing norms
2	Personal safety and use of PPE (personal protective equipment) in the laboratory
3	Laminar airflows– uses, types of cabinets, SOPs, applications, etc.
4	Biosafety cabinets – uses, types of cabinets, SOPs, applications, etc.
5	Preparation of glassware and plastic wares
6-8	Preparation of culture media
9-10	Preparation of buffers and solutions of different for laboratory use
11-12	Sampling methods
13-14	Techniques for quality analysis of milk and milk product
15-16	Techniques for quality analysis of meat and meat products (including poultry and egg)
17-18	Techniques for quality analysis of food/ feed and environmental samples
19	Analysis of water for quality and safety
20-21	Microbiological techniques: Plate counts - psychrophilic, mesophilic, thermophilic and thermoduric organisms
22-23	Microbiological techniques: enumeration techniques for psychrophilic, mesophilic, thermophilic and thermoduric organisms from samples of foods of animal origin
24-26	Techniques for isolation and identification of foodborne and zoonotic pathogens
27-28	Techniques for detection of microbial toxins associated with food-poisoning and outbreaks
29-30	Techniques for detection and confirmation of viral pathogens
31-32	Techniques for isolation, identification, enumeration, confirmation and characterization of fungi of public health significance
33-34	Immunological techniques used for the detection of zoonotic agents - hypersensitivity based tests
35-36	Serological techniques: precipitation and agglutination tests, counter immune-electrophoresis, ELISA, etc.
37-38	Electrophoresis (AGE, PAGE, SDS-PAGE, etc.) techniques
39-40	Chromatographic methods
41-42	Techniques for the detection and quantification of pesticides residues
43-44	Techniques for the detection and quantification of drugs using immunological and chromatographic methods
45	Methods for isolation and quantification of nucleic acids from pathogens from diverse biological specimens using latest molecular techniques
46-47	Molecular techniques for the detection and characterization of organisms of veterinary public health significance – PCR and other molecular techniques
48	Maintenance of laboratory records, log books of equipment and laboratory accreditation (NABL)



Course Title with Credit Load Ph.D. in Veterinary Public Health and Epidemiology

Course Code	Course Title	Credit Hours
VPE 601	Advances in Veterinary Public Health and Epidemiology*	2+1
VPE 602	Emerging, Re-emerging Zoonoses and One Health*	2+1
VPE 603	Advances in Food Safety and Quality Control of Foods of Animal/ Aquatic origin*	2+1
VPE 604	Biosecurity and Occupational Health Safety	2+1
VPE 605	Recent Concepts in Epidemiology and Disease Forecasting	2+1
VPE 606	Risk Analysis and Predictive Modelling	2+1
VPE 607	Advances in Environmental Hygiene	2+1
VPE 608	Herd Health Management and Disease Economics	2+1
VPE 609	Epidemiology of Trans-boundary, Non-infectious and Chronic diseases	2+1
VPE 610	Ecology and Animal/ Human Health	2+0
VPE 611	Diagnostic Approaches in Epidemiology	2+1
VPE 612	Surveys, Surveillance and Data Management	2+1
VPE 613	Research Methodology and Publication Ethics in VPE*	2+0
VPE 690	Special Problem	0+1
VPE 691	Doctoral Seminar-I*	0+1
VPE 692	Doctoral Seminar-II*	0+1
VPE 699	Doctoral Research	75

*Core Courses

Course Contents

Ph.D. in Veterinary Public Health and Epidemiology

I. Course Title : Advances in Veterinary Public Health and Epidemiology

II. Course Code : VPE 601

III. Credit Hours : 2+1

IV. Aim of the course

To acquaint with current/ contemporary issues concerning the veterinary public health, veterinary epidemiology and the one health.

V. Theory

Unit I

Contemporary status of Veterinary Public Health in India and abroad. Public Health in the 21st Century. Veterinary public health and its role in the society. Role of veterinary public health professionals in prevention and control of zoonoses. Organization and administration of veterinary public health agencies structure and functions. Data analysis framework in healthcare and social sectors. Evidence-based information updates on current VPH topics. Global animal disease surveillance.

Unit II

Recent diagnostic tools used for emerging public health problems including zoonoses. Molecular surveillance of recent pandemics of zoonoses. Modes of evolutionary emergence of disease agents pertinent to VPE.

Unit III

Application of bioinformatics, biotechnological and computational tools in food hygiene, safety, quality assurance and environmental health protection. Global pandemic threat preparedness. Emerging Disease Surveillance and Control. Biomedical models in veterinary public health.

VI. Practical

Estimation of burden of food-borne zoonotic diseases. Special problems related to field investigations of outbreaks of food poisoning and zoonotic diseases in a community. Application of recent analytical methods and *in-silico* techniques for public health research. Visits to hospitals to acquaint the students with public health related problems.

VII. Assignments

Each student will select at least two recent articles from journals related to the course and discuss the same in the class through presentation.

VIII. Suggested reading

- Eldridge BF and Edman JD. eds., 2012. *Medical entomology: A textbook on public health and veterinary problems caused by arthropods*. Springer Science and Business Media



- Noordhuizen, Josephus Pieter Thérèse Maria K Frankena, Michael V Thrusfield and EA M Graat. *Application of quantitative methods in veterinary epidemiology*. Wageningen Pers, 2001.
- Schwabe CW, Riemann HP and Franti CE. 1977. *Epidemiology in veterinary practice*. Lea and Febiger.
- Thrusfield M. 2018. *Veterinary epidemiology*. John Wiley and Sons.

I. Course Title : Emerging, Re-emerging Zoonoses and One Health

II. Course Code : VPE 602

III. Credit Hours : 2+1

IV. Aim of the course

To acquaint the students with emerging and re-emerging zoonotic diseases.

V. Theory

Unit I

Status of emerging and re-emerging zoonotic infections, National and international interests in zoonoses, Measurement and economics of zoonoses, Latest diagnostic and Management planning for zoonoses. Factors responsible for emergence and re-emergence of zoonotic diseases. Health threats at the human- animal-ecosystems/ environment interface (HAEI), a tripartite concept of OIE, WHO and FAO.

Unit II

Current challenges and strategies, euzoonoses, xenozoonoses, nosocomial zoonoses, newer zoonotic agents, viz., cat-scratch disease, rat bite fever, Creutzfeld-Jacob disease, Ebola, Marburg, Lassa, Nipah, Menangle, Herpes B, SARS, AI, ZIKA, MERS, etc.

Unit III

Simian and human immunodeficiency, bovine spongiform encephalopathy, hepatitis A and E, Toro, influenza viruses; re-emerging zoonoses with new pathology, viz., neuro-cysticercosis, campylobacteriosis, rabies, Guillain-Barre Syndrome, tuberculosis.

Unit IV

Safety regulations in laboratories, hospitals and biological plants. Use of bio safety cabinets. Bio security.

VI. Practical

Special problems related to emerging/ re-emerging/ prevalent zoonotic diseases in India. Status of Brucellosis and Tuberculosis in the India, OIE recommended diagnostic tests, vaccines/ strategies for prevention and control. Visits to rural health centres to acquire status of zoonotic diseases.

VII. Assignments

Each student will select at least two recent articles from journals related to course and discuss the same in the class through presentation.

VIII. Suggested reading

- Calvin W Schwabe. 1984. *Veterinary Medicine and Human health*. Williams and Wilkins
- Rezza G and Ippolito G. eds. 2017. *Emerging and Re-emerging Viral Infections*. Springer.
- Singh SK. ed. 2015. *Human Emerging and Re-emerging Infections*. John Wiley and Sons.



- I. Course Title** : **Advances in Food Safety and Quality Control of Foods of Animal/ Aquatic**
- II. Course Code** : **VPE 603**
- III. Credit Hours** : **2+1**

IV. Aim of the course

To provide expertise to students the advances in the food safety, quality control and quality assurance of animal origin foods.

V. Theory

Unit I

Food supply chain. Food handling practices. New age voluntary and mandatory food standards. Types and evolution of food standards. Characteristics of food safety hazards. Quality control, assurance and food safety specifications for animal origin foods such as meat, milk, egg and fish. Trends in green technologies in food production and processing. Impacts and performance of organic farming *vis-a-vis* conventional farming.

Unit II

Recent innovations in shelf-life extension, preservation and packaging. Requirements for food testing and calibration Laboratory Mechanism of food spoilage (microbial and non-microbial). Nature of major food-borne infections and intoxications. Traceability system. Waste reduction along the food supply chain.

Unit III

Rapid detection of food safety hazards. Food safety risk assessment. Quality assurance schemes applicable to foods of animal origin. Elements of national food control system. National food control systems. Global considerations and role of committees and agencies associated with food safety, quality control and quality assurance.

Unit IV

Genesis of food quality/ safety standard. Food quarantine and export guidelines, specifications and standards. National and international food safety compliances. Traceability of foods of animal origin.

VI. Practical

Special problems on quality and safety of foods of animal origin foods. Detection, enumeration and identification of major food-borne pathogens. Visits to food processing establishments. Environmental impact assessment of production of foods of animal origin.

VII. Assignments

Each student will select at least two recent articles from journals related to course and discuss the same in the class through presentation.

VIII. Suggested reading

- Marriott NG, Schilling MW and Gravani RB. 2018. *Principles of food sanitation*. Springer.
- Nolle LM and Toldrá F. eds., 2016. *Safety analysis of foods of animal origin*. CRC Press
- Paustenbach DJ. ed., 2015. *Human and Ecological Risk Assessment: Theory and Practice* (Wiley Classics Library). John Wiley and Sons.
- Toldrá F and Nolle LM. eds., 2017. *Advances in food diagnostics*. John Wiley and Sons.



- I. Course Title : Biosecurity and Occupational Health Safety**
II. Course Code : VPE 604
III. Credit Hours : 2+1

IV. Aim of the course

To acquaint students with biosafety and occupational health safety.

V. Theory

Unit I

Definitions. Physical, Chemical and Biological hazards. Bio-safety and bio-security. Elements of bio-security and bio-containment. Biosecurity requirements. Containment Barriers. Equipment safety. Risk assessment. Bio-safety levels. Laboratory safety. Bio-safety in microbiological and biomedical laboratories.

Unit II

Risk groups, Classification of organisms by risk groups. Classification of occupational groups. Laboratory designs. Transmission, spread, Maintenance and control of diseases affecting various occupational groups in contact with animals and their public health significance. Diseases associated with various occupations.

Unit III

Occupational safety and health. Occupational Health and Safety (OHS) management system standard ISO 45001. regulations pertaining to the Occupational safety and health. Occupational Safety and Health Administration. International Labour Organization.

VI. Practical

Diagnosis of occupational diseases of public health significance. Handling of Bio-safety cabinets. Relation of risk group to bio-safety levels, practices and equipment. Visit to BSL-3 and BSL-4 laboratories.

VII. Suggested reading

- Fleming DO and Hunt DL. 2006. *Biological safety: principles and practices* (No. Ed. 4). ASM Press.
- Guillén J. ed. 2017. *Laboratory Animals: Regulations and Recommendations for the Care and Use of Animals in Research*. Academic Press.
- Rabinowitz PM, Lefkowitz RY, Conti LA, Redlich CA and Weigler BJ. 2015. *Occupational health of laboratory animal workers*. In *Laboratory Animal Medicine* (pp. 1381-1402). Academic Press.
- World Health Organization. 2016. *Assessment Tool for Key Processes associated with the Design, Construction, Operation, Maintenance and Regulation of BSL-3 Facilities in the WHO African Region*.

- I. Course Title : Recent Concepts in Epidemiology and Disease Forecasting**
II. Course Code : VPE 605
III. Credit Hours : 2+1

IV. Aim of the course

To learn about different epidemiological aspects of major diseases and to develop suitable disease forecasting system.

V. Theory

Unit I

Review of epidemiological concepts and applications, recent concepts.

Unit II

Epidemiology of economically important diseases in the region (haemorrhagic septicaemia, foot and mouth disease, surra, brucellosis, PPR, swine fever, IBD, NCD, avian Influenza, sheep pox, contagious ecthyma, etc).

Unit III

Geographical Information System and its applications in epidemiology, various expert systems and their role in epidemiology.

Unit IV

Modelling and application of various models in disease forecasting. Epidemiological software and its applications, global and national early warning system.

VI. Practical

Epidemiological exercises of economically important diseases in the region, use of Geographical Information System in epidemiology, various expert systems, modelling and various models used in disease forecasting, development of suitable epidemiological software for the prevailing problems to attend disease outbreaks including laboratory investigations and reporting of routes.

VII. Suggested reading

1. Beaglehole R, Bonita R and Kjellstrom T. 1993. *Basic Epidemiology*, World Health Organization, Geneva.
2. Lilienfeld DE and Stolley P. 1994. *Fundamentals of Epidemiology*, 3rd ed., Oxford University Press, New York
3. Noordhuizen JPTM, Frankena K, van der Hoofd CM and Graat EAM: *Application of quantitative methods in Veterinary Epidemiology*. Wageningen Pers, Wageningen, The Netherlands. 1997.
4. Raj S Bhopal. 2016. *Concepts of Epidemiology: Integrating the ideas, theories, principles and methods of epidemiology*. 3rd Ed., Oxford University Press. Oxford.

I. Course Title : Risk Analysis and Predictive Modelling

II. Course Code : VPE 606

III. Credit Hours : 2+1

IV. Aim of the courses

To Acquaint the students with the latest knowledge on prediction of infections and the extent of risk in the population

Unit 1

Definitions. History of risk analysis. Relevance of risk analysis (RA) to food sector. Principles of risk analysis. Risk analysis components (risk assessment, management and communication). Microbial Risk Assessment (MRA) involving hazard identification, exposure assessment, hazard characterization, and risk characterization. Methodologies used in RA/ MRA. Qualitative and quantitative risk analysis. Quantitative Microbial Risk Assessment (QMRA) for foods of animal origin including water. Application of mathematical models to study propagation of microbial hazards from farm-to-fork. Risk-based decision-making.



Unit II

Variability and uncertainty inherent to biological data. Measurement and modelling of uncertainty and variability during risk assessment. Risk assessment, risk analysis and HACCP. Linking microbial food safety with risk assessment. Relevance of assumptions and observed data for predictive models. Study of software packages used for risk analysis.

Unit III

Mathematical modelling of microbial growth rate. Predictive modelling tools for food safety management. Microbial modelling for the prediction of product shelf life and safety. Applications of predictive modelling of microbial behaviour in foods.

V. Practical

Modelling of infectious diseases using computational and mathematical methods. Building and analysing models of infectious diseases. Study of population-level processes for infectious diseases of animals and humans. Performing risk analysis for selected food safety hazards using microbial risk analysis tools. Risk assessment using through simulation modelling.

VI. Suggested reading

1. Haas CN, Rose JB and Gerba CP. 1999. *Quantitative microbial risk assessment*. John Wiley and Sons.
2. Lelieveld HL, Holah J and Gabric D. eds., 2016. *Handbook of hygiene control in the food industry*. Woodhead Publishing.
3. Pastorok RA, Bartell SM, Ferson S and Ginzburg LR. eds., 2016. *Ecological modeling in risk assessment: chemical effects on populations, ecosystems, and landscapes*. CRC Press.
4. Subramaniam P and Wareing P. eds., 2016. *The stability and shelf life of food*. Woodhead Publishing.

I. Course Title : Advances in Environmental Hygiene

II. Course Code : VPE 607

III. Credit Hours : 2+1

IV. Aim of the course

To update knowledge on modern environmental pollution problem and control.

V. Theory

Unit I

Current status of problems pertaining to environmental hygiene, air, soil and water pollution, Disinfection procedures, Impact of global warming and other environmental problems leading to change in ecology of diseases and impact on human/ animal health; Carbon footprint, Eco-philosophy, Environmental ethics and Environmental economics, Environmental conflicts and cooperation.

Unit II

Environmental risks their assessment and management and reporting, modern global information, surveillance and monitoring systems, decision making and public awareness. Role of VPH in National Sanitation Programmes such as Swachh Bharat Abhiyan.

Unit III

International environmental management efforts, participatory international organizations and their selected programmes and selected legislations.

VI. Practical

Detection and monitoring/ estimation of air, soil and water pollution; detection of pathogens from environmental sources. Visits to water/ sewage treatment plants.

Assignments

Each student will select at least two recent articles from journals related to course and discuss the same in the class through presentation.

VII. Suggested reading

1. Curtis SE. 1983. *Environmental management in animal agriculture*. Iowa State University Press.
2. Frumkin H. ed., 2016. *Environmental health: from global to local*. John Wiley and Sons.
3. Paustenbach DJ. ed., 2015. *Human and Ecological Risk Assessment: Theory and Practice* (Wiley Classics Library). John Wiley and Sons.
4. Sparling DW. 2016. *Ecotoxicology essentials: environmental contaminants and their biological effects on animals and plants*. Academic Press.

I. Course Title : Herd Health Management and Disease Economics

II. Course Code : VPE 608

III. Credit Hours : 2+1

IV. Aim of the course

Adoption of holistic approach to address issues of herd health without affecting production.

V. Theory

Unit I

General principles, interactions between health and production and herd immunity.

Unit II

Dairy cattle: mastitis, brucellosis and haemo-protozoan control and health management of dairy cows and calves.

Unit III

Health and production in swine, sheep, goats and poultry, vaccination, biosecurity practices for prevention and control of diseases.

VI. Practical

Visit to various bovine, equine, sheep, goat and poultry farms, assessment of their problems, systematic programmes for prevention and control of specific diseases and its impact, calculation of disease economics. Animal-house hygienic practices.

Assignments

Each student shall select at least two recent articles from journals related to course and discuss the same in the class through presentation.

VII. Suggested Reading

- Dijkhuizen AA and Morris RS. 1997. *Animal health economics. Postgraduate Foundation in Veterinary Science*, University of Sydney, Sydney, Australia.
- FAO. 2016. *Economic analysis of animal diseases*. FAO Animal Production and Health Guidelines. No. 18. Rome.
- Schwabe CW. 1984. *Veterinary Medicine and Human Health*, Baltimore: Williams and Wilkins
- Rushton, Jonathan. 2009. *The economics of animal health and production*. CABI.



- I. Course Title** : **Epidemiology of Trans-boundary, Non-infectious and Chronic Diseases**
- II. Course Code** : **VPE 609**
- III. Credit Hours** : **2+1**

IV. Aim of the course

To provide students the expertise in elucidating epidemiology of non-infectious and chronic diseases.

V. Theory

Unit I

Establishment of causality and associations in non-infectious and chronic diseases. Characteristics of Koch's/ Henle-Koch postulates and Evans' rules of disease causation. Unified principles of establishing causality for both infectious and non-infectious diseases. Infectious disease and chronic disease connections. Causal role of infectious agents in cancer (relating criteria). Establishment of trends in disease occurrence. Epidemiology of non-infectious and chronic diseases affecting different systems in various animal species.

Unit II

Emerging infectious determinants of chronic diseases- reasons for emergence, range of pathways and epidemiology of chronic non-infectious disease. Study of characteristics of risk factors (genetic, physiological, environmental, behavioral, etc) associated with non-infectious and chronic diseases. Demographic, epidemiological and nutrition transition. Social determinants of non-communicable diseases. Spatial and temporal epidemiology of non-infectious diseases, viz., nutritional, reproductive, chemical poisoning, toxicity (pesticides, poisonous plants), metabolic diseases, toxicities, neoplastic and other miscellaneous diseases.

Unit III

Global status of non-communicable diseases. Modelling of non-infectious non-communicable diseases or chronic diseases. Economic Impact of chronic diseases. Prevention and control: current status and future perspectives.

VI. Practical

Measurement of burden of non-infectious and chronic diseases (mortality, morbidity, survival, risk factors, etc.). Controlled trials and short research problem(s) involving contemporary issues and research techniques. Animal models for the study of non-infectious and chronic diseases. Survey of non-infectious and chronic diseases using animal disease model systems.

VII. Suggested Reading

- Baldock C, Forman T, Geering B and Taylor B. 1999. *New Technologies in the fight against transboundary animal diseases*. In: FAO-Japan Cooperative Project: Collection of Information on Animal Production and Health. Rome, Italy: The Food and Agricultural Organization of the United Nations.
- Fernández PJ and White WR. 2016. *Atlas of transboundary animal diseases*. OIE (World Organisation for Animal Health).
- Martin SW, Meek AH and Willeberg P: *Veterinary epidemiology. Principles and methods*. 1986, IOWA State University Press/ Ames, Iowa, USA
- Noordhuizen JPTM, Frankena K, van der Hoofd CM and Graat EAM: *Application of*

quantitative methods in veterinary epidemiology. Wageningen Pers, Wageningen, The Netherlands. 1997.

- Thrusfield M: *Veterinary epidemiology*. 1995. Blackwell Science Ltd. Oxford, UK.

- I. Course Title : Ecology and Animal/ Human Health**
II. Course Code : VPE 610
III. Credit Hours : 2+0

IV. Aim of the course

To acquaint students about ecological basis of disease.

V. Theory

Unit I

Establishment of links between animal/ human health with the ecosystems. Assessment of changing trends in the environments and its on the animal/ human health. Study of emerging public health threats linked to the changes in the environment. Study of landscape epidemiology of diseases. Study of contemporary issues centered on ecological and evolutionary perspectives of infectious diseases.

Unit II

Animal–human-ecosystem interface. Study of ecological/ environmental factors influencing spatio-temporal occurrence of disease such as temperature, rainfall and other environmental factors. Ecological conditions and evolutionary dynamics. Disease ecology based explanatory and predictive models. Elucidation of natural history and host-parasite interactions linked to the ecological factors.

Unit III

Ecology of vector borne diseases. Vector dynamics and ecology. Study extrinsic incubation period. Understanding of critical risk factors of spread such as timing, distribution, abundance of competent vectors.

Unit IV

Study of cyclical patterns of disease. Mapping environmental conditions with disease. Establishing functional links between environmental modifications and disease. Linking climate change with disease occurrence. Study of dynamics of ENSO with climate change and disease. Evolution of disease alert and forecasting systems. Use of global positioning and remote sensing tools for disease management. Early warning and GIS based disease predictions.

VI. Suggested reading

- Norrgren L and Levensgood JM. eds., 2012. *Ecology and Animal Health* (No. 2). Baltic University Press.
- Waltner-Toews, David. 2007. *The Chickens Fight Back: Pandemic Panics and Deadly Diseases that Jump from Animals to Humans*. Vancouver: Greystone Books
- World Health Organization. 2013. “Zoonoses and Veterinary Public Health.” WHO

- I. Course Title : Diagnostic Approaches in Epidemiology**
II. Course Code : VPE 611
III. Credit Hours : 2+1

IV. Aim of the course

Learning of recent advanced molecular techniques for establishing disease diagnosis.



V. Theory

Unit I

The concept of molecular basis of a disease, molecular determinants of pathogenicity of infectious agents and their transmissibility to susceptible populations of livestock and poultry.

Unit II

Laboratory biosafety, Antigenic, Genetic and Biological characterization of field isolates of pathogens incriminated in field outbreaks, Differentiation of field and Vaccine strains, the concept of Marker vaccines, and Correlation of pathotypes and genotypes of a pathogen.

Unit III

Immunological tests, immunoblotting techniques and use of monoclonal antibodies in different ELISAs for antigenic analysis. Application of nucleic acid-based assays, viz., polymerase chain reaction (PCR) assays, nucleotide sequencing, restriction endonuclease analysis and RFLP analysis for genomic characterization using the field material directly or after extraction of nucleic acid from small scale cultures, use of radio-actively labelled or non-radioactive oligo-nucleotide probes in dot-blot and Southern hybridizations.

VI. Practical

Finger printing of the nucleic acid obtained from field isolates and their comparative analysis. PCR and ELISA for screening of field samples.

VII. Assignment

Each student shall select at least two recent articles from journals related to the course and discuss the same in the class through presentation.

VIII. Suggested reading

- Boniolo G and Nathan MJ. eds., 2016. *Philosophy of molecular medicine: Foundational issues in research and practice*. Taylor and Francis.
- Pfeiffer D. 1998. *Veterinary Epidemiology. An Introduction*. Institute of Veterinary, Animal and Biomedical Sciences. Massey University, Palmerston, New Zealand.
- Stites DP, Stobo JD, Fundenberg HH and Wells JV. 1982. *Basic and Clinical Immunology*, 4th Edition. Lange Medical Publications, Los Altos, USA.
- Thrusfield M. 2018. *Veterinary Epidemiology*, John Wiley and Sons.

I. Course Title : Surveys, Surveillance and Data Management

II. Course Code : VPE-612

III. Credit Hours : 2+1

IV. Aim of the course

To demonstrate different methodologies and procedures involved in conducting survey and surveillance and collection of data, analysis and interpretation of data. Systematic data collection, analysis and management

V. Theory

Unit I

Robust survey: Planning, Statistical models for the same and Surveillance, Purpose and method of sampling, Size of sample, Questionnaires. State, National and

International agencies (OIE, CDC, etc.), their data bases and their management systems.

Unit II

Goals and types of surveillance, monitoring, mechanism of surveillance and surveillance network.

Unit III

Disease/ data recording and reporting, vet. recording schemes, vet. information system and data bases.

Unit IV

Emergence of new diseases and re-emergence of old diseases. Epidemiology of globally and nationally important emerging/ re-emerging diseases and designing of strategies for their prevention and control.

VI. Practical

Prepare questionnaires on selective topics, survey for livestock and poultry farmers to find out usefulness/ effectiveness of vaccination/ artificial insemination/ other practices, surveillance of important diseases in different parts of state, data analysis and presentation of data, development of suitable software.

VII. Assignment

Each student will select at least two recent articles from journals related to course and discuss the same in the class through presentation.

VIII. Suggested reading

- Hawker J, Begg N, Reintjes R, Ekdahl K, Edeghere O and Van Steenberg JE. 2018. *Communicable disease control and health protection handbook*. John Wiley and Sons.
- Salman M. ed., 2008. *Animal disease surveillance and survey systems: methods and applications*. John Wiley and Sons.
- Thrusfield M. *Veterinary epidemiology*. John Wiley and Sons; 2018 Apr 30.

I. Course Title : Special Problem

II. Course Code : VPE 690

III. Credit Hours : 0+1

IV. Aim of the course

To provide expertise in handling practical research problem(s).

V. Practical

Short research problem(s) involving contemporary issues and research techniques. Presentation and discussion of novel research papers on the disease or intervention strategies such disease pathogenesis, pathobiology, epidemiology, host-agent-environmental relationships, molecular mechanisms/ diagnostics, spatio-temporal trends, etc. Planning a short research problem or working on a published research paper or new developments.



Course Outline-cum-Lecture Schedule for Doctoral Degree Programme

I. Course Title	: Advances in Veterinary Public Health and Epidemiology
II. Course Code	: VPE 601
III. Credit Hours	: 2+1

Lecture(s)	Topic
Theory	
1-3	Contemporary status of Veterinary Public Health in India and abroad. Public Health in the Twenty first Century
4	Veterinary public health and its role in the society
5-6	Role of veterinary public health professionals in prevention and control of zoonoses.
7	Opportunities for veterinary public health professionals
8-9	Organization and administration of veterinary public health agencies structure and functions
10-11	Data analysis framework in healthcare and social sectors
12-15	Evidence-based information updates on current VPH topics
16-17	Global animal disease surveillance
18-19	Recent diagnostic tools used for emerging public health problems including zoonoses
20-21	Molecular surveillance of recent pandemics of zoonoses
22-23	Modes of evolutionary emergence of disease agents pertinent to VPH
24-27	Application of bioinformatics, biotechnological and computational tools for food hygiene. food safety quality assurance environmental health protection
28-29	Global pandemic threat preparedness
30-31	Emerging Disease Surveillance and Control
32	Biomedical models in veterinary public health
Practical	
1	Assessment of health status of an individual
2-3	Estimation of disease burdens in a population
4-5	Estimation of burden of food-borne and zoonotic diseases
6	Molecular epidemiology and genetic analysis of agents of VPH significance
7	Case study related to field investigations of outbreaks of food poisoning
8	Case study related to zoonotic diseases in a community
9	Application of recent analytical methods (<i>in-vitro</i> , <i>invivo</i> and <i>in silico</i> techniques) used for public health research
10	Visits to hospitals to acquaint the students about public health related problems.
11	Health hazards across food supply chain
12	Hygiene of production/ processing of foods of animal origin
13	Safety management at the large-scale production or processing units of foods of animal origin
14	Longitudinal and integrated food safety assurance
15-16	Assignment: Each student will select at least two recent articles from journals related to the course and discuss in the class through presentation



I. Course Title	: Emerging, Re-emerging Zoonoses and One Health
II. Course Code	: VPE 602
III. Credit Hours	: 2+1

Lecture(s)	Topic
Theory	
1	Definitions – emerging and re-emerging zoonoses. Public health risks of emerging and re-emerging zoonoses
2	Status of emerging and re-emerging zoonotic infections
3	National and international interests in emerging and re-emerging zoonoses
4	Measurement of emerging and re-emerging zoonoses
5	Economics of emerging and re-emerging zoonoses
6	Factors responsible for emergence and re-emergence of zoonotic diseases
7	Role of wildlife in emerging and re-emerging zoonoses
8	Current concepts in the diagnosis of emerging and re-emerging diseases
9	Epidemiology and combating of emerging and re-emerging zoonotic diseases
10	Latest diagnostics and management planning for emerging and re-emerging zoonoses
11-12	Health threats at the human- animal-ecosystems/ environment interface (HAEI) - tripartite (OIE, WHO and FAO) initiatives
13	Comparative medicine and VPH - horizons and perspectives in emerging and re-emerging zoonotic infections
14	Current challenges and strategies in the area of euzoonoses, xenozoonoses, nosocomial zoonoses and newer zoonotic agents
15-16	Characteristics, host range, epidemiology and management of Cat-scratch disease, Rat bite fever, Ebola and Marburg
17-18	Characteristics, host range, epidemiology and management of Lassa, Nipah, and Menangle viruses
19-20	Characteristics, host range, epidemiology and management of SARS, Toro, ZIKA and MERS virus infections
21	Characteristics, host range, epidemiology and management of zoonotic influenza viruses
22	Characteristics, host range, epidemiology and management of herpes and hepatitis (A and E) viruses
23	Characteristics, host range, epidemiology and management of co-infections, super-infections and syndemics - Simian and human immunodeficiency viruses
24	Characteristics, host range, epidemiology and management of taeniasis/ cysticercosis
25	Characteristics, host range, epidemiology and management of Bovine spongiform encephalopathy
26	Characteristics, host range, epidemiology and management of Creutzfeldt-Jacob disease
27	Characteristics, host range, epidemiology and management of brucellosis, tuberculosis and other emerging bacterial zoonoses
28	Guillain-Barre Syndrome and related sequel due to emerging/ re-emerging zoonoses
29-30	Close collaborations with regional, national and international organizations in the control of emerging/ re-emerging pathogens
31-32	Case study on emerging/ re-emerging zoonotic disease
Practical	
1	Application of safety regulations in laboratories, hospitals and biological units for handling emerging/ re-emerging agents
2	Methods to elucidate epidemiology of emerging/ re-emerging zoonoses



Lecture(s)	Topic
3	Approach to establish role of wildlife in emerging/ re-emerging zoonoses
4	Epidemiology of drug resistant emerging/ re-emerging zoonotic agents
5	Establishing genetic basis of bacterial emerging/ re-emerging zoonoses
6	Establishing genetic basis of viral and prion emerging/ re-emerging zoonoses
7	Establishing genetic basis of fungal, rickettsial and chlamydial emerging/ re-emerging zoonoses
8	Recommended diagnostic testing (OIE) for emerging/ re-emerging zoonoses
9	Vaccination and other strategies for the prevention of emerging/ re-emerging zoonoses
10	Application of Novel molecular methods for the understanding of emerging/ re-emerging zoonoses
11	Study abundance, behaviour, profiling and dynamics of vectors associated with emerging/ re-emerging zoonoses
12	Institutional surveillance of emerging/ re-emerging zoonoses
13	Visits to health centre to study of zoonotic diseases and categorization of agents as emerging/ re-emerging zoonosis
14	Special problem related to emerging/ re-emerging or prevalent zoonotic diseases
15-16	Assignment: Each student will select at least two recent articles from journals related to course and discuss in the class through presentation

I. Course Title : Advances in Food Safety and Quality Control of Foods of Animal/ Aquatic Origin

II. Course Code : VPE 603

III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Food supply chain dynamics
2	Food production, processing and handling practices
3	Food safety and quality assurance of foods of animal origin
4	New age voluntary and mandatory food standards
5	Types and evolution of food standards
6	Characteristics of food safety hazards
7-8	Quality control, assurance and food safety specifications for animal origin foods such as meat, milk, egg and fish
9-10	Recent innovations in shelf-life extension, preservation and packaging
11	Requirements for food testing and calibration Laboratory Mechanism of food spoilage (microbial and non-microbial)
12	Nature of major food-borne infections and intoxications
13	Elimination of food safety hazards from primary production systems
14	Rapid detection of food safety hazards
15	Impact of animal feed on food safety. Prevention and control of risks arising due to animal feeds
16	Coordination of surveillance policies in animal health and food safety
17	Food safety challenges in animal production systems affecting global markets
18	Quality assurance schemes applicable to foods of animal origin
19	Veterinary services for public health and consumer safety
20	Food safety risk assessment
21	National food control systems and its elements



Lecture(s)	Topic
22	Genesis of food quality/ safety standard
23-24	Food quarantine and export guidelines, specifications and standards
25	National and international food safety compliances
26	Traceability system - Traceability of foods of animal origin
27	Global considerations and role of committees and agencies associated with food safety, quality control and quality assurance
28	Trends in green technologies in food production and processing
29	Waste reduction along the food supply chain
30	Impacts and performance of organic farming <i>vis-a-vis</i> conventional farming
31	Consumer perspectives of food quality and safety
32	Environmental impact assessment of production of foods of animal origin
Practical	
1-2	Detection, enumeration and identification of food safety hazards
3	Pre-requisite programs for ensuring food safety
4	Environmental impact assessment
5	Application of generic traceability system for foods of animal origin
6	Detection of allergens associated with foods of animal origin
7	Emerging technologies for microbial control in food processing
8-9	Methods of management of waste arising from production and processing units (foods of animal origin including aquaculture)
10	Rapid alert system for food and feed
11-12	Visit to food processing establishments
13-14	Special problems on quality and safety of foods of animal origin foods
15-16	Assignment: Each student will select at least two recent articles from journals related to course and discuss in the class through presentation

I. Course Title : Biosecurity and Occupational Health Safety

II. Course Code : VPE 604

III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Definitions: Bio-safety, bio-security and bio-containment; physical, chemical and biological hazards
2	Elements of bio-security and bio-containment
3	Nature of physical, chemical and biological hazards at work places
4-5	Bio-security requirements, Containment Barriers
6-7	Laboratory and equipment safety
8	Risk assessment
9	Bio-safety levels
10-11	Bio-safety in microbiological and bio-medical laboratories
12-13	Risk groups, classification of organisms by risk groups
14	Classification of occupational groups
15	Laboratory designs - Biosafety Level 1/ Animal Biosafety Level 1
16	Laboratory designs - Biosafety Level 2/ Animal Biosafety Level 2
17	Laboratory designs - Biosafety Level 3/ Animal Biosafety Level 3
18	Laboratory designs - Biosafety Level 4/ Animal Biosafety Level 4
19-21	Transmission, spread, maintenance and control of diseases affecting various occupational groups in contact with animals and their public health significance



Lecture(s)	Topic
22-23	Diseases associated with various occupations
24	Occupational safety and health
25	Occupational Health and Safety (OHS) management system standard ISO 45001
26	Regulations pertaining to the Occupational safety and health
27	Occupational Safety and Health Administration
28	Risk group classification, Bio-risk Management
29	Classification of infective microorganisms by risk groups
30	Institutional Biosafety Committees (IBCs)
31	The Bio-medical Waste Management (Amendment) Rules, 2018
32	International Labour Organization and its occupational safety provisions, Research Ethics and Compliance
Practical	
1	Standard laboratory practices
2	Handling of Bio-safety cabinets
3-4	Detection of occupational diseases of public health significance
5	Relation of risk group to biosafety levels, practices and equipment
6-7	Design of BSL-1 to BSL-4 laboratories
8	Survey of biosafety and biosecurity in biomedical laboratories
9-11	Transportation of dangerous pathogens/ samples – modes, guidelines and regulations
13	Activity spectrum of detergents and disinfectants
14	Personal protection, Bio-risk Assessment Sheet and Material Safety Data Sheet (MSDS)
15	Case study on occupational safety in specialized laboratories
16	Case study on biosafety level 3 or 4 laboratory

I. Course Title : Recent Concepts in Epidemiology and Disease Forecasting

II. Course Code : VPE 605

III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Epidemiological concepts of disease occurrence in population
2	Variations in disease by time, place, and animal/ person
3	Recent epidemiological approaches for elucidating cause and effect
4	Variations: Role of error, bias, and confounding
5	The concept of risk/ risk factor in relation to the disease
6	Characterization and quantification of risk in epidemiology
7	Concepts in the measures of disease frequency
8	Analysis and integration of data for epidemiological methods/ techniques
9	Concepts in epidemiological study designs
10	Recent concepts in the epidemiology of economically important bacterial animal diseases of the region (haemorrhagic septicaemia, brucellosis, etc)
11-12	Recent concepts in the epidemiology of economically important viral animal diseases, viz., FMD, Swine fever, Avian Influenza, Sheep Pox, IBD, NCD and others of the region
13-14	Recent concepts in the epidemiology of economically important fungal, parasitic



Lecture(s)	Topic
	and other animal diseases of the region
15	Geographical Information System (GIS)
16	Advancements in GIS technology for epidemiological application in Veterinary and Animal Sciences
17	Various expert systems and their role in epidemiology
18	Concepts in animal disease modelling, Animal disease modelling, Disease prediction models
19	Modelling of economically important animal diseases
20	Modelling of emerging zoonotic infections
21	Advances in disease forecasting
22	Application of advanced disease forecasting concepts for animal/ zoonotic diseases
23	Disease early warning systems
24	Global and national disease early warning systems
25	Epidemiological softwares and their applications related to animal/ zoonotic infections
26	Common software packages and databases used in veterinary practice
27	Epidemiological Concepts Regarding Disease Monitoring and Surveillance
28	Advances in the practice of Public Health Surveillance
29	Real-time animal tracking using global positioning systems (GPS)
30	Use of advanced computing and remote sensing/ satellite technology for the study of animal/ zoonotic diseases
31	Case study related to application of recent epidemiological tool
32	Case study related to disease forecasting
Practical	
1	Use of Geographical Information System to study epidemiology of disease
2	Disease expert systems for animal/ zoonotic diseases
3	Disease modelling for animal/ zoonotic diseases
4	Model designing for disease forecasting
5	Study of epidemiology of disease outbreaks using advanced epidemiological techniques
6	Investigation of animal/ zoonotic diseases using recent epidemiological tools
7	Advanced disease reporting system
8	Study of animal/ zoonotic diseases using advanced computing tools
9	Study of animal/ zoonotic diseases using remote sensing/ satellite technology
10	Risk mapping for animal/ zoonotic diseases
11-12	Epidemiological exercises of economically important diseases of the region
13	Use of artificial intelligence and neural networks in veterinary epidemiology
14	Integrated disease surveillance system – prototype development
15	Case study related to advanced epidemiological tool
16	Case study related to advanced disease forecasting/ modelling

I. Course Title : Risk Analysis and Predictive Modelling

II. Course Code : VPE 606

III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Definitions, History of risk analysis
2	Relevance of risk analysis (RA) to food sector



Lecture(s)	Topic
3	Principles of risk analysis
4	Risk analysis components (risk assessment, management and communication)
5	Risk assessment
6	Risk management
7	Risk communication
8	Microbial Risk Assessment (MRA) involving hazard identification, exposure assessment, hazard characterization, and risk characterization
9	Hazard identification
10	Exposure assessment
11	Hazard characterization
12	Risk characterization
13	Methodologies used in risk analysis (RA)/ Microbial Risk Assessment MRA
14	Qualitative and quantitative risk analysis
15	Qualitative risk analysis
16	Quantitative Microbial Risk Assessment (QMRA) for foods of animal origin including water
17	Application of mathematical models to study propagation of microbial hazards from farm-to-fork
18	Risk-based decision-making
19	Variability and uncertainty inherent to biological data
20	Measurement and modelling of uncertainty and variability during risk assessment.
21	Integration of risk assessment/ risk analysis with HACCP and other quality management or assurance systems
22	Linking microbial food safety with risk assessment
23	Relevance of assumptions and observed data for predictive models
24	Study of software packages used for risk analysis
25	Mathematical modelling of microbial growth rate in food/ feeds
26	Predictive modelling tools for food safety management
27	Microbial modelling for the prediction of product shelf-life and safety
28	Applications of predictive modelling of microbial behaviour in foods
29	Meta-analysis in risk analysis of animal/ zoonotic diseases
30	Risk prediction models
31	Multivariate prediction models
32	Case study related to MRA of foods of animal origin

Practical

1. Microbial Risk Assessment (MRA)
2. Risk assessment
3. Risk management
4. Risk communication
5. Qualitative MRA
6. Quantitative MRA
7. Modelling of infectious diseases using computational and mathematical methods.
8. Building and analyzing models of infectious diseases
9. Study of population-level processes for infectious diseases of animals and humans
10. Performing risk analysis for food safety hazards using microbial risk analysis tools
11. Risk assessment using high throughput simulation modelling
12. Investigation of uncertainty, variability and sensitivity analysis techniques using computer models
13. Risk prediction models – study of prototype
14. Meta-analysis – study of prototype



Lecture(s)	Topic
15.	Multivariate prediction models – study of prototype
16.	Case study on MRA

I. Course Title : Advances in Environmental Hygiene
II. Course Code : VPE 607
III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Current status of problems pertaining to environmental hygiene
2	Status, impact and management of air pollution
3	Status, impact and management of global warming
4	Status, impact and management of soil pollution
5	Status, impact and management of water pollution
6	Status, impact and management of environmental problems
7	Impact of pollution on the ecology of diseases
8	Environmental impact of intensive animal husbandry
9	Impact of intensive animal husbandry on the public health
10	Animal sector consequences of carbon footprints
11	Eco-philosophy, policy and advocacy of environmental hygiene with veterinary/ animal husbandry perspectives
12	Environmental economics
13	Environmental conflicts and cooperation
14	Ethics and compliance - sustainable animal husbandry and environmental safety
15	Disinfects and disinfection procedures
16	Environmental risk analysis (assessment and management)
17	Occupational health impact of animal farming
18	Occupational environmental hygiene and safety linked to animals
19	Health risk profiling and risk analysis of animal farming and trade
20	Epidemiology of chronic occupational disease induced by environmental pollution
21	Ecotoxicology of toxicants used in the farming
22	Bio-accumulation, concentration and bio-magnification of pollutants, toxicants and hazardous substances in the environment
23	Reporting of environmental issues and global informatics
24	Environmental hazard surveillance and monitoring systems
25	Decision making and public awareness
26	Role of VPH in National Sanitation Programmes (Swachh Bharat Abhiyan and other governmental programmes)
27	International environmental management efforts
28	International organizations and programmes
29	Legislations on environmental hygiene, safety and policy
30	Case study on ammonia as pollutant from animal sector
31	Case study on hydrogen sulphide as pollutant from animal sector
32	Case study on methane as pollutant from animal sector

Practical

- 1 Hygiene and sanitization of animals and animal premises
- 2 Detection and monitoring of pollutants emanating from animals to the air
- 3 Detection and monitoring of pollutants emanating from animals to the soil



Lecture(s)	Topic
4	Detection and monitoring of pollutants emanating from animals to the water
5	Detection and monitoring of pollutants emanating from animals to other environmental sources
6	Advanced environmental hazard measurement methods
7	Measurement of health effects of environmental toxicants
8	Environmental risk assessment methods
9	Risk analysis of animal contributed ammonia
10	Risk analysis of animal contributed hydrogen sulphide
11	Risk analysis of animal contributed methane
12	Risk analysis of animal contributed other environmental hazards
13-14	Visits to remediation unit, waste water treatment plant, sewage treatment plants, tannery, etc. to study characteristics, impact and mitigation of hazards and associated risks
15-16	Assignments: Each student will select at least two recent articles from journals related to course and discuss in the class through presentation

I. Course Title : Herd Health Management and Disease Economics

II. Course Code : VPE 608

III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	General principles of herd health
2	Interaction between health and production
3	Health effects of animal and zoonotic infections at the farm level
4	Direct and indirect losses due to zoonotic diseases
5	Components of the economic impact of animal diseases
6	Herd health management and disease economics
7	Linking herd health with economics – margin of returns
8	Health effects of animal and zoonotic infections at the regional/ state/ national/ international level
9	Interactions between health, production and disease
10	General principles of enhancing herd immunity
11	Economic methods of disease control for decision support
12	Herd health management – intervention options and their economic assessment
13	Quantification of financial effects of animal disease
14	Methods for optimizing decisions at individual animal, herd and population levels
15	Determination of costs and benefits of disease control measures
16	Estimation of extent of the disease and potential spread
17	Economic aspects and impact of zoonotic diseases
18	Estimation of cost of animal/ zoonotic disease on livelihoods outcomes (income, health, and trade), including environmental impacts
19	Assessment of the cost-effectiveness of control strategies used to reduce the risk of animal/ zoonotic diseases
20	Identification of factors affecting adoption of zoonotic risk reduction strategies
21	Estimation of disability adjusted life years (DALYs) parameters
22	Herd health management and disease economics of diseases in cattle/ buffalo
23	Herd health management and disease economics of diseases in sheep/ goat
24	Herd health management and disease economics of diseases in swine



Lecture(s)	Topic
25	Herd health management and disease economics of diseases in poultry
26	Herd health management and disease economics of diseases in other livestock
27	Preventive healthcare through vaccination
28	Preventive healthcare through bio-security practices
29	Economic benefits of prevention and control of diseases
30	Zoning and creation of disease-free area
31	Disease eradication and surveillance
32	Case study on eradication of disease–Economic perspectives
Practical	
1	Study of framework of animal health management
2	Steps and methods for assessment of the economic impact of a disease
3	Assessing economic merit of interventions to control disease
4	Decision analysis and decision support systems for promoting animal health
5	Modelling animal health economics
6	Modelling the economics of Veterinary Services at the Farm Level
7	Modelling the economics of National Disease Control Programs
8	Economic modelling techniques (i.e. partial budgeting, cost-benefit analysis, decision analysis, and systems simulation) for veterinary decision making
9	Economic assessment of problems, programmes, prevention/ control measures, impact, etc.
10	Economic evaluation of hygienic practices in the animal house
11	Estimation of burden of animal/ zoonotic diseases
12	Estimation of DALY and other disease parameters
13	Case study on economic impact of zoonotic diseases
14	Visit to various livestock farms, assessment of their problems
15-16	Assignments: Each student shall select at least two recent articles from journals related to course and discuss in the class through presentation

I. Course Title : Epidemiology of Trans-boundary, Non-infectious and Chronic Diseases

II. Course Code : VPE 609

III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Definition and characteristics of trans-boundary diseases
2	Global trends in the occurrence of trans-boundary diseases
3	Role of wildlife in emergence of trans-boundary diseases
4	Prevention/ control of trans-boundary diseases
5	Important trans-boundary diseases categorized according to the aetiology
6	Important trans-boundary diseases categorized according to the animal species
7	New Technologies to fight transboundary animal diseases
8	Role of veterinary public health and veterinary services in the management of non-infectious and chronic diseases
9	Establishment of causality and associations in non-infectious and chronic diseases
10	Characteristics of Koch's/ Henle-Koch postulates and Evans' rules of disease causation
11	Unified principles of establishing causality for both infectious and non-infectious diseases



Lecture(s)	Topic
12	Infectious and chronic disease connections
13	Causal role of infectious agents in cancer (relating criteria)
14	Global status of non-communicable diseases
15	Establishment of trends of non-infectious and chronic disease occurrence
16	Epidemiology of non-infectious and chronic diseases affecting different species (livestock/ poultry) and production systems
17	Determinants of chronic and non-infectious diseases- reasons for emergence range of pathways and epidemiology
18	Study of characteristics of risk factors (genetic, physiological, environmental, behavioural, etc) associated with non-infectious and chronic diseases
19	Demographic, epidemiological and nutritional factors
20	Economic impact of chronic and non-communicable diseases
21	Social determinants of non-communicable diseases
22	Spatial and temporal epidemiology of nutritional and metabolic diseases
23	Spatial and temporal epidemiology of reproductive diseases
24	Spatial and temporal epidemiology of chemical poisonings and toxicities (pesticides, poisonous plants, etc)
25	Spatial and temporal epidemiology of neoplastic and other miscellaneous diseases
26	Modelling of non-infectious non –communicable diseases or chronic diseases
27	Trends in the prevention and control of non-infectious and chronic disease – current status and future perspectives
28	Early detection, notification and surveillance
29	Participatory surveillance
30	Case study on vector-borne trans-boundary diseases
31	Case study on non-infectious chronic livestock disease
32	Case study on emerging/ re-emerging zoonotic trans-boundary diseases
Practical	
1	Detection and characterization of trans-boundary diseases
2	Capacity building and training
3	Study of the role of wildlife in trans-boundary animal diseases
4	Wildlife disease surveillance
5	Study of wildlife–livestock interface and disease ecology
6	Disease investigation - data and information collection, collation and sharing
7	Surveillance for trans-boundary diseases
8	Measurement of burden of non-infectious and chronic diseases (mortality, morbidity, survival, risk factors, etc.)
9	Survey of non-infectious and chronic diseases
10	Animal models for the study of non-infectious and chronic diseases
11	Establishment of evidence/ proof of causation of non-infectious and chronic diseases
12	Study of risk factors associated with non-infectious and chronic diseases
13	Measurement of socioeconomic impacts associated with non-infectious and chronic diseases
14	Controlled trials involving contemporary non-infectious and chronic diseases
15	Undertaking short research problem(s)
16	Case study on trans-boundary/ chronic livestock disease



I. Course Title	: Ecology and Animal/ Human Health
II. Course Code	: VPE 610
III. Credit Hours	: 2+0

Lecture(s)	Topic
Theory	
1	Definitions related to ecology and animal or human health
2	Linkage between human/ animal health and the ecosystem
3	Spill-over of diseases – elucidation of social and ecological basis of disease
4	Assessment of changing trends in the environments and its impact on the animal/ human health
5	Study of emerging public health threats linked to the changes in the environment
6	Study of landscape epidemiology of diseases
7	Study of contemporary issues centred on ecological and evolutionary perspectives of infectious diseases
8	Animal–human–ecosystem interface
9	Study of ecological/ environmental factors influencing spatio-temporal occurrence of disease such as temperature, rainfall and other environmental factors
10	Ecological conditions and evolutionary dynamics
11	Disease ecology based explanatory and predictive models
12	Elucidation of natural history and host-parasite interactions linked to the ecological factors
13	Ecology of vector borne diseases
14	Vector dynamics and ecology
15	Study extrinsic incubation period
16	Understanding of critical risk factors of disease spread – timing, distribution, and abundance of competent vectors
17	Study of cyclical patterns of disease
18	Mapping environmental conditions with disease
19	Establishing functional links between environmental modifications and disease
20	Linking climate change with disease occurrence
21	Impact of climate change on disease occurrence
22	Study of dynamics of ENSO with climate change and disease
23	El Niño/ Southern Oscillation (ENSO), influence on global climate variability and disease occurrence
24	Evolution of disease alert and forecasting systems
25	Use of global positioning and remote sensing tools for disease management
26	Early warning and GIS based disease predictions
27	Role of bio-security measures in curtailing transmissible diseases at the animal-animal, animal-human and human-human interface
28	Biology and ecology of vector-borne diseases – ecology of disease – the intersection of human and animal health
29	Impact of ecological/ environmental factors on the emergence of human/ animal diseases
30	Clusters of disease outbreaks
31	Environmental impact of antimicrobial resistance
32	Preparedness for combating the impacts of climate change



I. Course Title	: Diagnostic Approaches in Epidemiology
II. Course Code	: VPE 611
III. Credit Hours	: 2+1

Lecture(s)	Topic
Theory	
1	Concepts of molecular basis of a disease
2	Molecular epidemiology of diseases/ infections
3	Molecular determinants of pathogenicity and virulence amongst agents
4	Dynamics of disease transmissibility in populations of livestock and poultry
5-6	Epidemiology of antigenic, genetic and biological diversity amongst pathogens associated with disease/ outbreaks
7	Differentiation of field isolates (wild) from vaccine strains (markers, DIVA, etc).
8	Marker vaccine development
9	Detection and characterization of pathotypes, serotypes, biotypes and genotypes of pathogens
10	Understanding epidemiology of disease using immunological, immunoblotting and monoclonal antibody-based tests
11	Understanding epidemiology of disease using conventional and rapid enzyme immune assays. Use of monoclonal antibodies in different ELISAs for antigenic analysis
12	Understanding epidemiology of disease using pathogen typing methods, viz., polymerase chain reaction, sequencing, RFLP, etc.
13	Understanding epidemiology of disease using radio-actively labelled or non-radioactive oligo-nucleotide probes - dot-blot and Southern hybridizations
14	Evaluation of diagnostic tests/ assays using epidemiological approaches
15	Vaccine efficacy/ effectiveness trails
16	Epidemiology of screening and confirmatory diagnostic assays
17	Estimation of disease burden in populations
18	Estimation of frequency and pattern of health events in a population
19	Designing of epidemiological studies
20	Representation disease data/ information
21	Study of disease databases and online resources
22	Quantification of zoonotic agents using conventional and molecular tools
23	Rapid detection of foodborne and zoonotic agents
24	On-site, on-farm and animal-side detection systems- approaches and applications
25	Phylogenetic analysis of disease agents
26	Use of modern bio-informatics and disease informatics tools for the study of zoonotic and other determinants of public health significance
27	Source tracing of origin of infectious agents
28	Outbreak investigation and disease reporting including notifiable diseases
29	Traceability of livestock and its implications
30	Multi-centric molecular typing and validation of foodborne and zoonotic agents
31	Epidemiology of chronic disease makers
32	Case study on quantitative epidemiological analysis
Practical	
1	Molecular fingerprinting of pathogens
2	Molecular epidemiology of foodborne and zoonotic agents
3-4	Detection and characterization of pathogens using nucleic acid based techniques
5	Sero-epidemiology – methods and applications
6-7	Multi-locus sequence typing (MLST), pulsed-field gel electrophoresis (PFGE), and amplified fragment length polymorphism (AFLP) typing of pathogens

Lecture(s)	Topic
8	Source tracing of outbreaks
9	Construction and characterization of epidemic curve
10	Spatio-temporal clustering of diseases
11	Mapping disease and risk factors
12	Calculation of variables and confounders using logistic regression analysis
13	Epidemiological analysis for the disease prediction, early warning and forecasting
14	Epidemiological analysis involving remote sensing, GIS and satellite technologies
15-16	Assignment: Each student shall select at least two recent articles from journals related to the course and discuss in the class through presentation

I. Course Title : Surveys, Surveillance and Data Management

II. Course Code : VPE 612

III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Robust survey: planning, statistical models. Survey iceberg (tools and technologies).
2	Structured population-based surveys, types of surveys.
3	Survey design - Sampling, Sampling methods, Sample size, etc.
4	National surveys.
5	Surveillance – definition, goals and types of surveillance system.
6	Principles of surveillance.
7	Critical elements of surveillance.
8	Surveillance methods and approaches.
9	Surveillance for distribution and occurrence of infection.
10	Information architecture for surveillance.
11	Structured non-random surveillance.
12	Surveillance programmes. Designing an active surveillance program.
13	Surveillance to demonstrate freedom from disease or infection.
14	Epidemiological surveillance network.
15	Components of regional or national surveillance system.
16	Statistical models for surveillance.
17	Softwares used for surveillance.
18	State, National and International agencies (OIE, CDC, etc.), databases and management systems.
19-20	Surveillance of emerging and re-emerging diseases
21	Animal health surveillance
22	Data and database
23-24	Data acquisition - Sampling and questionnaires
25	Disease/ data recording and reporting
26	Veterinary data recording schemes and information system (databases)
27	National veterinary epidemiology and disease informatics
28-29	Epidemiology informatics on globally and nationally important emerging/ re-emerging diseases and designing of strategies for their prevention and control.
30	Analysis of disease data using software analysis
31	Study of veterinary epidemiology and disease informatics software (e.g. EpiInfo)
32	Case study on disease surveillance



Lecture(s)	Topic
Practical	
1	Data collection, storage and quality control
2	Sampling methods - confidence level, sample unit, sample size, etc.
3	Statistical methods for analysis of disease data
4	Preparation and analysis of questionnaires
5	Questionnaire survey for disease prevalence
6	Data analysis using computer software
7	Data analysis and representation of data pertaining to animal disease/ productivity
8	Survey for livestock and poultry diseases
9	Study/ development of computer software for animal disease/ productivity
10	Evaluation of veterinary/ animal husbandry interventions
11	Evaluation of animal disease surveillance systems
12	Study of national health surveys related to animal/ human disease
13	Surveillance of economically important disease of the region/ state
14	Usefulness/ efficacy/ effectiveness of vaccines/ vaccination
15-16	Assignment: Each student will select at least two recent articles from journals related to course and discuss in the class through presentation

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Veterinary Para-Clinical Subjects

– Veterinary Pharmacology and Toxicology



Course Title with Credit Load

M.V.Sc. in Veterinary Pharmacology and Toxicology

Course Code	Course Title	Credit Hours
VPT 501	Concepts of Pharmacology, Drug Design and Development*	2+0
VPT 502	Autonomic and Autacoid Pharmacology*	2+1
VPT 503	CNS Pharmacology	2+1
VPT 504	Digestive and Respiratory Pharmacology	2+1
VPT 505	Cardiovascular and Urinary System Pharmacology	2+0
VPT 506	Endocrine and Reproductive Pharmacology	2+1
VPT 507	Chemotherapy*	2+1
VPT 508	Toxicology of Xenobiotics*	2+1
VPT 509	Toxinology	2+1
VPT 510	Pharmacological Techniques*	0+2
VPT 511	Techniques in Toxicology*	0+2
VPT 512	Ethnopharmacology	1+1
VPT 513	Fundamentals of Pharmacokinetics	1+1
VPT 591	Master's Seminar*	1+0
VPT 599	Master's Research	30

*Core courses



Course Contents

M.V.Sc. in Veterinary Pharmacology and Toxicology

- I. Course Title** : Concepts of Pharmacology, Drug Design and Development
II. Course Code : VPT 501
III. Credit Hours : 2+0

IV. Aim of the course

To study the basic concepts of drug actions, and drug design and development.

V. Theory

Unit I

Scope of pharmacology, Drugs and other therapeutic agents, Principles of biopharmaceutics and veterinary dosage forms, Dynamics of ADME; Principles of therapeutics; Rationale and Empirical, Various other types of therapeutics.

Unit II

Pharmacodynamics targets for drug actions (enzymes, ion channels, structural and transporter proteins) evidence of drug action through receptor, Signal transduction mechanisms (GPCR, enzyme linked receptor), Regulation and malfunctioning of diseases.

Unit III

Quantitation of drug-receptor interactions and elicited effects, Drug-drug interactions and adverse drug reactions.

Unit IV

Drug invention: Screening, Assaying, Designing and Development of drugs, Clinical trials, Drug safety, Regulations and standards; Gene based therapy and drug delivery system.

- I. Course Title** : Autonomic and Autacoid Pharmacology
II. Course Code : VPT 502
III. Credit Hours : 2+1

IV. Aim of the course

To study the pharmacological basis of the therapeutic uses of autonomic and autacoid drugs.

V. Theory

Unit I

Anatomical and physiological considerations of autonomic and somatic motor nervous system and Neurohumoral transmission.

Unit II

Agents modulating peripheral nervous system, Non-adrenergic-non cholinergic (NANC) transmission.



Unit III

Pharmacology of adrenergic agonists, Antagonists and Adrenergic neuron blockers.

Unit IV

Pharmacology of cholinergic agonists, Antagonists and cholinergic neuron blockers.

Unit V

Drugs acting at the Neuromuscular Junction and Autonomic Ganglia.

Unit VI

Autacoids: Introduction to immunity and inflammation, Immunostimulants, Immunosuppressants and Tolerogens, Pharmacological aspects of histamine, serotonin, kinins, eicosanoids and platelet activating factor, Angiotensins and other putative autacoids.

VI. Practicals

Pharmacological experiments on intact and isolated preparations for studying the effects of various prototype autonomic and autacoids drugs on vascular, intestinal, respiratory, urinary and reproductive smooth muscles, autonomic ganglia, skeletal muscles; blood pressure, ECG, heart, etc.

I. Course Title : CNS Pharmacology

II. Course Code : VPT 503

III. Credit Hours : 2+1

IV. Aim of the course

To study the pharmacology of drugs acting on central nervous system (CNS).

V. Theory

Unit I

Anatomical and physiological considerations and neurohumoral transmission in CNS.

Unit II

Historical development, theories, principles and stages of general anaesthesia.

Unit III

Recent advances in pharmacology of general anaesthetics and therapeutic gases, local anaesthetics, sedatives, hypnotics, neuroleptics, antiepileptics.

Unit IV

Pharmacology of CNS stimulants, analeptics, opioid agonists and antagonists; non-steroidal anti-inflammatory agents, central muscle relaxants, Pharmacology and regulations of euthanizing agents.

VI. Practicals

Study of pharmacodynamics of prototype drugs of each class of drugs in experimental animals.



- I. Course Title** : **Digestive and Respiratory Pharmacology**
II. Course Code : **VPT 504**
III. Credit Hours : **2+1**

IV. Aim of the course

To study the pharmacological aspects of drugs acting on digestive and respiratory systems.

V. Theory

Unit I

Physiological considerations of GIT functions in ruminants and non-ruminants. Pharmacology of drugs acting on gastrointestinal tract. Appetite stimulants, emetics and anti-emetics.

Unit II

Pharmacology of anti-ulcer drugs, modulators of gastric and intestinal motility and secretions.

Unit III

Agents promoting digestive functions; bile acids and pancreatic enzymes, drugs affecting liver; rumen pharmacology.

Unit IV

Gastrointestinal protectant and adsorbents, laxatives and cathartics.

Unit V

Physiological considerations of respiratory functions in animals. Pharmacology of drugs acting on respiratory system: Bronchodilators, Antitussives, Mucolytics, Expectorants, Decongestants. Drugs used in treatment of asthma.

VI. Practicals

Study of effects of drugs on digestive and respiratory functions using different *in-vitro* and *in vivo* animal models.

- I. Course Title** : **Cardiovascular and Urinary System Pharmacology**
II. Course Code : **VPT 505**
III. Credit Hours : **2+0**

IV. Aim of the course

To study the pharmacological aspects of drugs acting on CVS and kidneys.

V. Theory

Unit I

Cardiac electrophysiology consideration, Pharmacology of antiarrhythmic drugs, Cardiac glycosides, Myocardial stimulants.

Unit II

Antihypertensive, Antihypotensive and Antihyperlipidaemic drugs.

Unit III

Coagulants and anticoagulants, Thrombolytic agents, Plasma expanders, Drugs affecting haemopoietic system and antiplatelet drugs.



Unit IV

Pharmacology of drugs affecting renal functions and fluid-electrolyte balance: Diuretics, Antidiuretics, Urinary acidifiers, Urinary alkalizers, Urinary antiseptics and Uricosuric and other anti-gout drugs. Principles of acid-base balance, fluid and electrolyte therapy and blood substitutes.

I. Course Title : Endocrine and Reproductive Pharmacology

II. Course Code : VPT 506

III. Credit Hours : 2+1

IV. Aim of the course

To study the pharmacology of drugs affecting endocrine functions.

V. Theory

Unit I

Drugs affecting endocrine functions of hypothalamus, pituitary, thyroid, adrenals and pancreas.

Unit II

Drugs affecting calcium and phosphorus homeostasis.

Unit III

Drugs affecting male reproductive organs, spermatogenesis and erectile dysfunctions.

Unit IV

Drugs affecting female reproductive organs: ovulation, oestrus, conception, gestation and lactation.

Unit V

Oxytocic and other drugs affecting uterus.

VI. Practicals

To study the effects of various endocrine agonists and antagonists in animal models and isolated tissues.

I. Course Code : VPT 507

II. Course Title : Chemotherapy

III. Credit Hours : 2+1

IV. Aim of the course

To study the recent advances in chemotherapeutic agents with relevance to their molecular mechanisms and therapeutic aspects.

V. Theory

Unit I

General consideration and principles of Chemotherapy, Classification of chemotherapeutic agents; Molecular mechanism of Antimicrobial resistance-development and Prevention strategies; Combination therapy, Therapeutic failure.

Unit II

Systemic and gut acting sulphonamides, diaminopyrimidines, sulfones, quinolones, nitrofurans, nitroimidazoles.

**Unit III**

Penicillins, Cephalosporins, Carbapenems, Carbacephems, monobactam, beta lactamase inhibitors.

Unit IV

Aminoglycosides, Tetracyclines, Chloramphenicol and its congeners, macrolides, lincosamides.

Unit V

Antitubercular drugs, Glycopeptides, and Polypeptide antibiotics, Methenamine, Carbadox, Novobiocin, Virginiamycin, Spectinomycin, Oxazolidinones and newer agents.

Unit VI

Antiprotozoans, Anthelmintics, Ectoparasiticides

Unit VII

Antifungal agents, Antiviral and Anti-neoplastic drugs.

VI. Practicals

Assay of chemotherapeutic agents, Antibiotic sensitivity tests. Determination of minimum inhibitory concentration (MIC), Mutant Prevention Concentration (MPC), Minimum Bactericidal Concentration (MBC) and time kill kinetics. Molecular techniques for intervention of antimicrobial resistance. Determination of anthelmintic properties of drugs using *in-vitro* models.

I. Course Title : Toxicology of Xenobiotics

II. Course Code : VPT 508

III. Credit Hours : 2+1

IV. Aim of the course

To study the molecular basis of poisoning and antidotal therapy in animals.

V. Theory**Unit I**

Principles and scope of toxicology.

Unit II

Molecular mechanism of action of poisons and their detoxification, rational approach for diagnosis and treatment of poisonings.

Unit III

Toxicology of metals, non-metals, agrochemicals, solvents and vapors, common salt, urea and other feed additives. Toxicity of drugs.

Unit IV

Genotoxic and other effects of radiations and radioactive chemicals; toxicogenomics and developmental toxicology; forensic and regulatory aspects of toxicology.

VI. Practicals

Extraction, separation and detection of common poisons in toxicological specimens, study of toxicity and antidotal treatment in animals, designing of animal toxicity experiments and general toxicity spot tests.



- I. Course Title : Toxinology**
II. Course Code : VPT 509
III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge of molecular basis of toxicity induced by toxins of plants, microbes and animals origin.

V. Theory

Unit I

Classification and identification of different types of toxins.

Unit II

Toxicity induced by abrin, strychnine, dhurin, amygdaline, sanguine, solamine, gossypol, beta-amino propionitryl, beta-oxolyl amino L-alanine, other Phytotoxins

Unit III

Toxin induced Teratogenicity, Thiamine deficiency and Phototoxicity.

Unit IV

Toxicology of mycotoxins: aflatoxins, rubratoxins, ochratoxins, sporidesmin, citrinin, F-2 toxin, trichothecenes, tremorgens and ergot alkaloids.

Unit V

Zootoxins: snake venom, scorpion, spider and insect stings and bufotoxins, Puffer fish and Shell fish toxins. Bacterial toxins (botulinum and tetanus toxins)

VI. Practicals

Detection of alkaloids, glycosides, cyanides, nitrate/ nitrite, tannins, saponins, resins and oxalates. Detection of mycotoxins in the samples of feed/ fodder and animal tissue. Identification of toxic weeds and plants of the state/ local area.

- I. Course Title : Pharmacological Techniques**
II. Course Code : VPT 510
III. Credit Hours : 0+2

IV. Aim of the course

To impart the knowledge of various pharmacological techniques and screening methods of drugs.

V. Practicals

Unit I

Principles of drug action and bioassay. Construction of dose-response plots and their significance. Determination of EC_{50} , median effective (ED_{50}), toxic (TD_{50}) or lethal doses (LD_{50}) from dose-response plots. Calculation of dissociation rate constants, therapeutic ratio, margin of safety, potency ratio, pA_x , pD_x and pD'_x values.

Unit II

Techniques for setting up isolated and intact preparations, recording of BP in hen/ rat, recording of ECG in rat/ other small animals.

**Unit III**

Organization of screening programme of drugs; multidimensional screening procedures and gross observational methods. Specific tests for evaluation of tranquillizing, hypnotic, analgesic, anticonvulsant, general and local anaesthetic, muscle relaxant, anti-inflammatory, antipyretic, antiarrhythmic, antihypertensive and antihyperglycemic activities.

Unit IV

Guidelines for safety studies on drugs.

- I. Course Title** : **Techniques in Toxicology**
II. Course Code : **VPT 511**
III. Credit Hours : **0+2**
IV. Aim of the course

To understand the animal toxicity tests and assessment of various toxicants using specific tests.

V. Practicals**Unit I**

Designing of animal models in toxicological studies. Introduction to different toxicological guidelines for *in-vitro* and *in vivo* studies (OECD, WHO, EPA, etc.). *In silico* toxicity prediction.

Unit II

Animal toxicity tests for acute, sub-acute and chronic toxicity.

Unit III

Specific toxicity tests for Neurotoxicity, Immunotoxicity, Behavioural, Reproductive and Developmental, Inhalation Toxicity, Mutagenicity, Carcinogenicity.

Unit IV

Toxicological tests for the study of metabolism, synergism and antagonism. Assay for marker enzymes, analysis of toxicant residues in biological materials.

- I. Course Title** : **Ethnopharmacology**
II. Course Code : **VPT 512**
III. Credit Hours : **1+1**
IV. Aim of the course

To impart the knowledge and importance of traditional Indian medicine.

V. Theory**Unit I**

Historical aspects of traditional Indian remedies. Alternate systems of medicine in animals. Scope of Ethnopharmacology.

Unit II

Classification and identification of medicinal plants. Classification, Metabolism and interactions of Phytoconstituents.



Unit III

Standardization and clinical validation of bioactive molecules from plant sources. Therapeutic and adverse effects of potential herbal drugs. Indigenous drugs used as glactagogues, carminatives, antiseptics, antidiarrhoeals, anthelmintics, Immuno-stimulants, antimicrobials, bioenhancers, analgesics, anti-inflammatory agents, etc.

VI. Practicals

Identification of medicinal plants. Preparation of plant extracts in various solvents using different techniques. Phytochemical screening of plant extracts. Evaluation of pharmacological activities of extracts using *in-vitro* and *in-vivo* methods.

I. Course Title : Fundamentals of Pharmacokinetics

II. Course Code : VPT 513

III. Credit Hours : 1+1

IV. Aim of the course

To study the disposition of drugs and dosage regimen.

V. Theory

Unit I

Routes of drug administration, ADME, plasma protein binding, factors modifying ADME

Unit II

Basic concept of pharmacokinetics, Order of pharmacokinetics processes (zero order, first order and mixed order), Models of pharmacokinetics analysis of drugs (compartmental, non-compartmental model)

Unit III

Compartmental models of drug distribution, determinants of absorption, distribution and elimination, rate constants (C_{max} , T_{max})

Unit IV

Calculation of pharmacokinetic parameters, dosage regimen and bioavailability based on compartmental analysis, Non-compartmental pharmacokinetic modelling.

VI. Practicals

Analysis of pharmacokinetic data and determination of different pharmacokinetic parameters and bioavailability of drugs in normal and diseased animal models.

Course Outline-cum-Lecture Schedule for Master Degree Programme

- I. Course Title** : Concepts of Pharmacology, Drug Design and Development
- II. Course Code** : VPT 501
- III. Credit Hours** : 2+0
- IV. Aim of the course**
To study the basic concepts of drug actions, and drug design and development.
- V. Lecture/ Practical schedule**

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Scope of pharmacology, nature and sources of drugs and other therapeutic agents	2
2.	Principles of biopharmaceutics and dosage forms of drugs	2
3.	Principles of Pharmacokinetics-Absorption, distribution, metabolism and excretion of drugs.	4
4.	Principles of drug action, rational, empirical and various other therapeutics	2
5.	Pharmacodynamics-targets for drug actions (enzymes, ion channels, structural and transporter proteins)	4
6.	Receptor mediated drug action, types of drug receptors, second messengers of drug action and signal transduction	4
7.	Regulation and malfunctioning of diseases.	1
8.	Quantitation of drug-receptor interactions and elicited effects	2
9.	Drug interactions and adverse drug reactions	2
10.	Drugs design and development, Screening and drug assay	3
11.	Clinical drug trials	2
12.	Drug safety, drug standards and regulations	2
13.	Gene therapy and novel drug delivery systems.	2

- I. Course Title** : Autonomic and Autacoid Pharmacology
- II. Course Code** : VPT 502
- III. Credit Hours** : 2 + 1
- IV. Aim of the course**
To study the pharmacological basis of therapeutic uses of autonomic and autacoid drugs.



V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Introduction to autonomic nervous system (ANS), Anatomical and physiological considerations of autonomic and somatic motor nervous system	2
2.	Neurohumoral transmission	2
3.	Exceptions to generalization of ANS, Agents modulating peripheral nervous system, non adrenergic-non cholinergic (NANC) transmission	3
4.	Sympathetic nervous system, adrenergic agonists, antagonists and adrenergic neuron blockers	4
5.	Therapeutic uses of sympathetic drugs and blockers	1
6.	Parasympathetic nervous system, cholinergic agonists, antagonists and cholinergic neuron blockers	4
7.	Therapeutic uses of parasympathetic drugs and blockers	1
8.	Ganglion stimulating and blocking drugs	2
9.	Neuromuscular blocking drugs	1
10.	Introduction to immunity and inflammation	2
11.	Immunostimulants, immunosuppressants and tolerogens	1
12.	Histaminergic and antihistaminics	2
13.	Serotonin and antiserotonin agents	1
14.	Kinins as mediators of inflammation	2
15.	Eicosanoids and platelet activating factor	3
16.	Angiotensins and other putative autacoids	2
17.	Angiotensins and inhibitors of renin-angiotensin system	1
Practical		
1.	Effect of sympathetic agonists and antagonists on intact and isolated preparations through experiments/ simulation programmes.	5
2.	Effect of sympathetic agonists and antagonists on intact and isolated preparations through experiments/ simulation programmes.	5
3.	Effects of autonomic drugs on blood pressure, ECG, etc.	2
4.	Effect of autacoids on different systems	4

I. Course Title : CNS Pharmacology

II. Course Code : VPT 503

III. Credit Hours : 2 +1

IV. Aim of the course

To study the pharmacology of drugs acting on central nervous system (CNS)

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Introduction to CNS – Physiological and anatomical considerations	1
2.	Drugs action on CNS	1
3.	Central neurotransmitters	2



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
4.	General anaesthesia – History, theories and stages of general anaesthesia	1
5.	Adjuvants to general anaesthetics	1
6.	Inhalant general anaesthetics	3
7.	Injectable general anaesthetics	3
8.	Local anaesthetics	2
9.	Hypnotics and sedatives	3
10.	Psychotropic drugs and drugs modifying abnormal behaviour of animals	3
11.	Anticonvulsants	2
12.	Opioid agonists (analgesics) and antagonists	3
13.	Non steroidal anti-inflammatory drugs (NSAIDs)	3
14.	CNS stimulants	1
15.	Central muscle relaxants	1
16.	Drugs of abuse	2
17.	Currents topics/ Discussion on library assignments	2
Practicals		
1.	Study on general anaesthetics	1
2.	Study on local anaesthetics	2
3.	Study on sedatives and hypnotics	2
4.	Study on anticonvulsants	1
5.	Study on antipyretics	1
6.	Study on analgesics	2
7.	Study on anti-inflammatory drugs	2
8.	Study on psychotropic drugs	2
9.	Study on CNS stimulants	1
10.	Study on central muscle relaxants.	1

I. Course Title : Digestive and Respiratory Pharmacology

II. Course Code : VPT 504

III. Credit Hours : 2 + 1

IV. Aim of the course

To study the pharmacological aspects of drugs acting on digestive and respiratory systems.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Drugs affecting salivary secretions – Sialics and antisialics	1
2.	Drugs affecting gastric secretion – Stomachics, histamine and gastrin analogues	2
3.	Gastric antisecretory and antiulcer drugs – H ₂ -receptor antagonists and proton pump inhibitors	2
4.	Antacids	2
5.	Emetics	1
6.	Antiemetics	2
7.	Carminatives and antizymotics	1



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
8.	Appetizers and digestants	1
9.	Pro-kinetics	2
10.	Cathartics	2
11.	Antidiarrhoeic drugs	2
12.	Physiological basis of renal pharmacology	2
13.	Diuretics	3
14.	Drugs affecting fluid, electrolyte and acid-base balance	2
15.	Drugs affecting urinary pH and tubular transport	1
16.	Antitussives	1
17.	Expectorants	1
18.	Analeptics	1
19.	Bronchodilators and other drugs acting on respiratory system	1
20.	Drugs acting on skin and mucous membrane – Demulcents, emollients, protectants, counterirritants, caustics, keratolytics, and wound cleansing agents	2
21.	Current topics/ Discussion on library assignments.	2
Practicals		
1.	Effects of drugs on digestive functions using different <i>in-vitro</i> models	4
2.	Effects of drugs on digestive functions using <i>in vivo</i> animal models	4
3.	Effects of drugs on respiratory functions using different <i>in-vitro</i> models	4
4.	Effects of drugs on respiratory functions using different animal models	

I. Course Title : Cardiovascular and Urinary System Pharmacology

II. Course Code : VPT 505

III. Credit Hours : 2 + 0

IV. Aim of the course

To study the pharmacological aspects of drugs acting on CVS and kidneys.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	General considerations to cardiovascular system	2
2.	Myocardial stimulants – Cardiac glycosides and other myocardial stimulants	3
3.	Anti-arrhythmic drugs	3
4.	Vasodilators and antianginal drugs	2
5.	Antihypertensive agents	1
6.	Haemostatics and coagulants	2
7.	Anti-coagulants	2
8.	Fibrinolytic and anti-platelet drugs	1
9.	Haemtaopoietic drugs	2
10.	Blood components and blood substitutes	1
11.	Drugs used in treatment of shock	2
12.	Antihyperlipoproteinemics	1
13.	Physiological basis of renal pharmacology	2
14.	Diuretics	3



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
15.	Drugs affecting fluid, electrolyte and acid-base balance	3
16.	Drugs affecting urinary pH and tubular transport	2
17.	Current topics/ Discussion on library assignments	2

I. Course Title : Endocrine and Reproductive Pharmacology

II. Course Code : VPT 506

III. Credit Hours : 2 + 1

IV. Aim of the course

To study the pharmacology of drugs affecting endocrine functions.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
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Theory

1.	General considerations to Endocrine and reproductive systems	2
2.	Pharmacology of drugs affecting endocrine functions of Pituitary gland	3
3.	Pharmacology of drugs affecting endocrine functions of thyroid gland	2
4.	Pharmacology of drugs affecting endocrine functions of adrenals	3
5.	Pharmacology of drugs affecting endocrine functions of the Pancreas	2
6.	Physiological basis of calcium and phosphorus homeostasis	2
7.	Hormonal regulation of calcium and phosphorus homeostasis.	2
8.	Pharmacology of drugs affecting male reproductive organs,	2
9.	Drugs affecting spermatogenesis	2
10.	Pharmacology of drugs affecting female reproductive organs	2
11.	Drugs affecting ovulation	2
12.	Drugs affecting oestrus	1
13.	Drugs affecting conception	2
14.	Drugs affecting gestation	2
15.	Drugs affecting lactation	2
16.	Current topics/ Discussion on library assignments	3

Practicals

1.	Effects of various hormones in animal models and isolated tissues.	4
2.	Effects of various hormones in and isolated tissues	4
3.	Effects of different hormone antagonists in animal models	4
4.	Effects of different hormone antagonists in isolated tissues	4

I. Course Title : To study the recent advances in chemotherapeutic agents with relevance to their molecular mechanisms and therapeutic aspects.

II. Course Code : VPT 507

III. Credit Hours : 2 + 1

IV. Aim of the course

To study the recent advances in chemotherapeutic agents with relevance to their molecular mechanisms and therapeutic aspects.



V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	General principles of antibacterial therapy, classification of antibacterial drugs, clinical use of antibiotics, antibiotic combinations. Bacterial resistance	2
2.	Sulfonamides	2
3.	Penicillins and Beta-lactamase inhibitors	2
4.	Cephalosporins	2
5.	Aminoglycosides and Aminocyclitols	2
6.	Chloramphenicol and Thiamphenicol	2
7.	Tetracyclines	2
8.	Macrolide antibiotics and Membrane antibiotics	2
9.	Quinolones – Spectrum, mechanism, kinetics and uses	2
10.	Antifungal agents	2
11.	Antiviral agents	2
12.	Anticancer agents – General principles, classification, mechanism, toxicity, uses	2
13.	Anthelmintics – Antinematodal drugs, Anticestodal drugs, Antitrematodal drugs	2
14.	Ectoparasiticides	2
15.	Antiprotozoan Drugs	2
16.	Antitubercular drugs	2
17.	Curent discussions and assignments	2
Practical		
1.	General methods for assay of chemotherapeutic agents	2
2.	Estimation of sulfonamides in biological fluids	2
3.	Estimation of penicillins in biological fluids	3
4.	Estimation of oxytetracyclines in biological fluids	2
5.	Estimation of trimethoprim in biological fluids	2
6.	Estimation of nitrofurans in biological fluids	2
7.	Antibiotic sensitivity tests	2

I. Course Title : Toxicology of Xenobiotics

II. Course Code : VPT-508

III. Credit Hours : 2 + 1

IV. Aim of the course

To study the molecular basis of poisoning and antidotal therapy in animals.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Introduction, definitions and fields of toxicology	1
2.	History and scope of toxicology	1
3.	Sources and classification of toxicants	1
4.	General modes of action of poisons	1



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
5.	Detoxification of poisons	2
6.	Principles and fundamentals of toxicology	3
7.	Factors affecting toxicity	1
8.	Diagnosis of poisoning	2
9.	Treatment and management of poisonings	2
10.	Toxicology of metals – Arsenic, mercury, lead, copper, molybdenum, cadmium and iron	5
11.	Toxicology of agrochemicals – Insecticides, herbicides, fungicides and rodenticides	5
12.	Toxicology of solvents and vapours	2
13.	Feed additives – Growth and performance enhancers, non-protein nitrogen compounds, common salt	2
14.	Radiations and radioactive chemicals	2
15.	Genetic and developmental toxicology	2
16.	Regulatory and forensic toxicology	2
17.	Current topics/ Discussion of library assignments	2
Practical		
1.	Collection of material for toxicological investigations	2
2.	Dispatch and processing of samples for toxicological investigations	2
3.	Extraction and separation of poisons from toxicological specimens	2
4.	Identification and detection of common poisons	3
5.	Designing and experiments for acute, subacute and chronic toxicities	2
6.	Calculation of TD50 and LD50	2
7.	Antidotal treatment in animals	2

I. Course Title : Toxinology

II. Course Code : VPT 509

III. Credit Hours : 2 + 1

IV. Aim of the course

To impart knowledge of molecular basis of toxicity induced by toxins of plants, microbes and animals origin.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Classification, identification and chemical constituents of poisonous plants	2
2.	Nitrate/ nitrite poisoning: sources, mechanism of toxicity, clinical findings, diagnosis, treatment and control	2
3.	Cyanide poisoning – Causes, cyanogenetic plants: jowar, etc., mechanism of toxicity diagnosis and treatment	2
4.	Photosensitization – <i>Lantana camara</i> : mechanism of toxicity, clinical signs and treatment	2
5.	Bracken fern poisoning – Clinical signs, diagnosis and treatment	2
6.	Poisoning due to strychnos nux-vomica, Ricinus communis and	



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
	kaner – Mechanism of toxicity, clinical signs, diagnosis and treatment	2
7.	Toxicity due to dhatura, Abrus precatorius, Ipomoea carnea – Mechanism of toxicity, clinical signs and treatment	2
8.	Toxicity due to plants containing oxalate – Mechanism of toxicity, clinical signs and treatment	2
9.	Mycotoxins – Hepatotoxins (sporidesmin, aflatoxins and rubratoxins): mechanism of toxicity, symptoms and treatment	2
10.	Nephrotoxins (ochratoxin, citrinin) neurotoxins (penitren A and Patulin). Ergot alkaloids, estrogenism and Trichothecene toxins: clinical signs and treatment	3
11.	Bacterial toxins – Diphtheria toxins, Botulinum toxin, Cholera toxin, tetanus toxin, E.coli., Enterotoxin, Endotoxin	3
12.	Toxicity due to snake venom – Mechanism of toxicity, clinical signs and treatment	3
13.	Toxicity due to scorpion – Mechanism of toxicity, clinical signs and treatment	2
14.	Toxicity due to spider and insect stings and toad poisoning – Mechanism of toxicity, clinical signs and treatment	2
15.	Current topics/ Discussion of library assignments	3

Practicals

1.	Detection of alkaloids, glycosides, cyanides, nitrate/ nitrite, tannins, saponins, resins and oxalates in toxic plants	8
2.	Phytochemical analysis of toxic plant extracts	2
3.	Detection of mycotoxins in the samples of feed/ fodder and animal tissue	2
4.	Identification of toxic weeds and plants of the state/ local area	2

I. Course Title : Pharmacological Techniques

II. Course Code : VPT 510

III. Credit Hours : 0 + 2

IV. Aim of the course

To impart the knowledge of various pharmacological techniques and screening methods of drugs.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Practicals		
1.	Principles of drug action	1
2.	Bioassay. Types of bioassay, bioassay techniques	3
3.	Setting up of an isolated tissue preparation and an intact preparation	2
4.	Study of dose response relationship	2
5.	Suprmaximal effect by cumulative dose response study	1
6.	Study on isolated organ assembly	3
7.	Intact frog heart perfusion	1
8.	Recording of blood pressure in animals	2
9.	Recording of ECG in animals	1



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
10.	Screening Programme of drugs: General and multidimensional	2
11.	Gross observational methods in Screening procedures	2
12.	Calculation of EC50, potency ratio, PDv, PDx PD values	1
13.	Screening of hypnotic activity	1
14.	Study of analgesic, antipyretic and anti-inflammatory activity in laboratory animals	2
15.	Study of general and local anaesthesia in experimental animals	1
16.	Study of anticonvulsant and muscle relaxant effect of drugs	2
17.	Study of antiarrhythmic and antihypertensive action of test compound	2
18.	Study of antihyperglycemic and anticholinesteric activity	1

I. Course Title : Techniques in Toxicology

II. Course Code : VPT 511

III. Credit Hours : 0 + 2

IV. Aim of the course

To understand the animal toxicity tests and assessment of various toxicants using specific tests.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Practicals		
1.	Animal models for toxicological studies	2
2.	Animal toxicity tests for acute, subacute, and chronic toxicity	2
3.	Specific toxicity test for neurotoxicity	1
4.	Specific toxicity test for immunotoxicity	1
5.	Specific toxicity test for developmental toxicity	1
6.	Specific toxicity test for behavioral toxicity	1
7.	Specific toxicity test for mutagenicity	1
8.	Specific toxicity test for reproductive toxicity	1
9.	Specific toxicity test for inhalation toxicity	1
10.	Study specific toxicity test for carcinogenicity	1
11.	Animal toxicological tests to study metabolism	1
12.	Animal toxicological tests for synergism	1
13.	Animal toxicological tests for study of antagonisms	1
14.	Good laboratory practices in toxicology	2
15.	Assays for marker enzymes: AchE, GPx, SOD, Catalase	3
16.	Biochemical analysis of suspected toxicity specimens	2
17.	Haematological evaluation of toxicological samples	2
18.	Determination of pesticide residues using Gas Chromatography	2
19.	Analysis of toxicant residues in biological materials	2
20.	Recent advances	1



I. Course Title : Ethnopharmacology

II. Course Code : VPT 512

III. Credit Hours : 1 + 1

IV. Aim of the course

To impart the knowledge and importance of traditional Indian medicine.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	History, traditional remedies and regional folklore in disease cure.	1
2.	Plant drugs with proven pharmacological and therapeutic efficacy	1
3.	Indigenous drugs used in treatment of various gastrointestinal ailments	1
4.	Indigenous drugs used as antimicrobials	1
5.	Indigenous drugs used as analgesics	1
6.	Indigenous drugs used in cardiovascular disorders	1
7.	Indigenous drugs used in CNS disorders	1
8.	Indigenous drugs used in behavioural disorders	1
9.	Indigenous drugs used in Renal and Urinary tract disorders	1
10.	Indigenous drugs used in eye, ear and skin disorders	1
11.	Therapeutic and adverse effects of potential herbal drugs	2
12.	Alternate systems of medicine in animals – Homeopathy	2
13.	Alternate systems of medicine in animals – Folklore medicine	2
14.	Current topics/ Discussion of library assignments	2
Practicals		
1.	Identification of medicinal plants	1
2.	Various processes used in purification and preparation of active constituents from medicinal plants	4
3.	Classification, identification and chemical constituents of medicinal plants	2
4.	Preparation of plant extracts in various solvents using different techniques	2
5.	Phytochemical screening of plant extracts	2
6.	Pharmacological screening of extracts using <i>in-vitro</i> methods	2
7.	Evaluation of pharmacological activities of extracts using in animals	2

I. Course Title : Fundamentals of Pharmacokinetics

II. Course Code : VPT 513

III. Credit Hours : 1 + 1

IV. Aim of the course

To study the disposition of drugs and dosage regimen.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Dosage forms of drugs	1
2.	Routes of drug administration	1



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
3.	Transfer of drugs across biological membranes	2
4.	Absorption of drugs	1
5.	Distribution of drugs	1
6.	Biotransformation of drugs	2
7.	Excretion of drugs	1
8.	Principles of pharmacokinetics	2
9.	Various Pharmacokinetics models	1
10.	Important pharmacokinetic parameters	2
11.	Dosage regiment	1
12.	<i>In-vitro</i> plasma protein binding of drugs	1
Practicals		
1.	Various methods of drug assay	2
2.	Microbiological assay for antimicrobial drugs	2
3.	HPLC techniques	4
4.	Bioavailability of drugs	1
5.	Pharmacokinetics in animal disease models	2
6.	<i>In-vitro</i> plasma protein binding of drugs	1
7.	Determination of different pharmacokinetic parameters	2
8.	Analysis of pharmacokinetic data	2
9.	PK-PD modelling and Time kill kinetics	1



Course Title with Credit Load

Ph.D. in Veterinary Pharmacology and Toxicology

Course Code	Course Title	Credit Hours
VPT 601	Molecular Pharmacology*	3+0
VPT 602	Advances in Autacoid Pharmacology	1+0
VPT 603	Pharmacology of Herbal Drugs	2+1
VPT 604	Biotransformation of Xenobiotics	2+0
VPT 605	Clinical Pharmacology and Pharmacokinetics*	2+1
VPT 606	Pharmacogenomics	2+0
VPT 607	Immunopharmacology and Immunotoxicology	2+0
VPT 608	Molecular Toxicology	3+0
VPT 609	Clinical Toxicology*	2+1
VPT 610	Ecotoxicology	3+0
VPT 611	Regulatory Toxicology	2+1
VPT 690	Special Problem	0+1
VPT 691	Doctoral Seminar I*	1+0
VPT 692	Doctoral Seminar II*	1+0
VPT 699	Doctoral Research	75

*Core courses

Course Contents

Ph.D. in Veterinary Pharmacology and Toxicology

- I. Course Title** : Molecular Pharmacology
II. Course Code : VPT 601
III. Credit Hours : 3+0

IV. Aim of the course

To understand the identification and characterization of receptors and drug receptors interactions and underlying mechanisms of drug receptor interactions and its effects.

V. Theory

Unit I

Physicochemical properties of drugs, Forces involved in binding of drugs to receptors, Classification of receptors, Molecular structure of receptors, Properties and regulation of receptors, Receptors for physiological regulatory molecules.

Unit II

Receptor conformation and configuration. Structure activity relationship. Ligand binding study of receptors. Cellular mechanism of signal transduction and second messenger systems; Structures, Types and Functions of membrane ion channels.

Unit III

Theories of drug receptor interactions; Analysis of dose response Relationship and molecular mechanisms of drug actions, Quantitation of drug-receptor interactions and effects, receptors as pharmaceutical targets.

Unit IV

Calcium homeostasis within the cells, pharmacology of mitogen-activated protein (MAP) kinases/ extracellular signal-regulated kinases (ERK) and small G proteins. Methods of identification, isolation and characterization of receptors.

- I. Course Title** : Advances in Autacoid Pharmacology
II. Course Code : VPT 602
III. Credit Hours : 1+0

IV. Aim of the course

To study the pharmacodynamics and clinical implications of autacoids.

V. Theory

Unit I

Histamine and antihistamines, serotonin and its antagonists.

Unit II

Kinins (Bradykinin, kallikrein, Neurokinin, Substance P, Atrial natriuretic peptides and others).



Unit III

Angiotensins, agonists and antagonists.

Unit IV

Eicosanoids, platelet-activating factors, slow reacting substances of anaphylaxis, Putative neurotransmitters (purine nucleotides, peptides, amino acids and nitric oxide).

Unit V

Pharmacotherapy of inflammation, fever, pain and gout; clinical manifestation of autacid imbalance.

I. Course Title : Pharmacology of Herbal Drugs

II. Course Code : VPT 603

III. Credit Hours : 2+1

IV. Aim of the course

To study the Pharmacological, Therapeutic and Toxicological aspects of potential medicinal plants.

V. Theory

Unit I

Historical aspect, Chemical constituents of medicinal plants and their classification.

Unit II

Identification, Collection, Preservation, Purification, Isolation, Standardization and Clinical validation of bioactive molecules from vegetable sources.

Unit III

Characterization of pharmacological, therapeutic and toxic effects of potential herbal drugs.

Unit IV

Strategies for development of herbal drugs.

VI. Practical

Extraction, detection, phytochemical analysis and fractionation of medicinal plant extracts. Screening of plant extracts for potential pharmacological activity; Pharmacological effects of herbal drugs on intact and isolated preparations.

I. Course Title : Biotransformation of Xenobiotics

II. Course Code : VPT 604

III. Credit Hours : 2+0

IV. Aim of the course

To study the molecular mechanisms of biotransformation of xenobiotics.

V. Theory

Unit I

Process of drug biotransformation phase I, phase II, and III, Microsomal and non-microsomal metabolizing enzyme systems.

**Unit II**

Mechanisms and processes of synthetic biotransformation

Unit III

Chemical, biological, genetic and environmental factors affecting drug biotransformation mechanisms.

Unit IV

Metabolic interactions, Enzyme induction and inhibition. Scope of biotransformation in drug development.

I. Course Title : Clinical Pharmacology and Pharmacokinetics

II. Course Code : VPT 605

III. Credit Hours : 2+1

IV. Aim of the course

To study the efficacy and disposition of drugs in clinical conditions.

V. Theory**Unit I**

Scope of clinical pharmacology. Drug discovery and clinical trials. Pharmacovigilance, pharmacoepidemiology and pharmacoconomics.

Unit II

Various drug delivery systems-ruminal, intravaginal, intramammary, etc. Targeted drug delivery systems-liposomes, microparticles, nanoparticles, etc. Factors modifying drug delivery.

Unit III

Application of pharmacokinetic principles in therapeutics. PK-PD relationship and its applications.

Unit IV

Alterations in pharmacological behaviour of drugs in clinical conditions, neonates and pregnancy. Drug interactions and adverse drug reactions. Therapeutic drug monitoring. Rationale of drug use. Medication control programs in performance animals.

VI. Practicals

Analysis of pharmacokinetic data and determination of different pharmacokinetic parameters and drugs interactions in normal and diseased animal/ models.

I. Course Title : Pharmacogenomics

II. Course Code : VPT 606

III. Credit Hours : 2+0

IV. Aim of the course

To study the concepts of genomics in drug development.

V. Theory**Unit I**

History, concepts and definitions of pharmacogenomics transcriptomics, proteomics and metabolomics. Genomic basis of species variations in drug response.



Unit II

Genetic polymorphism and its impact on pharmacokinetics, drug target receptors and disease-drug response.

Unit III

Pharmacogenomics and drug development, Pharmacogenomics in clinical practice, role of bioinformatics in pharmacogenomics.

Unit IV

Concept of gene therapy, gene therapy of inherited diseases, DNA repair and inactivation strategies. Synthesis of therapeutic proteins.

- I. Course Title : Immunopharmacology and Immunotoxicology**
- II. Course Code : VPT 607**
- III. Credit Hours : 2+0**
- IV. Aim of the course**

To study the pharmacological intervention of immune functions.

V. Theory

Unit I

General aspect of immune system and its interaction with nervous and endocrine systems. Chemical mediators of immune system.

Unit II

Immunomodulators; Immunostimulants, Immunosuppressant and Tolerogens; Immunological basis of drug allergy and drug tolerance.

Unit III

Immunotoxic effects of xenobiotics and environmental pollutants.

Unit IV

Immune deficiencies and autoimmune reactions. Immunotherapeutic applications in asthma, arthritis, cancer, dermatology, and organ transplant, etc.

- I. Course Title : Molecular Toxicology**
- II. Course Code : VPT 608**
- III. Credit Hours : 3+0**
- IV. Aim of the course**

To understand the mechanisms and targets of cellular/ molecular toxicity.

V. Theory

Unit I

Cellular, sub-cellular and molecular targets and mechanism of toxicity.

Unit II

Cellular dysfunctions and their consequences, Mechanism of cell death in toxicity, repair and disrepair of toxic damage.

Unit III

Molecular mechanisms of target organ directed toxicity of xenobiotics- brain,



hematopoietic system, GIT, liver, lungs, kidneys, reproductive system, skin, etc.

Unit IV

Mechanism of chemical mutagenesis, carcinogenesis, teratogenesis and radiation toxicity.

I. Course Title : Clinical Toxicology

II. Course Code : VPT 609

III. Credit Hours : 2+1

IV. Aim of the course

To study the concepts of clinical toxicology and forensic toxicology.

V. Theory

Unit I

Scope of clinical and forensic toxicology. Toxicological investigation, management and antidotal therapy of poisonings.

Unit II

Clinical aspects of poisoning due metals, non-metals and pesticides.

Unit III

Clinical aspects of poisoning due to mycotoxins, animal and bacterial toxins, solvents and vapours, drugs and other food/ feed contaminants.

Unit IV

Forensic toxicology. GLP in toxicological evaluation.

VI. Practical

General screening of biological material for toxicants, analysis of clinical samples for poisons, use of biomarkers in the assessment of toxicity.

I. Course Title : Ecotoxicology

II. Course Code : VPT 610

III. Credit Hours : 3+0

IV. Aim of the course

To impart knowledge regarding ecotoxicology for conservation of healthy eco-system.

V. Theory

Unit I

Basic principles of ecotoxicology. Sources of contamination and effects of pollutants on eco-health.

Unit II

Chemical contamination of air, water, soil and food by major agricultural and industrial chemicals – pesticides, hydrocarbons and metals. Fate of chemicals in the environment and target species.

Unit III

Toxic effects of radiations. Marine and wildlife as monitors of environmental quality, Bioaccumulation and Biomagnifications of toxicants.



Unit IV

Biomarkers of monitoring the impact of environmental pollutants, Environmental hazard and Risk identification from Mixture of chemicals, Contamination control and approaches to rehabilitating damaged ecosystems, Nanoparticle toxicology, ecological emergencies.

I. Course Title : Regulatory Toxicology

II. Course Code : VPT 611

III. Credit Hours : 2+1

IV. Aim of the course

To study acts and regulations and risk assessment regarding use of drugs, chemicals and cosmetics.

V. Theory

Unit I

Principles of risk assessment. Test protocols for toxicity studies of various national and international regulatory agencies.

Unit II

Regulatory essential dose levels in chemical risk assessment (NOEL, NOAEL, LOEL, LOAEL and AOEL). Recommended acceptable levels of environmental pollutants.

Unit III

Risk assessment in practice. Classification and marking/ branding of chemicals. Monitoring/ surveillance of chemicals. Exposure assessment and modelling.

Unit IV

Quality control in safety research (GLP). Operation of product register.

VI. Practical

Good laboratory practice in toxicological research. Screening procedures in regulatory toxicology. Determination of MRL, ADI, NOEL, NOAEL, LOEL, LOAEL and AOEL. Visit to nearest industrial area.

I. Course Title : Special Problem

II. Course Code : VPT 690

III. Credit Hours : 0+1

IV. Aim of the course

To provide expertise in handling practical research problem(s).

V. Practical

Short research problem(s) involving contemporary issues and research techniques.

Course Outline-cum-Lecture Schedule for Doctoral Degree Programme

- I. Course Title** : Molecular Pharmacology
II. Course Code : VPT 601
III. Credit Hours : 3 + 0

IV. Aim of the course

To understand the identification and characterization of receptors and drug receptors interactions and underlying mechanisms of drug receptor interactions and its effects.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Concept of receptors and forces involved in binding of drugs to receptors	2
2.	Methods of identification, isolation and characterization of receptors.	2
3.	Quantitative aspects and theories of drug-receptor interactions	2
4.	Signal transduction mechanisms: transducers, effectors and second messengers	2
5.	Classification and structures of receptors – Receptor conformation and configuration – Iono-receptors	2
6.	G-protein coupled receptors	2
7.	Enzymatic receptors	2
8.	Steroid receptors	2
9.	Molecular mechanisms of drug actions	2
10.	Receptors for physiological regulatory molecules	2
11.	Receptors as pharmaceutical targets.	2
12.	Hepatic and extra-hepatic metabolism of drugs	3
13.	Structures, types and functions of membrane ion channels.	3
14.	Role of cytochrome P450 isozymes in drug metabolism	2
15.	Metabolic enzyme induction and inhibition	2
16.	Factors affecting drug metabolism	2
17.	Mechanism of bioactivation and cytotoxicity – Electrophilic metabolites, free radicals and reactive oxygen species	3
18.	Drug induced mechanism of cell death – Necrosis and apoptosis	2
19.	Cytoprotective mechanisms against bioactive substances – Role of glutathione and other protectants	2
20.	Calcium homeostasis within the cells	2
21.	Pharmacology of mitogen-activated protein (MAP) kinases/ extracellular signal-regulated kinases (ERK) and small G proteins	3
22.	Current topics/ Discussion of library assignments	2



- I. Course Title : Advances in Autacoid Pharmacology**
II. Course Code : VPT 602
III. Credit Hours : 1 + 0

IV. Aim of the course

To study the pharmacodynamics and clinical implications of autacoids.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1	Histamine and antihistamines	2
2	5-Hydroxytryptamine and anti-5-HT drugs	2
3	Serotonin and its antagonists	2
4	Kinins	1
5	Angiotensins and inhibitors of renin-angiotensin system	2
6	Lipid-derived autacoids-prostaglandins and leukotrienes	2
7	Platelet activating factor	1
8	Cytokines and other autacoids	2
9	Neurohumoral transmission – purine nucleotides, peptides, amino acids and nitric oxide	2
10	Current topics/ Discussion on library assignments	1

- I. Course Title : Pharmacology of Herbal Drugs**
II. Course Code : VPT 603
III. Credit Hours : 2 + 1

IV. Aim of the course

To study the pharmacological, therapeutic and toxicological aspects of potential medicinal plants.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Introduction to indigenous pharmacology – History, definitions and scope	1
2.	Basic requirements and classification of indigenous drugs	2
3.	Collection and preparations of indigenous drugs	1
4.	Extraction of drugs	2
5.	Purification of drugs by heat processes – Distillation, evaporation, sublimations,	2
6.	Filtration and clarification	1
7.	Plant drugs with proven pharmacological and therapeutic efficacy	1
8.	Indigenous drugs used in treatment of various gastrointestinal ailments	2
9.	Indigenous drugs used as antimicrobials	1
10.	Indigenous drugs used as analgesics	1
11.	Indigenous drugs used in cardiovascular and CNS disorders	2
12.	Indigenous drugs used in behavioural disorders	1
13.	Indigenous drugs used in Renal and Urinary tract disorders	2



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
14.	Indigenous drugs used in	1
15.	Indigenous drugs used in eye, ear and skin disorders	3
16.	Indigenous drugs used in reproductive disorders	1
17.	Therapeutic and adverse effects of potential herbal drugs	1
18.	Alternate systems of medicine in animals – Homeopathy	1
19.	Alternate systems of medicine in animals – Ayurvedic concepts	2
20.	Alternate systems of medicine in animals – Folklore medicine	1
21.	Alternate systems of medicine in animals – Unani medicine	1
22.	Discussion on few review articles on herbal drugs from journals	2
Practical		
1.	Fundamental techniques in indigenous pharmacology	2
2.	Extraction and purification of drugs from medicinal plants	4
3.	Bioassay of indigenous drugs	3
4.	Pharmacological screening of indigenous drugs – Effect on isolated smooth muscle of ileum	2
5.	Effect on skeletal muscle	1
6.	Effect on perfused heart	1
7.	Effect on uterus	1
8.	Effect on trachea	1

I. Course Title : Biotransformation of Xenobiotics

II. Course Code : VPT 604

III. Credit Hours : 2 + 0

IV. Aim of the course

To study the molecular mechanisms of biotransformation of xenobiotics.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1	Introduction, importance of drug metabolism. Mechanisms and processes of drug biotransformation	1
2	Synthetic and non-synthetic pathways of drug metabolism. Phase reactions- oxidative, reductive, and hydrolytic reactions	1
3	Phase II reactions- conjugation (glucuronidation, sulfation, methylation, acetylation), conjugation with glutathione, aminoacids and thiosulfates	1
4	Oxidation- molecular details, cytochrome P 450 system. Types of CYP enzymes with special reference to CYP 3A4, 1A2, 2D6, 2E1	1
5	Important drugs metabolized by different CYP isoforms- molecular mechanisms involved	1
6	Nuclear receptor mediated transcriptional regulation of cytochrome P 450 system- Nuclear receptors and their ligands	1
7	7-ethoxy-resorufin O-deethylation (EROD) and 7-methoxyresorufin O-demethylation (MROD) as markers of Cytochrome P450 1 activities in hepatic microsomes	1



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
8	Activity of liver enzymes during the acute and chronic phases of diseases- role of Total bilirubin, Aspartate transaminase (AST), AST/ ALT ratio, Alkaline phosphatase (ALP), Gamma glutamyl transpeptidase (GGT)	1
9	Use S9 liver fraction from animals for the prediction of <i>in vivo</i> drug metabolism, Chemical inhibition assays of S9 fraction	1
10	Xenobiotic response systems- AhR (aryl hydrocarbon receptor), ER (estrogen receptor), PPAR (peroxisome proliferator-activated receptor)	1
11	Response systems - VDR (Vitamin-D-Receptor), FXR (farnesoid-X-receptor), HNF4 (hepatocyte nuclear factor), Nrf2-Keap1.	1
12	Concept of orphan nuclear receptors in different phases of metabolism	1
13	Role of Pregnane-X-Receptor (PXR), Constitutive-Androstane-Receptor (CAR), Liver-X-Receptor (LXR) in metabolism of commonly used drugs. Cross-talk in metabolism pathways	1
14	Role of genetically modified animals in drug metabolism studies	1
15	Specific studies on PXR, CAR, LXR involving gene knockout mice, transgenic mice. Cholesterol and bile acid homeostasis. Search for new response elements	1
16	Reduction reactions- molecular details with specific reaction examples of drugs undergoing reduction: of hydrogenation, decarboxylation, amination	1
17	Hydrolysis- molecular details with specific reaction examples of drugs undergoing hydrolysis with enzymes like esterases, peptidases, and amidases	1
18	Glucuronidation- mechanism, sites, general influencing factors	1
19	Glucuronidation affected drugs – metabolism of morphine, oxazepam carbamazepine, acetaminophen, testosterone, zidovudine), inhibitors and inducers of glucuronidation (barbiturates, ibuprofen, etc.	1
20	Sulfation-Tyrosine sulfation (function, Regulation, Posttranslational modification)	1
21	Acetylation- Ultrastructural Aspects of the Heterogeneous Acetylation	1
22	Phase II Biotransformation Reactions-Glutathione-S-Transferase, Glutathione S-conjugates as prodrugs to target drug-resistant tumors	1
23	Phase III – further modification and excretion- detoxification of endogenous reactive metabolites such as peroxides and reactive aldehydes, sites	1
24	Membrane transport – permeability barriers and detoxification, receptor mediated transcytosis, role of the solute carrier (SLC) and the ATP-binding Cassette (ABC) transporters; implications in drug resistance	1
25	Drug metabolism in organs other than liver- role of kidney, intestine and placenta	1
26	Drug metabolism in fetus and new born. <i>In-vitro</i> and <i>in-vivo</i> studies in drug metabolism; metabolic schemes of selected drugs	1
27	Factors influencing drug metabolism: Stereochemical, Physicochemical and biological factors	1
28	Strain difference in biotransformation, sex, age, environment factors, Genetic factors (pharmacogenetics) heritable factors recognized by use of drugs	1
29	Pathological states- Effect of liver dysfunction on the metabolism of drugs; effect on dosage regimens	1



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
30	Effect of renal dysfunction on the metabolism of different drugs	1
31	Chemical, biological, genetic and environmental factors. Species variations affecting drug biotransformation mechanisms	1
32	Biotechnology involved in drug metabolism studies- Electrophoretic Mobility Shift Assay (EMSA), northern, western/ southern blotting, PCR, real-time PCR	1
33	Preparation and Analysis of Total RNA Extracted from Hepatocytes for metabolism studies. Sulfation assay using P ³² , Site-directed Mutagenesis, etc.	1
34	Methods to determine glutathione in liver and blood. Importance of Gamma-glutamylcysteine (GGC) as the immediate precursor to GSH	1
35	Cell lines as tools for drug metabolism studies. Predicting <i>in-vivo</i> drug metabolism from <i>in-vitro</i> studies, Cultured hepatocytes (cryopreserved or fresh) for induction and down-regulation studies	1

I. Course Title : Clinical Pharmacology and Pharmacokinetics

II. Course Code : VPT 605

III. Credit Hours : 2 + 1

IV. Aim of the course

To study the efficacy and disposition of drugs in clinical conditions.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Introduction and general principles of pharmacokinetics including absorption, distribution, metabolism and excretion	3
2.	Graphical plotting and interpretation of kinetic data	2
3.	Calculation of pharmacokinetic constants	2
4.	Pharmacokinetic models and their application	2
5.	Determination of pharmacokinetic parameters and their significance	3
6.	Computation of dosage regimen	2
7.	Plasma protein binding of drugs	2
8.	Erythrocyte penetration of drugs	2
9.	Factors modifying pharmacokinetics of drugs	2
10.	Pharmacokinetics of drugs in diseased models	3
11.	Urinary excretion of drugs	1
12.	Kinetics following single and multiple doses	2
13.	Non-compartmental pharmacokinetic modelling	2
14.	Application of pharmacokinetics in clinical practice	2
15.	Drug therapy in neonate and geriatric animals	2
16.	Current topics/ Discussion on library assignments	2
Practical		
1.	Estimation of drugs by chemical and microbiological assays	3
2.	Graphical representation of plasma levels of drugs	1
3.	Determination of pharmacokinetic models	1



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
4.	Calculation of kinetic constants and parameters	2
5.	Calculation of dosage regimen	1
6.	Renal clearance studies of drugs	1
7.	<i>In-vitro</i> experiments on plasma protein binding	2
8.	Calculation of constants of plasma protein binding	1
9.	<i>In-vitro</i> erythrocytic penetration of drugs	1
10.	Pharmacokinetic parameters and adjustment of dosage regimen in diseased conditions	2

I. Course Title : Pharmacogenomics

II. Course Code : VPT 606

III. Credit Hours : 2 + 0

IV. Aim of the course

To study the concepts of genomics in drug development.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Introduction- basic pharmacogenomic nomenclature and principle	1
2.	Pharmacogenomics and bioinformatics: past, present and future, species variations affecting drug responses	1
3.	Optimized drug development- Pharmacogenomics impacts on pharmacokinetics and pharmacodynamics	1
4.	Increased and decreased responsiveness to drug effects/ toxicities and novel drug effects- prediction through databases	1
5.	Personalized medicine using genotyping technologies- Optimized drug therapy	1
6.	Challenges of Pharmacogenomic Testing- access, feasibility, cost	1
7.	Genetic basis of disease – Impact of genetic variations on drug metabolism	1
8.	Ethical applications, social and economic implications	1
9.	Genetic polymorphism- Relevance to a drug, Relevance to a disease, Types of nomenclature- Star Nomenclature, Genotype Nomenclature, Haplotype Nomenclature	1
10.	Genetic polymorphism types-Single nucleotide polymorphism (SNP), Variable number tandem repeat, Gene deletion, Copy number variant	1
11.	Single Nucleotide Polymorphism (SNP)- Synonymous polymorphism, Non-synonymous polymorphism, Variable Number Tandem Repeat: UGT1A1	2
12.	Gene Deletions and Copy Number Variants- Ultra-rapid metabolizers, Extensive metabolizers, Intermediate metabolizers, Poor metabolizers	1
13.	Potential Roles for Healthcare Professionals- Implications for Clinical Practice	1
14.	Pharmacogenomic Resources- Centers for Disease Control and Prevention (CDC), Food and Drug Administration (FDA),	1
15.	Gene therapy: gene transfer technology, viral vectors, natural delivery strategies.	1



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
16.	Transient and Stable Transfection, Transfection Methods- Lipid-mediated method	1
17.	Calcium-phosphate mediated method of transfection, diethylaminoethyl-dextran mediated method of transfection	1
18.	Electroporation- Steps of the electroporation transfection, Biolistics (Gene gun/ microparticle bombardment), Laser transfection	1
19.	Drugs and gene therapy of inherited diseases- approaches, cell types, vectors	1
20.	Genetic inactivation strategies- key concepts. RNA interference (RNAi), Chemical modification on siRNA	1
21.	Engineered nucleases- zinc finger nucleases (ZFNs), transcription activator like effector nucleases (TALENs), clustered regularly interspaced short palindromic repeat associated (CRISPR associated) system	1
22.	DNA repair- Sources of damage –Nuclear versus mitochondrial, Senescence and apoptosis. Mechanisms- Direct reversal, Single-strand damage, Double-strand breaks, Translesion synthesis, Medicine and DNA repair modulation	2
23.	Cancer gene therapy- Immunotherapy, Oncolytic virotherapy- history, current clinical trials, future directions	1
24.	Boosting the immune response, Gene therapies to make cancer treatments effective	1
25.	Pro drug gene therapy, Blocking processes that protect cancer cells, Using altered viruses	1
26.	Role of bioinformatics in pharmacogenomic- Bioinformatics and drug discovery, Barriers to bioinformatics progress in drug design process	1
27.	Pharmacogenomics in drug discovery and development- Personalized/ effective medication.	1
28.	Reviving orphan drug, Barriers to pharmacogenomics progress in drug designing and development.	1
29.	Clinical applications of bioinformatics, genomics, and pharmacogenomics, Relationships and exchange of information with other resources	1
30.	Time dependent inhibition of genes involved in cytochrome P450 (CYP450) enzymes (single point, IC 50 shift)	1

I. Course Title : Immunopharmacology and Immunotoxicology

II. Course Code : VPT 607

III. Credit Hours : 2 + 0

IV. Aim of the course

To study the pharmacological intervention of immune functions.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Introduction to immunology	1
2.	General aspect of Immune system	3



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
3.	Cellular components of immune system	2
4.	General principles of immunopharmacology	1
5.	Immunomodulators and their use in animals	2
6.	Immunostimulants and their role in animal health and diseases	2
7.	Immunosuppressants, and tolerogens – clinical applications	2
8.	Immunological basis of drug allergy and drug tolerance	2
9.	Neuroendocrine immune interactions	2
10.	Immunotoxic effects of environmental and other pollutants	3
11.	Molecular mechanisms of immunotoxicity	2
12.	Immunomodulatory effect of xenobiotics	2
13.	Implications of immune alterations in health and disease	2
14.	Immune deficiencies, autoimmune response to xenobiotics,	2
15.	Immunoregulants and their therapeutic applications in asthma, arthritis, cancer, dermatology and organ transplant etc	2
16.	Other immunological drugs	2
17.	Current discussions and assignments	2

I. Course Title : Molecular Toxicology

II. Course Code : VPT 608

III. Credit Hours : 3+0

IV. Aim of the course

To understand the mechanisms and targets of cellular/ molecular toxicity.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Cellular, sub-cellular and molecular targets and mechanism of toxicity	2
2.	Concept of receptors and forces involved in binding of xenobiotics to receptors	3
3.	Quantitative aspects and theories of xenobiotic-receptor interactions	3
4.	Signal transduction mechanisms: transducers, effectors and second messengers	2
5.	Classification and structures of receptors – Receptor conformation and configuration – Iono-receptors	2
6.	G-protein coupled receptors	2
7.	Enzymatic receptors	2
8.	Steroid receptors	2
9.	Biophysics of toxicants	2
10.	Hepatic and extra-hepatic metabolism of xenobiotics	3
11.	Metabolic enzyme induction and inhibition	3
12.	Mechanism of bioactivation and cytotoxicity – Electrophilic metabolites, free radicals and reactive oxygen species	3
13.	Molecular mechanisms of target organ directed toxicity of xenobiotics- brain, hematopoietic system, GIT, liver, lungs, kidneys, reproductive system, skin, etc.	4
14.	Cellular dysfunctions and their consequences	2
15.	Repair and disrepair of toxic damage	2



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
16.	Xenobiotic induced mechanism of cell death – Necrosis and apoptosis	3
17.	Risk Assessment	2
18.	Mechanism involved in carcinogenesis, mutagenesis, teratogenesis	2
19.	Radiation toxicity	2
20.	Current topics/ Discussion of library assignments	2

I. Course Title : Clinical Toxicology

II. Course Code : VPT 609

III. Credit Hours : 2 + 1

IV. Aim of the course

To study the concepts of clinical toxicology.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Introduction, history, definition and scope of clinical toxicology	1
2.	Importance and processes of forensic toxicology	1
3.	Toxicological investigations	1
4.	Management and antidotal therapy of poisonings	1
5.	Toxicity of metals – Arsenic, lead, mercury, selenium, molybdenum, and other metals	3
6.	Toxicity of non-metals – Fluoride, nitrite/ nitrate, sodium chloride, phosphorus	3
7.	Toxicity of insecticides – Chlorinated hydrocarbons, organophosphates, carbamates, pyrethroids, and botanical and newer insecticides	3
8.	Toxicity of fumigants	1
9.	Toxicity of herbicides	2
10.	Toxicity of fungicides	1
11.	Toxicity of rodenticides	2
12.	Toxicity of fertilizers	2
13.	Toxicity of solvents and vapours	2
14.	Toxic plants – Plants causing cyanide poisoning, photosensitization, thiamine deficiency and oxalate poisoning	3
15.	Mycotoxins	2
16.	Venomous stings and bites – Snake, scorpion, spider, bees and wasps	2
17.	Toxicity of therapeutic agent	2
18.	GLP in toxicological evaluation	2
Practicals		
1.	Extraction, separation and detection of various poisons in suspected materials	3
2.	Use of blood and tissue biomarker enzymes in assessment of toxicity, viz., acetylcholinesterase, carboxylesterase, etc.	3
3.	Demonstration of poisoning and their antidotal treatment	3
4.	Evaluation of antioxidant profile of toxicosed animals	2
5.	Analysis of poisons in biological samples	2



S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
6.	Use of biomarkers in the assessment of toxicity	1
7.	Good laboratory practices evaluation	1
8.	Identification and collection of poisonous plants	1

I. Course Title : Ecotoxicology

II. Course Code : VPT 610

III. Credit Hours : 3 + 0

IV. Aim of the course

To impart knowledge regarding ecotoxicology for conservation of healthy eco-system.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
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Theory

1.	Introduction and basic principles of ecotoxicology	2
2.	Sources of environmental contamination	2
3.	Effects of pollutants on eco-health	2
4.	Fate of chemicals in the environment and target species	2
5.	General aspects of hazards associated with Air and water pollutants	2
6.	Radiation and its hazards	2
7.	Toxicity of pesticides in relation to environmental contamination	3
8.	Toxicity of metals related to agriculture	3
9.	Nanoparticle toxicology	2
10.	Ecological emergencies	2
11.	Residues of agrochemicals in food and ecosystem	2
12.	Marine and wildlife as monitors of environmental quality	2
13.	Bioaccumulation and biomagnifications of toxicants	1
14.	Forensic and regulatory toxicology as related to agrochemicals	3
15.	Hazards of toxicants in domestic and wild life	3
16.	Biomarkers of monitoring the impact of environmental pollutants	3
17.	Environmental hazard and risk identification from mixture of chemicals	2
18.	Contamination control measures	3
19.	Approaches to rehabilitating damaged ecosystems	3
20.	Ethical, moral, and professional issues in toxicology	2

I. Course Title : Regulatory Toxicology

II. Course Code : VPT 611

III. Credit Hours : 2 + 1

IV. Aim of the course

To study acts and regulations and risk assessment regarding use of drugs, chemicals and cosmetics.

**V. Lecture/ Practical schedule**

S. No.	Name of Topic	No. of Tentative Lectures/ Practicals
Theory		
1.	Introduction to toxicology; scope and industrial application	1
2.	Drug and development in modern industry	1
3.	Regulatory toxicology and pre-clinical pharmaceutical testing services-linkage	2
4.	Principles of Hazard Identification	1
5.	Different guidelines for safety assessments	1
6.	Methods of toxic dose estimation	2
7.	Risk assessment and post marking surveillance	2
8.	Procedure for acute, sub-acute and chronic toxicity study	3
9.	Toxicity test guidelines and different routes	2
10.	Guidelines for herbal safety risk assessment evaluation	1
11.	Working principle of FDA and Indian legislations	1
12.	Schedules of drugs and classification of industrial chemicals	1
13.	Approaches to hazard identification-carcinogenicity	2
14.	Modern concept tolerance: classification, evaluation	2
15.	Dose-response assessment LOEL, LOAEL and AOEL, NOEL, NOAEL, ADI, etc.	3
16.	Guidelines for registration of medicines	2
17.	Specific aspects of drug registration legislation abroad	1
18.	Central drugs standard control organization – CDSCO- India	2
19.	Concept of GLP India and abroad; Role of GLP in toxicological evaluation	2
Practical		
1.	Introduction to good laboratory practices in toxicology	2
2.	Screening procedures in regulatory toxicology	3
3.	Evaluation of acceptable daily intake	2
4.	Determination of No-observable effect level and NOAEL	2
5.	Determination of Low-observable effect level and LOAEL	2
6.	Determination of AOEL	2
7.	Mandatory toxicity testing protocols	2

Suggested Reading

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ANNEXURE I

List of BSMA Committee Members for Veterinary Para-Clinical Subjects

Name	Address	Specialization
Dr Placid E. D'Souza Former Dean and Retd. Professor-cum-Director CAFT in Veterinary Parasitology CVSc, Bengaluru Chairman	Department of Veterinary Parasitology, Veterinary College, KVAFSU, Regional campus Bengaluru -560024	Veterinary Parasitology
Dr K P Singh Principal Scientist-cum-Head Convener	Division of Veterinary Pathology Indian Veterinary Research Institute, Izatnagar, Bareilly-243 122 (UP)	Veterinary Pathology
Dr R K Asrani Professor	Department of Veterinary Pathology, Dr G C Negi College of Veterinary and Animal Sciences, CSK HPKV, Palampur-176 062 (HP)	Veterinary Pathology
Dr Veer Singh Professor and Head	Division of Veterinary Parasitology, Dantiwada Agricultural University, Gujarat-385 506	Veterinary Parasitology
Dr Rajesh Katoch Professor and Head	Division of Veterinary Parasitology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu-180 009	Veterinary Parasitology
Dr Sunil Maherchandani Professor	Department of Veterinary Microbiology, Rajasthan University of Veterinary and Animal Sciences, Bikaner-334 001	Veterinary Microbiology

Annexure



Name	Address	Specialization
Dr A K Tiwari Principal Scientist and Head	Division of Veterinary Microbiology, Indian Veterinary Research Institute, Izatnagar, Bareilly-243 122 (UP)	Veterinary Microbiology
Dr N K Mahajan Dean, PGS	Department of Veterinary Public Health and Epidemiology, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar-125 001	Veterinary Public Health
Dr S P Singh Retired Professor	Department of Veterinary Public Health and Epidemiology, G. B. Pant University of Agriculture and Technology, Pantnagar-263 145, Uttarakhand	Veterinary Public Health
Dr Vinod Kumar Professor and Head	Department of Veterinary Pharmacology, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar-125 001, Haryana	Veterinary Pharmacology
Dr V K Dhumka Professor and Head	Department of Veterinary Pharmacology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana-141 012, Punjab	Veterinary Pharmacology

Restructured and Revised
Syllabi of Post-graduate Programmes
Vol. 3

Animal Production Sciences

- Animal Genetics and Breeding
- Animal Nutrition
- Livestock Production and Management
- Livestock Products Technology
- Poultry Science

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Acknowledgements

At the outset, we, on behalf of all the Members of BSMA on Animal Production Sciences (BSMA-APS), would like to thank the Indian Council of Agricultural Research for nominating us to revise the syllabi.

The BSMA on Animal Production Sciences has been tasked with the revision of the existing ICAR syllabi in respect of five disciplines namely, Animal Genetics and Breeding, Animal Nutrition, Livestock Production and Management, Livestock Products Technology and Poultry Science.

The task of revising the existing syllabi for higher education is always a challenging one. However, this enormous task has been successfully completed thanks to the sincere efforts of all the Members of the BSMA-APS Committee. During this revision process, a total of four workshops were carried out at different parts of the country to facilitate greater participation of the faculty involved in the postgraduate teaching. We would, therefore, like to express my sincere gratitude to the Hon'ble Vice-Chancellors of Chhattisgarh Kamdhenu University (Durg), Assam Agricultural University (Guwahati), PV Narsimha Rao Telangana Veterinary University (Hyderabad) and SK University of Agricultural Sciences and Technology of Kashmir (Srinagar) for their kind consent to host the workshops. We are also thankful to the Deans of the respective colleges (College of Veterinary Sciences, Anjora, Durg; College of Veterinary Sciences, Khanapara, Guwahati; College of Veterinary Science, Rajendranagar, Hyderabad; College of Veterinary Science, Shuhama, Srinagar) alongside the Organizing Secretaries and the respective local faculty from the five disciplines for putting in a lot of efforts to make the workshops successful.

The present syllabus is the outcome of the collective efforts of many senior academicians with longstanding experiences in postgraduate teaching and research. The present syllabi development involved inputs received from more than 25 veterinary colleges/ agricultural universities besides the direct contribution of 64 Subject Matter Experts specially invited to the workshops for their direct contribution to the syllabus development process through collective interactions.

Ashok Kumar Pattanaik
Convener, BSMA-APS

Sita Prasad Tiwari
Chairman, BSMA-APS

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Animal Production Sciences

– Animal Genetics and Breeding

Preamble

(Animal Genetics and Breeding)

Livestock plays an important role in Indian economy. About 20.5 million people depend upon livestock for their livelihood. Livestock contribute 16% to the income of small farm households as against an average of 14% for all rural households. Livestock provides livelihood to two-third of rural community. It also provides employment to about 8.8 % of the population in India. India has vast livestock resources. Livestock sector contributes 4.11% GDP and 25.6% of total Agriculture GDP. The economy of farmer is greatly influenced by livestock keeping. The farmers in India maintain mixed farming system i.e. a combination of crop and livestock where the output of one enterprise becomes the input of another enterprise thereby realize the resource efficiency. The livestock serve the farmers in four different ways: income, employment, food and social security. So the conservation and development of indigenous livestock is the need of the hour. The study of the subject of Animal Genetics and Breeding and its application for conservation and improvement of livestock is very important.

Genetic improvement in domesticated animal populations that are used for agricultural production mainly involves selection of males and females that, when mated, are expected to produce progeny that perform better than the average of the current generation. Performance usually includes a combination of multiple characteristics, or traits, most of which are quantitative in nature. Animal breeding involves the selective breeding of livestock with the intention to improve desirable (and heritable) qualities in the next generation. This course introduces the steps required to design a program for breeding animals and teaches the genetic and statistical concepts that are needed to build a solid breeding program. By following this course the students can learn the key aspects of improving and increasing productivity and learn what it takes to create and maintain a healthy strong population. Students will learn how an animal breeder balances the need for improving the desirable qualities of the animals with the need for genetic diversity and long-term sustainability of the breeding program. Also students will learn about the scientific concepts in genetics that are applied in animal breeding, as well as how to apply the genetic models and computational methods that are used in animal breeding. Professionals working with animals will be able to use the knowledge from this course to understand the impact of breeding on animal populations and use genetic principles to make their decisions. This course will allow an advanced starting point for further studies, such as M.Sc. level courses in breeding.

Although animal breeding was practiced long before the science of genetics and the relevant disciplines of population and quantitative genetics were known, breeding programs have mainly relied on simply selecting and mating the best individuals on their own or relatives' performance. This is based on sound quantitative genetic principles, developed and expounded by Lush, who attributed much of his understanding to Wright, and formalized in Fisher's infinitesimal model. Analysis at the level of individual loci and gene frequency distributions has had relatively little impact. Now with access to genomic data, a revolution in which molecular information is being used to enhance response with "genomic selection" is occurring. The predictions of breeding value still utilize multiple loci throughout the

genome and, indeed, are largely compatible with additive and specifically infinitesimal model assumptions.

The main goal in animal breeding is to select individuals that have high breeding values for traits of interest as parents to produce the next generation and, to do so, as quickly as possible. To date, most programs rely on statistical analysis of large data bases with phenotypes on breeding populations by linear mixed model methodology to estimate breeding values on selected candidates. However, there is a long history of research on the use of genetic markers to identify quantitative trait loci and their use in marker-assisted selection but with limited implementation in practical breeding programs. The advent of high-density SNP genotyping, combined with novel statistical methods for the use of this data to estimate breeding values, has resulted in the recent extensive application of genomic or whole-genome selection in dairy cattle and research to implement genomic selection in other livestock species is underway. The high-density SNP data also provides opportunities to detect QTL and to uncover the genetic architecture of quantitative traits, in terms of the distribution of the size of genetic effects that contribute to trait differences in a population. Experimental results show that this genetic architecture differs among traits but that for most traits, over 50% of the genetic variation resides in genomic regions with small effects that are of the order of magnitude expected under a highly polygenic model of inheritance.

In indigenous livestock breed improvement program and conservation of indigenous livestock courses, different schemes like Rastriya Krishi Vikash Yojana (RKVY), Rastriya Gokul Mission (RGM) and National Programme for Bovine Breeding and Dairy Development (NPBBDD) launched by GoI under Ministry of Agriculture, Animal Husbandry, Dairying and Fisheries are included.

Addition of Courses

In M.V.Sc. degree programme, six new courses are proposed namely AGB-611 (Swine Breeding), AGB-612 (Pet Animal Breeding- dogs and cats), AGB-613 (Wild Animal Genetics and Breeding), AGB-614 (Equine Breeding), AGB-615 (Camel Breeding), AGB-616 (Yak and Mithun Breeding) and AGB-617 (Statistical Methods in Animal Breeding).

In Ph.D. degree programme, one new course is proposed namely AGB-707 (Statistical Software in Animal Breeding) based on inputs of stakeholders and contemporary requirement.

The course contents have been decided and modified as per suggestions of all the stakeholders during four workshops held at Durg, Guwahati, Hyderabad and Srinagar. Assuming the priority day-by-day, the areas which need to be strengthened in Animal Genetics and Breeding are: Molecular Techniques in Animal Breeding, Biometrical Techniques in Animal Breeding, Bio-informatics in Animal Genetics and Breeding, Breeding for different species having regional importance, viz., Swine, Camel, Equine, Yak and Mithun Breeding. Pet Animal Breeding is important in the sense that majority of people are fond of keeping pets where pedigreed dog and cats are the choice. Wild Animal Genetics and Breeding is an essential part for conservation of wild life now-a- days.

Deletion of Courses

In Ph.D., one course has been deleted namely AGB-707 (Utilization of non-additive genetic variance in farm animals) which appears to be redundant and/ or contents included elsewhere.



Changes of Name of Courses

Title of five courses in M.V.Sc. and five courses in Ph.D. have been modified as per the following Table:

Course Code	Old Title/ Existing	Modified Title
AGB 601	Animal Cytogenetics and Immunogenetics	Animal Cytogenetics and Immunogenetics I
AGB 602	Molecular Genetics in Animal Breeding	Molecular Genetics I
AGB 605	Biometrical Techniques in Animal Breeding	Biometrical Genetics I
AGB 608	Small Farm Animal Breeding (sheep, goat, swine and rabbit)	Sheep and Goat Breeding
AGB 610	Laboratory Animal Breeding	Laboratory Animal and Rabbit Breeding
AGB 701	Recent Advances in Animal Genetics	Molecular Genetics II
AGB 702	Recent Trends in Animal Breeding	Trends in Animal Breeding
AGB 703	Advances in Biometrical Genetics	Biometrical Genetics II
AGB 705	Bioinformatics in Animal Genetics and Breeding	Bioinformatics in Animal Breeding
AGB 706	Advances in Molecular Cytogenetics	Animal Cytogenetics and Immunogenetics II

Change of Credit Hours

For AGB 604 and AGB 605, credit hours have been reduced from 3+1 to 2+1. For AGB 610, credit hour has been increased from 1+0 to 2+0 to accommodate rabbit breeding components. For AGB 705, credit hour has been modified from 2+0 to 1+1 to accommodate practical classes.

For M.V.Sc. degree programme, out of the total of 20 credit hours from major, 15 credits hours have been decided as core (compulsory) courses and five credit hours from optional major courses. For Ph.D. degree programme, out of the total 12 credit hours 10 credit hours have been decided as core (compulsory) courses and two credits from optional major courses.

Course Title with Credit Load

M.V.Sc. in Animal Genetics and Breeding

Course Code	Course Title	Credit Hours
AGB 601*	Animal Cytogenetics and Immunogenetics I	2+1
AGB 602*	Molecular Genetics I	2+1
AGB 603*	Population and Quantitative Genetics	2+1
AGB 604*	Selection Method and Breeding System	2+1
AGB 605*	Biometrical Genetics I	2+1
AGB 606	Conservation of Animal Genetics Resources	2+0
AGB 607	Cattle and Buffalo Breeding	2+1
AGB 608	Sheep and Goat Breeding	2+0
AGB 609	Poultry Breeding	2+1
AGB 610*	Laboratory Animal and Rabbit Breeding	2+0
AGB 611	Swine Breeding	1+0
AGB 612	Pet Animal Breeding (Dogs and Cats)	1+0
AGB 613	Wild Animal Genetics and Breeding	1+0
AGB 614	Equine Breeding	1+0
AGB 615	Camel Breeding	1+0
AGB 616	Yak and Mithun Breeding	1+0
AGB 617	Statistical Methods in Animal Breeding	2+1
AGB 691	Seminar	1+0
AGB 699	Research	30

Course Contents

M.V.Sc. in Animal Genetics and Breeding

I. Course Title : Animal Cytogenetics and Immunogenetics I

II. Course Code : AGB 601

III. Credit Hours : 2+1

IV. Why this course?

To provide basic and advanced theoretical and practical training in animal cytogenetics and immunogenetics with an ulterior aim of enhancing animal production.

V. Aim of the course

This course is aimed to train students in identifying genetic/ chromosomal abnormalities and reviewing genetic mechanisms responsible for the generation of diversity in genes for immunoglobulin, TLR and MHC, etc., facilitating the better application of both classical and molecular cytogenetics and immunogenetics for animal improvement.

VI. Theory

Unit I (7 Lectures)

Physical and chemical basis of heredity; Development in animal cytogenetics and immunogenetics of farm animals; Inborn errors of metabolism and inherited disorders; immunoglobulin and their types; Antigen-antibody interactions; Immune response; ELISA.

Unit II (10 Lectures)

Chromatin structure of eukaryotes; Chromosome number and morphology in farm animals; Karyotyping and banding; Chromosomal abnormalities and genetic syndromes; DNA packing in chromosomes; Types of DNA; FISH chromosome painting and PRINS; SCH and RH panel mapping.

Unit III (10 Lectures)

Genetic variants in blood group systems of farm animals; Major histocompatibility complex: BoLA, BuLA; Genetics of biochemical variants and their applications; Immune response genes and concepts of disease resistance including major genes; Hybridoma and its significance; Concept of immunofertility; TLRs and interleukins.

Unit IV (3 Lectures)

Mutation and assays of mutagenesis; Sister chromatid exchanges.

VII. Practical (15 Classes)

Identification of Barr bodies; *In-vitro* and *in vivo* preparation of somatic metaphase chromosomes; Screening of chromosomal abnormalities; Microphotography and karyotyping; Banding procedures for comparing the chromosomal complement; FISH and PRINS; ELISA; Immunocompetence tests.

VIII. Teaching methods

Blackboard; PPT-animations; Hands-on practical training; application based practical

approach; Visit labs specialising in animal cytogenetics and immunogenetics; Research article discussion in the classroom.

IX. Learning outcome

Upon successful completion, the students will be able to understand the immune response (IR) and its role in disease resistance along with the role of allelic variations in IR genes in animal production in addition to the advances in the field of animal cytogenetics and immunogenetics.

X. Suggested Reading

- Gersen SL and Keagle MB. 2013. *The Principles of Clinical Cytogenetics*. Springer.
- Hare WCD and Singh EL. 1999. *Cytogenetics in Animal Reproduction*. CABI.
- Panayi GS and David CS. 1984. *Immunogenetics*. Elsevier.
- Roitt I. 1997. *Essential Immunology*. Blackwell.
- Summer AT and Chandley AC. 1993. *Chromosome Today*. Chapman and Hall.

I. Course Title : Molecular Genetics in Animal Breeding

II. Course Code : AGB 602

III. Credit Hours : 2+1

IV. Why this course?

To provide basic and advanced concepts of molecular genetics and their application to different species of animals

V. Aim of the course

This aim of this course is to study genes and their functions to understand their role in animal breeding and selection. Also aimed at the genetics of populations including quantitative genetics and its applications in animal breeding.

VI. Theory

Unit I (8 Lectures)

Basic concepts in molecular genetics; Concepts of proteomics and genomics; Genesis and importance of molecular techniques; Genome organization: physical and genetic map, current status of genome maps of livestock; Gene expression and control.

Unit II (8 Lectures)

Molecular markers and their applications; RFLP, RAPD, Microsatellite/ Minisatellite markers, SNP marker, DNA fingerprinting.

Unit III (7 Lectures)

DNA sequencing; Genome sequencing; Genomic Library; Polymerase Chain Reaction (PCR) and its types (PCR-RFLP, AS-PCR, etc.) and applications; Transgenesis and methods of gene transfer; Recombinant DNA technology and applications.

Unit IV (7 Lectures)

Analysis of molecular genetic data; Quantitative Trait Loci (QTL) mapping and its application in animal breeding; Genome scan, candidate gene approach.

VII. Practical (15 Classes)

Extraction and purification of genomic DNA; Gel electrophoresis; Restriction enzyme digestion of DNA and analysis; PCR-RFLP; PCR-SSCP; Bioinformatics tool for DNA sequence analysis; Isolation of RNA; cDNA synthesis; Statistical methods for analyzing molecular genetic data.



VIII. Teaching methods

Blackboard; PPT-animations; Web-courses (if available); Hands-on practical training; Application based practical skills; Visit labs specialising in molecular genetics critical discussion of articles in the area.

IX. Learning outcome

Upon successful completion, the students will have an understanding of how genes control biological functions from cellular activities to development, techniques used to manipulate gene functions in addition to genomics, proteomics and their applications in livestock improvement.

X. Suggested Reading

- Akano IE. 1992. *DNA Technology*. IAP Academic Press.
- Brown TA. 2006. *Genome 3*. Garland Science Publishers.
- Clark D and Pazdernik N. 2012. *Molecular Biology*, 2nd ed. Elsevier.
- Micklos DA, Fryer GA and Crotty DA. 2003. *DNA Science*. Cold Spring Harbor.
- Setlow JK. 2006. *Genetic Engineering – Principles and Methods*, Springer.

I. Course Title : Population and Quantitative Genetics

II. Course Code : AGB 603

III. Credit Hours : 2+1

IV. Why this course?

To study the genetic structure of the animal population and the importance of genetic variation and covariation among quantitative traits.

V. Aim of the course

To impart knowledge on the general structure of animal population and factors affecting it and estimation of genetic and phenotypic parameters of different quantitative traits.

VI. Theory

Unit I (15 Lectures)

Genetic structure of population; Hardy Weinberg Law; Idealized population; Factors affecting changes in gene and genotypic frequencies; Systematic processes; Approach to equilibrium under different situations: Single autosomal locus with two alleles, single sex-linked locus, two pairs of autosomal linked and unlinked loci; Linkage equilibrium and disequilibrium; Combined effect of all forces changing gene frequency.

Unit II (10 Lectures)

Dispersive process - small population: random genetic drift; Effective population size; Regular and irregular inbreeding systems; Founder effect and bottleneck; Effective number of founders and ancestors.

Unit III (10 Lectures)

Quantitative genetics: Gene effects, population mean, breeding value; Variance and its partitioning; Genotype-environment interaction and correlation; Resemblance between relatives.

Unit IV (10 Lectures)

Genetic and phenotypic parameters (heritability, repeatability, correlations): Methods of estimation, uses, possible biases, precision, optimal designs; Scale effects and threshold traits.

VII. Practical (15 Classes)

Estimation of gene and genotypic frequencies under different conditions; Estimation of inbreeding in regular and irregular systems; Estimation of effective population size; Computation of quantitative genetic effects; Estimation of variance components; Computation of heritability, repeatability, genetic, phenotypic and environmental correlations and their standard errors.

VIII. Teaching methods

Lectures; PPT-Presentations; MS-Excel for estimation of data.

IX. Learning outcome

Understanding the effect of gene and genotype frequencies on the genetic structure of populations, and estimation of genetic variation and covariation among different quantitative traits.

X. Suggested Reading

- Bulmer MG. 1980. *The Mathematical Theory of Quantitative Genetics*. Clarendon Press.
- Crow JF and Kimura M. 2009. *An Introduction to Population Genetics*. Harper and Row.
- Falconer DS and Mackay TFC. 1996. *An Introduction to Quantitative Genetics*. Longman.
- Jain JP. 1982. *Statistical Techniques in Quantitative Genetics*. Tata McGraw-Hill.
- Pirchner F. 1983. *Population Genetics in Animal Breeding*. Springer.

I. Course Title : Selection Method and Breeding System

II. Course Code : AGB 604

III. Credit Hours : 2+1

IV. Why this course?

To explain the methodology of selection and breeding systems for improvement of livestock and poultry.

V. Aim of the course

To study different methods of selection and factors affecting it, various mating systems and their use in animal genetics and the concepts of recent selection techniques.

VI. Theory

Unit I (6 Lectures)

Types of selection and their genetic consequences; Response to selection: Prediction and improvement.

Unit II (12 Lectures)

Theoretical aspects of accuracy and efficiency of selection bases; Prediction of breeding value using different criteria; Combined selection; Correlated response and efficiency of indirect selection.

Unit III (12 Lectures)

Selection for several traits; Different types of selection indices; Evaluation of short



term and long term selection experiments: bidirectional selection, asymmetry of response, selection limit.

Unit IV (15 Lectures)

Different mating systems: assortative mating, inbreeding, out-breeding; Genetic and phenotypic consequences and applications of various mating systems in animal improvement; Heterosis; Selection for general and specific combining abilities; Genetic polymorphism and its application in genetic improvement; Basic concepts of marker-assisted selection (MAS) and genomic selection.

VII. Practical (15 Classes)

Prediction of direct and correlated response; Computation of realized heritability and genetic correlation; Computation of selection index; Estimation of breeding values from different sources of information; Determining the accuracy of selection; Estimation of heterosis for different types of crosses; Estimation of GCA and SCA.

VIII. Teaching methods

Blackboard; PPT-animations; Hands-on practical training; application based practical approach; Visit labs specialising in animal cytogenetics and immunogenetics; Research article discussion in the classroom.

IX. Learning outcome

Good knowledge of the application of selection methods and mating systems in animal improvement, and application of selection for combining abilities.

X. Suggested Reading

- Falconer DS and Mackay TFC. 1996. *An Introduction to Quantitative Genetics*. Longman.
- Jain JP. 1982. *Statistical Techniques in Quantitative Genetics*. Tata McGraw-Hill.
- Tomar SS. 1996. *Text Book of Population Genetics*, vol. I. *Qualitative Inheritance*. Universal Publishers.
- Tomar SS. 2010. *Text Book of Animal Breeding*. Universal Publishers.
- Tomar SS. 2014. *Text Book of Population Genetics*, vol II. *Quantitative Inheritance*. Universal Publishers.

I. Course Title : Biometrical Genetics I

II. Course Code : AGB 605

III. Credit Hours : 2+1

IV. Why this course?

To educate about the various biometrical techniques for data analysis and their applications

V. Aim of the course

To impart knowledge about common diseases and disorders of poultry, diagnosis, vaccination, prevention, control and treatment.

VI. Theory

Unit I (8 Lectures)

Nature and structure of animal breeding data; Source of variation; Adjustment of data; Outliers and their removal; Basic concepts in statistical inference and experimental designs.

Unit II (7 Lectures)

Introduction to matrix algebra; Types of matrices and their operations; Determinants and their properties; Matrix inversion and its applications.

Unit III (15 Lectures)

Multiple regression and correlations; Fisher's discriminant function and its application; D^2 statistics in divergent analysis; Cluster analysis; Fixation index; Genetic distance estimation and phylogeny construction; Linear models and their types; Least-squares (LS) analysis; Generalized LS and weighted LS; BLUE, BLUP; Methods of estimation of variance components: ANOVA, ML, REML, MINQUE, MIVQUE; Bayesian approach.

Unit IV (15 Lectures)

Animal model; Reduced animal model; Sire model; Maternal grandsire model; Maternal effects model; Repeatability model; Random regression model; Threshold model; Multidimensional scaling (MDS) and principal component analysis (PCA); Database management and use of software in animal breeding.

VII. Practical (15 Classes)

Collection, compilation, coding and transformation of animal breeding data; Matrix applications, determinant and inverse of matrices; Building of models for various types of data; Least-squares analysis of data; Estimation of BLUE and BLUP solutions; Formation of numerator relationship, dominance and identical by descent matrix; Estimation of variance components.

VIII. Teaching methods

Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom.

IX. Learning outcome

Students will develop skills in analyzing breeding data using different biometrical techniques.

X. Suggested Reading

- Henderson CR. 1984. *Application of Linear Models in Animal Breeding*. University of Guelph Press.
- Mather K and Jinks JL. 1977. *Introduction to Biometrical Genetics*. Chapman and Hall.
- Searle SR. 2014. *Linear Models*. John Wiley and Sons.
- Singh RK and Chaudhary BD. 2012. *Biometrical Methods in Quantitative Genetic Analysis*. Kalyani Publishers.

I. Course Title : Conservation of Animal Genetics Resources

II. Course Code : AGB 606

III. Credit Hours : 2+0

IV. Why this course?

To study the concepts of conservation of animal genetic resources (AnGR)

V. Aim of the course

To impart knowledge on AnGR in India and their characterization, concepts and methods of conservation and national and international strategies for conservation of AnGR.



VI. Theory

Unit I (12 Lectures)

Domestic animal diversity in India: Origin, history and utilization; Present status and flow of AnGR and its contribution to livelihood security; Methodology for phenotypic and genotypic characterization of livestock and poultry breeds through systematic surveys; Management of breed; Physical, biochemical and performance traits and uniqueness of animals of a breed; Social, cultural and economic aspects of their owners/ communities rearing the breed.

Unit II (12 Lectures)

Methods for increasing effective population size of endangered breed/ species: Effective number of alleles, inbreeding effective size, variance effective size, minimum viable population size; Methodology for characterization of AnGR; nuDNA and mtDNA based diversity analysis and relationship among the breeds; Concept of conservation: *In-situ* and *ex-situ* (*in-vivo* and *in-vitro*); Models of conservation; Prioritization of breeds for conservation; Strategies for conservation of livestock and poultry genetics resources; Gene bank concept; Preservation of ecosystem.

Unit III (6 Lectures)

Status, opportunities and challenges in the conservation of AnGR; IPR issues on animal genetic resources/ animal products or by-products; Registration of livestock breeds and protection of livestock owner's rights in India; Breed societies and their role in conservation.

VII. Practical -

VIII. Teaching methods

Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom

IX. Learning outcome

Conservation strategies of AnGR, their characterization and methods of conservation to protect biodiversity

X. Suggested Reading

- Nivsarkar AE, Vij RK and Tantia MS. 2000. *Animal Genetic Resources of Indian Cattle and Buffaloes*. ICAR.
- Oldenbroek K. 2007. *Utilisation and Conservation of Farm Animal Genetic Resources*. WA Publishers.
- Sahai R and Vij RK. 1997. *Domestic Animal Diversity, Conservation and Sustainable Development*. SI Publishers.
- Van Vleck LD, Pollak E and Bltenacu EAB. 1987. *Genetics for Animal Sciences*. WH Freeman.

I. Course Title : Cattle and Buffalo Breeding

II. Course Code : AGB 607

III. Credit Hours : 2+1

IV. Why this course?

To educate the concept of cattle and buffalo breeding and improvement in dairy production

V. Aim of the course

To impart knowledge on different breeds of cattle and buffalo and their economic

traits, sire evaluation methods and breeding systems and different cattle and buffalo breeding programmes.

VI. Theory

Unit I (15 Lectures)

History of dairy cattle and buffalo breeding; Evolution of cattle and buffalo breeds and their characteristics; Population dynamics and production systems; Inheritance of important economic traits; Recording and handling of breeding data; Standardization of records; Computation of correction factors for the adjustment of the data; International Committee on Animal Recording (ICAR) and INAPH.

Unit II (12 Lectures)

Progeny testing under farm and field conditions; Evaluation of bulls by different models; Estimation of breeding values of the cows; Nucleus breeding system; Marker-assisted selection and genomic selection.

Unit III (12 Lectures)

Crossbreeding in cattle in India and abroad; Development of new breeds; Conservation of threatened breeds of cattle and buffaloes; Role of breed associations in dairy improvement; Breeding policy: national and state.

Unit IV (6 Lectures)

Import of exotic germplasm for breeding cattle in the tropics; Appraisal of buffalo and cattle breeding programme; Role of breed associations in dairy improvement.

VII. Practical (15 Classes)

Performance recording; Standardization of records; Estimation of economic traits; Computation of genetic parameters; Genetic gain; Sire evaluation methods; Estimation of heterosis; Culling and replacement.

VIII. Teaching methods

Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom

IX. Learning outcome

After completion of the course, the students get good knowledge of different breeds of cattle and buffalo and breeding programmes

X. Suggested Reading

- Chakravarty AK and Vohra V. 2011. *Sustainable Breeding in Cattle and Buffalo*. Satish Serial Publications.
- Lasley JF. 1972. *Genetics of Livestock Improvement*. IBH.
- Oldenbroek K and van der Waaij L. 2014. *Text book of Animal Breeding and Genetics*. Wageningen University and Research Centre (Free Online).
- Schmidt GM, Van Vleck LD and Hutjens MF. 1988. *Principles of Dairy Science*. WH Freeman.
- Van Vleck LD, Pollak EJ and Bltenacu EAB. 1987. *Genetics for Animal Sciences*. WH Freeman.

I. Course Title : Sheep and Goat Breeding

II. Course Code : AGB 608

III. Credit Hours : 2+0

IV. Why this course?

To educate about sheep and goat breeding concepts and development in small ruminants



V. Aim of the course

To impart knowledge on different breeds of sheep and goat and their economic traits, breeding systems and selection strategies, and different sheep and goat breeding policies.

VI. Theory

Unit I (8 Lectures)

Breeds; Economic traits; Population dynamics and production systems; Prolificacy; Breeding records and standardization; Computation of correction factors.

Unit II (12 Lectures)

Genetic parameters; Selection of males and female; Selection indices for sheep and goat; Breeding systems; Breeding strategies for improvement of production (meat, milk and wool) and reproduction (fertility and fecundity); Inbreeding and its effects on production traits; Group breeding schemes; Development of new breeds; Strategies for introgression of genes (fecundity and growth).

Unit III (10 Lectures)

Breeding policy; Sheep and goat improvement programme in India; Conservation of breeds; Culling and replacement; Equivalent Animal Death Rate (EADR).

VII. Teaching methods

Blackboard; PPT-presentations

VIII. Learning outcome

After completion of the course, the students get a good knowledge of different breeds of sheep and goat and their breeding policies

IX. Suggested Reading

- Jindal SK. 2013. *Goat Production and Health Management*. New India Publishers.
- Karim SA. 2010. *Climate Change and Stress Management: Sheep and Goat Production*. Satish Serial Publications.
- Mulugeta A. 2016. *Sheep and Goat Production Text Book*. Lambert Academic Publishers.
- Prasad J. 2018. *Goat, Sheep and Pig, Production and Management*. Kalyani Publishers.
- Ross CV. 1988. *Sheep Production and Management*. Prentice-Hall.

I. Course Title : Poultry Breeding

II. Course Code : AGB 609

III. Credit Hours : 2+1

IV. Why this course?

To educate about advances in poultry breeding practices

V. Aim of the course

To impart knowledge on different species of poultry and their economic traits, selection criteria and selection indices, and conservation of poultry genetic resources.

VI. Theory

Unit I (10 Lectures)

Origin and history of poultry species: Chicken, turkey, duck and quail; Poultry classes and breeds; Important qualitative traits in poultry including lethal; Economic traits of egg and meat-type chicken and their standardization; Different mating systems.

**Unit II (10 Lectures)**

Selection criteria and selection indices; Response to selection; Genetic controls; Genotype and environment interaction; Inbreeding and its effects on production traits in egg and meat-type chickens; Development of inbred lines and strains; Strain and line crosses; Introduction to diallel cross; Utilisation of heterosis and reciprocal effect; Recurrent selection, reciprocal recurrent selection and modified RRS; Specialized sire and dam lines; Genetic improvement programs in poultry; Selection strategies for the improvement of layers and broilers; Performance testing of commercial strains; Backyard poultry.

Unit III (4 Lectures)

Industrial breeding; Artificial insemination in chicken; Auto-sexing; Random Sample Test.

Unit IV (6 Lectures)

Biochemical variants and immunogenetics of poultry; Use of molecular genetics in poultry breeding; Quantitative trait loci; Marker-assisted selection and genomic selection; Conservation of poultry genetic resources.

VII. Practical (15 Classes)

Inheritance of qualitative traits; Economic traits of egg-type and meat-type chicken; Procedures of standardization; Estimations of heritability, the correlation between various production traits; Inbreeding co-efficient and heterosis; Selection of sires and dams; Osborne index; Restricted selection index; Collection and evaluation of semen and insemination; Estimation of GCA and SCA.

VIII. Teaching methods

Blackboard; PPT-presentations

IX. Learning outcome

Students get acquainted with different poultry species, applications of selection methodology and molecular genetics in poultry for higher productivity.

X. Suggested Reading

- Brereton G and Roadnight S. 2000. *21st Century Poultry Breeding*. Gold Cockerel Books.
- Crawford RD. 1990. *Poultry Breeding and Genetics*. Elsevier.
- Hutt FB. 2003. *Genetics of Fowl*. Norton Greek Press.
- Muir WM and Aggrey SE. 2003. *Poultry Genetics, Breeding and Biotechnology*. CABI.
- Singh RP and Kumar J. 1994. *Biometrical Methods in Poultry Breeding*. Kalyani Publishers.

I. Course Title : Laboratory Animal and Rabbit Breeding

II. Course Code : AGB 610

III. Credit Hours : 2+0

IV. Why this course?

To educate about laboratory animal breeding principles and commercial rabbit breeding.

V. Aim of the course

To impart knowledge on different laboratory animals and their importance, selection and mating methods, and commercial rabbit production and management.



VI. Theory

Unit I (6 Lectures)

Introduction to laboratory animal genetics; Breeding colonies of mice, rats, hamsters, guinea pigs and rabbits and their maintenance; Use of primates in animal research.

Unit II (4 Lectures)

Selection methods and mating systems: Monogamous, polygamous and others.

Unit III (12 Lectures)

Development of genetically controlled laboratory animals; Rules for nomenclature: Inbred strains, outbred stocks, mutant stocks, recombinant inbred strains, transgenic strains; Gene targeting and production of 'gene knock-out' animals; Production and use of specific pathogen-free animals; Guidelines and SOPs for the establishment of lab animal house; Genetic control and monitoring; Record-keeping; Ethics of laboratory animal research: FELASA, CPCSEA and IAEA regulations.

Unit IV (8 Lectures)

Rabbit production and management systems; Rabbit breeds for meat and wool; Economic traits and their inheritance; Breeding records and standardisation; Selection methods and breeding systems.

VII. Teaching methods

Blackboard; PPT-presentations

VIII. Learning outcome

Students get a view on breeding importance of laboratory animals and their applications in animal genetics. Additionally, knowledge of commercial rabbit production will also be developed

IX. Suggested Reading

- Hafez ESE. 1970. *Reproduction and Breeding Techniques for Laboratory Animals*. Philadelphia.
- Peter RC, Nephi MP, Steven DL and James IM. 1987. *Rabbit Production*, 6th ed. Vero Media Inc.
- Shinde AK, Swarnkar CP and Naqvi SMK. 2013. *Sheep and Rabbit Production and Utilization Technologies*. CSWRI Publications.
- Sirosis M. 2004. *Laboratory Animal Breeding: Principles and Procedures*. Elsevier.
- Tuffery AA. 1995. *Laboratory Animals: An Introduction for Animal Experimenters*. J Wiley and Sons.
- USDA. 2014. *A Complete Hand Book of Backyard and Commercial Rabbit Production*. Peace Corps (Free Online).
- Van Vleck LD, Pollak EJ and Bltenacu EAB. 1987. *Genetics for Animal Sciences*. WH Freeman.
- Weichbrod RH, Thompson GAH and Norton JN. 2018. *Management of Animal Care and Use Programs in Research, Education, and Testing*, 2nd ed. CRC Press.

I. Course Title : Swine Breeding

II. Course Code : AGB 611

III. Credit Hours : 1+0

IV. Why this course?

To educate about swine breeding principles and swine improvement programme in India

V. Aim of the course

To impart knowledge on different breeds of swine and their economic traits, breeding systems and selection methods, and breeding policies and conservation methods.

VI. Theory

Unit I (7 Lectures)

History and development of swine industry; Different breeds of pigs; Economic traits; Breeding records and standardization; Computation of correction factors; Culling and replacement; Equivalent Animal Death Rate (EADR).

Unit II (6 Lectures)

Genetic parameters; Bases and methods of selection; Selection of boars and sows; Breeding systems; Breeding strategies for improvement of indigenous and pure exotic breeds; Inbreeding and its effects on performance traits; Exploitation of heterosis; Development of synthetic varieties/ breeds.

Unit III (2 Lectures)

Swine breeding policy; National swine improvement programme; Conservation of breeds.

VII. Teaching methods

Blackboard: PPT-presentations: Research article discussion in the classroom

VIII. Learning outcome

Get acquainted with different breeds of swine, breeding methods and swine improvement programmes in India

IX. Suggested Reading

- ATARI. 2019. *Pig Farming: Promising Agri-business in Punjab*. ATARI-I Publication (Free Online).
- Board E. 2008. *Handbook of Pig Farming*, Engineers India Research Institute Publications.
- Das A, Tamuli AK, Mohan NH and Thomas R. 2013. *Handbook of Pig Husbandry*, Today and Tomorrow Printers.
- Das A, Tamuli, MK, Thomas R and Banik S. 2012. *Scientific Pig Production Practices*, NRC on Pig Publication.
- FAO. 2009. *Farmer's Hand Book on Pig Production*. FAO Publication.
- Oldenbroek K and van der Waaij L. 2014. *Text Book of Animal Breeding and Genetics*. Wageningen University and Research Centre (Free Online).

I. Course Title : Pet Animal Breeding (Dogs and Cats)

II. Course Code : AGB 612

III. Credit Hours : 1+0

IV. Why this course?

To educate about pet animal breeding principles which are contemporary in the defence establishment and affluent civic society

V. Aim of the course

To impart knowledge on different breeds of cats and dogs besides the principles of breeding management.



VI. Theory

Unit I (9 Lectures)

Breeds of dogs: Classification of breeds, important Indian and exotic breeds; Pedigree breeding and maintenance of breeding records; Kennel Club; Breed associations; Breeding management of dog.

Unit II (6 Lectures)

Breeds of cats: Classification of breeds, important Indian and exotic breeds; Pedigree breeding and maintenance of breeding records; Breeding management of cat.

VII. Teaching methods

Blackboard; PPT-animations; research article discussion in the classroom

VIII. Learning outcome

Different breeds of cats and dogs and their breeding management

IX. Suggested Reading

- Battaglia CL. 1990. *Dog Genetics: How to Breed Better Dogs*. TFH Publications.
- Harmer H. 1974. *Dogs and How to Breed Them*, 2nd ed. Gifford Publications.
- Hedberg K. 1992. *The Dog Owner's Manual on Selecting, Raising and Breeding Dogs*. Watermark Press.
- Moore AS. 1981. *Breeding Purebred Cats: A Guide for the Novice and Small Breeder*. Abraxes Publication.
- Robinson R. 1997. *Genetics of Cat Breeders*. Science Direct Publications.
- Vella CM and McGonagle JJ. 1997. *Breeding Pedigreed Cats*. Howell Book House.
- Vella C and Shelton L. 1999. *Genetics for Cat Breeders and Veterinarians*. Elsevier.
- Vine LL. 1977. *Breeding, Whelping and Natal Care of Dogs*. Acro Publication, NY.
- White K. 1980. *Dog Breeding: A Guide to Mating and Whelping*. Bartholomew Publications.

I. Course Title : Wild Animal Genetics and Breeding

II. Course Code : AGB 613

III. Credit Hours : 1+0

IV. Why this course?

To educate about wild animal breeding

V. Aim of the course

To impart knowledge on wildlife biodiversity in India, wild animal breeding in nature and captivity, and conservation of wild animals.

VI. Theory

Unit I (4 Lectures)

Wildlife biodiversity of India; Adaptation and natural selection; Species and speciation; Population dynamics; Variation; Loss of genetic variation; Hardy-Weinberg equilibrium.

Unit II (6 Lectures)

Inbreeding: Inbreeding depression, effective population size, demographic bottleneck; Genetic considerations in the translocation of wild animals; Wild animal breeding in nature and captivity; Captive breeding projects and principles; Concept of landscape genetics.

**Unit III (5 Lectures)**

Conservation of wild animals; Cryopreservation of semen and embryos of endangered species; Frozen zoo concept; Genetic markers; Application of molecular and cytogenetic techniques in wildlife breeding; Genetic defects in wild animals; Wildlife Protection Act.

VII. Teaching methods

Blackboard; PPT-animations; research article discussion in the classroom

VIII. Learning outcome

Breeding and conservation methods of wild animals

IX. Suggested Reading

- Devera GK, Katerina VT and Charlotte KB. 2012. *Wild Animals in Captivity: Principles and Techniques of Zoo Management*. University of Chicago Press.
- Kleiman DG, Allen ME, Thompson KV and Lumpkin S. 1997. *Wild Mammals in Captivity-Principles and Techniques*. Chicago Press.
- Linda JS. 2017. *A Field Guide of Tracking Mammals in North East*. Countryman Press.
- Nicholas FW. 1987. *Veterinary Genetics*. Oxford Science Publication.
- Parragon. 2006. *The Encyclopaedia of Wildlife*. Parragon Books Service Ltd.
- Ranjitsinh MK. 2017. *A Life with Wildlife: From Princely India to the Present*, Harper Collins Publications.
- Saha GK and Mazumdar S. 2017. *Wildlife Biology: An Indian Perspective*. PHI Learning Pvt Ltd.

I. Course Title : Equine Breeding

II. Course Code : AGB 614

III. Credit Hours : 1+0

IV. Why this course?

To educate about breeding practices in equines

V. Aim of the course

To impart knowledge on classification of light and work-horses, breeding management and selection strategies in equines, and biotechnology in equine breeding programmes requirements of poultry and factors influencing the same.

VI. Theory**Unit I (4 Lectures)**

Equine population in India; Domestic diversity, its origin, history and utilization; Breeds of native and exotic horses; Types and classes of light and work-horses.

Unit II (6 Lectures)

Cytogenetics of horses and donkeys; Breeding of horses and donkeys and production of mules; Foaling and care of foal; Important quantitative and qualitative traits and their inheritance; Recording and handling of breeding data; Standardization of records.

Unit III (5 Lectures)

Stallion and mare complementation; Judging criteria for elite animals; Conservation strategies; Selecting the mare and the stallion for breeding; Ongoing breed improvement programmes; Biotechnology in equine breeding programmes.



VII. Teaching methods

Blackboard; PPT-presentations

VIII. Learning outcome

Breeding and conservation methods of equines

IX. Suggested Reading

- McKinnon AO, Squires EL, Vaala WE and Varner DD. 2011. *Equine Reproduction*. Wiley Blackwell.
- Morel MCGD. 2008. *Equine Reproductive Physiology, Breeding and Stud Management*. CABI.
- Samper JC. 2008. *Equine Breeding Management and Artificial Insemination*. Science Direct Publications.

I. Course Title : Camel Breeding

II. Course Code : AGB 615

III. Credit Hours : 1+0

IV. Why this course?

To educate about camel breeding, an emerging economically important species of livestock

V. Aim of the course

To impart knowledge on breeding management of camels, breed improvement programmes, and application of molecular genetic methods in camel breeding.

VI. Theory

Unit I (7 Lectures)

Population dynamics and economic importance; Breeds of the camel; Production systems and herd structure; Inheritance of important economic traits; Recording and handling of breeding data; Standardization of records; Cytogenetics of the camel; Behaviour and breeding management.

Unit II (5 Lectures)

Judging criteria for elite animals; Selection of breeding stock; Breeding seasons; Methods for detection of heat; Natural service and artificial insemination; Breed improvement programmes.

Unit III (3 Lectures)

Conservation strategies; Immune status of camel; Molecular genetics in camel breeding.

VII. Teaching methods

Blackboard; PPT-presentations; Research article discussion in the classroom

VIII. Learning outcome

Breeding and conservation methods of camels

IX. Suggested Reading

- Dmitriez NG and Ernst LK. 1989. *Animal Genetic Resources of the USSR*. FAO.
- Wilson RT. 1984. *The Camel*. Longman.
- Selected Research Articles

- I. Course Title : Yak and Mithun Breeding**
II. Course Code : AGB 616
III. Credit Hours : 1+0

IV. Why this course?

To educate about Yak and Mithun breeding

V. Aim of the course

To impart knowledge on breeds/ types of Yak and Mithun, production systems in Yaks and Mithun, their behaviour and breeding management including conservation strategies and molecular genetics in Yak and Mithun breeding.

VI. Theory

Unit I (7 Lectures)

Population dynamics and economic importance; Breeds/ types of yak and mithun; Production systems; Inheritance of important economic traits; Recording and handling of breeding data; Standardization of records; Cytogenetics of yak and mithun; Behaviour and breeding management.

Unit II (5 Lectures)

Judging criteria for elite animals; Selection of breeding stock; Breeding seasons; Methods for detection of heat; Natural service and artificial insemination; Breed improvement. programmes

Unit III (3 Lectures)

Conservation strategies; Molecular genetics in yak and mithun breeding.

VII. Teaching methods

Blackboard; PPT-presentations; Research article discussion in classroom

VIII. Learning outcome

Breeding and conservation methods of yak and mithun

IX. Suggested Reading

- Das PJ, Deori S and Deb SM. 2017. *Arunachali Yak*. NRC on Yak, Dirang, India.
- Gupta SC, Gupta N and Nivsarkar AE. 1996. *Mithun - A Bovine of Indian Origin*.
- Nivsarkar AE, Gupta SC and Gupta N. 1997. *Yak Production*. ICAR Publication.
- Pal RN. 2003. *The Yak*, 2nd ed. FAO; RAP Publication.
- *Selected Research Articles*

- I. Course Title : Statistical Methods in Animal Breeding**
II. Course Code : AGB 617
III. Credit Hours : 2+1

IV. Why this course?

To educate about Statistical Methods in Animal breeding

V. Aim of the course

To impart knowledge on the transformation of data, sampling, standard error and importance, basics of statistical inferences, and analysis of variance.



VI. Theory

Unit I (12 Lectures)

Measures of central tendency; Measures of dispersion; Correlation and regression; Probability; Theory of distributions; Transformation of data; Sampling: Theory, need and properties; Estimators: Concept, standard error and importance.

Unit II (8 Lectures)

Basics of statistical inferences; Parametric tests: Z , t and F distribution; Non-parametric test: c^2 sign test, run test and rank test; Confidence interval.

Unit III (10 Lectures)

Analysis of variance: One and two way; Experimental designs: CRD, RBD and LSD; Missing plot techniques; Analysis of covariance.

VII. Practical (15 Classes)

Measures of central tendency; Measures of dispersion; Correlation and regression; Transformation of data; Probability; Z , t , F and c^2 tests; CRD, RBD and LSD; Analysis of covariance

VIII. Teaching methods

Blackboard; PPT-presentations

IX. Learning outcome

Application of statistical methods in animal breeding

X. Suggested Reading

- Gianola D and Hammond K. 1990. *Advances in Statistical Methods for Genetic Improvement of Livestock*. Springer.
- Gupta SC and Kapur VK. 2014. *Fundamentals of applied statistics*. Sultan Chand and Sons.
- Gupta SC. 2016. *Fundamentals of Statistics*. Himalaya Publishing House Pvt Ltd.
- Pillai SK and Sinha HC. 1968. *Statistical Methods for Biological Workers*. Ram Prasad and Sons.
- Snedecor GW and Cochran WG. 1989. *Statistical Methods*. Wiley India Publications.



Course Title with Credit Load

Ph.D. in Animal Genetics and Breeding

Course Code	Course Title	Credit Hours
AGB 701*	Molecular Genetics II	2+0
AGB 702*	Trends in Animal Breeding	2+0
AGB 703*	Biometrical Genetics II	2+1
AGB 704*	Advances in Selection Methodology	2+1
AGB 705	Bioinformatics in Animal Breeding	1+1
AGB 706	Animal Cytogenetics and Immunogenetics II	2+0
AGB 707	Statistical Software in Animal Breeding	1+1
AGB 791	Seminar I	1+0
AGB 792	Seminar II	1+0
AGB 799	Research	75

*Core courses

Course Contents

Ph.D. in Animal Genetics and Breeding

I. Course Title : Molecular Genetics II

II. Course Code : AGB 701

III. Credit Hours : 2+0

IV. Why this course?

To educate about the latest tools and techniques of animal genetics and their uses in animal sciences

V. Aim of the course

To impart knowledge on the eukaryotic genome, gene editing, gene knock-out and silencing, transgenic animals their benefits in livestock production, and genomic selection.

VI. Theory

Unit I (10 Lectures)

Eukaryotic genome: Gene families, pseudogenes, SnRNPs; Types of RNA including miRNA; Gene conversion; Tandem repeats; Minisatellites and microsatellites; Sequencing of EST.

Unit II (10 Lectures)

Transposable elements; Transcription and RNA processing; Translation; Regulation of gene expression; Differential expression analysis; Serial analysis of gene expression; Selective gene amplification; The proteasome and longevity of proteins; Gene editing; Gene targeting; Gene knock-out and silencing.

Unit III (10 Lectures)

Transgenic animals: Application, ethical issues; Gene therapy; Bio-pharming; Cloning; Genome imprinting; Epigenetic modification; Creation of SNP chips and microarray technology; Next-generation sequencing; Genomic selection.

VII. Teaching methods

Blackboard; PPT-animations; Research article discussion in classroom

VIII. Learning outcome

Epigenetic Modification and transgenic animal production

IX. Suggested Reading

- Brown TA. 2006. *Genome 3*. Garland Science Publishers
- Clark DP. 2012. *Molecular Biology*. Academic Cell
- Hugo van den Berg. 2015. *Cell Biology and Molecular Genetics*. IPO Publishers
- Pasternak JJ. 2005. *An Introduction to Human Molecular Genetics: Mechanisms of Inherited Diseases*. Wiley
- Puehler A and Timmis KN. 1984. *Advanced Molecular Genetics*. Springer
- Watson, JD, Tania AB, Bell SP, Gann A, Levine A and Losick R. 2017. *Molecular Biology of the Gene*. Pearson Education Publication

- I. Course Title : Trends in Animal Breeding**
II. Course Code : AGB 702
III. Credit Hours : 2+0

IV. Why this course?

To acquaint with recent trends in animal breeding and designing of need-based breeding strategies

V. Aim of the course

To impart knowledge on identification of novel traits and their role in breed improvement programme, development of mixed model equations, formulation of detailed breeding plans and advanced techniques in genetic manipulation for multiplication and improvement of livestock species.

VI. Theory

Unit I (12 Lectures)

Identification of novel traits and their role in breed improvement programme; Development of mixed model equations; Advancement in biometrical methods including artificial neural network and Bayesian approach; Detection of QTL; Ancestry informative markers for admixture analysis.

Unit II (10 Lectures)

Formulation of detailed breeding plans; Breeding for disease resistance and functional traits; Breeding for climate resilience; Inheritance of animal behavior traits; Breeding for animal welfare; Impact analysis of different breed improvement programme in various livestock species.

Unit III (8 Lectures)

Advanced techniques in genetic manipulation for multiplication and improvement of livestock species: Use of sexed semen, gene introgression, and cloning, etc.

VII. Teaching methods

Blackboard; PPTs; Research article discussion in the classroom

VIII. Learning outcome

Breeding for disease resistance and functional traits; Breeding for climate resilience

IX. Suggested Reading

- Brah GS. 2016. *Animal Breeding: Principles and Applications*. Kalyani Publishers.
- Lynch M and Walsh B. 1998. *Genetics and Analysis of Quantitative Traits*. Oxford University Press.
- Morde RA and Thompson R. 2014. *Linear Models for the Prediction of Animal Breeding Values*. CABL.
- Oldenbroek K and van der Waaij L. 2014. *Text book of Animal Breeding and Genetics*. Wageningen University and Research Centre (Free Online).
- Tomar SS. 2010. *Textbook of Animal Breeding*. Universal Publishers.
- Zeggini E and Morris A. 2010. *Analysis of Complex Disease Association Studies*. Academic Press.



I. Course Title : Biometrical Genetics II

II. Course Code : AGB 703

III. Credit Hours : 2+1

IV. Why this course?

To impart knowledge about recent advances in population genetic theory and application in animal breeding.

V. Aim of the course

To impart knowledge on multivariate analysis, QTL gene mapping, mating designs and other advanced biometrical techniques pertaining to animal breeding.

VI. Theory

Unit I (8 Lectures)

Multivariate analysis; Discriminant function; D^2 analysis; Principal component analysis; Path analysis.

Unit II (8 Lectures)

Mating designs: Basis, diallel, partial diallel, NCD-1, 2, 3 for reciprocal and maternal effects.

Unit III (5 Lectures)

Prediction of recombinant inbred lines using genetic parameters; Advances in genotype-environment interaction and selection indices.

Unit IV (9 Lectures)

QTL mapping; Analysis of SNP data for genomic selection; Advances in the estimation of variance component and prediction of breeding value: Threshold, dominance, random regression and survival models.

VII. Practical (15 Classes)

Discriminant function; D^2 analysis; Principal component analysis; Path analysis; Estimation of GCA and SCA through diallel, partial diallel, NCD-1, 2, 3; Advances in construction of selection indices; QTL mapping; Analysis of SNP data for genomic selection; Advances in estimation of variance components.

VIII. Teaching methods

Blackboard; PPTs; Research article discussion in the classroom

IX. Learning outcome

Students can analyze data on Animal Genetics using different Biometrical Techniques

X. Suggested Reading

- Choudhuri S. 2014. *Bioinformatics for Beginners*. Academic Press.
- Daniel S and Daniel G. 2012. *Likelihood, Bayesian, and MCMC Methods in Quantitative Genetics*. Springer.
- Kute N and Shinde G. 2016. *Principles of Biometrical Genetics*. Daya Publications.
- Marther K. 1997. *Biometrical Genetics*. Springer.
- Michael JK and Harpal SP. 1996. *The Genetical Analysis of Quantitative Traits*. Springer.
- Pawar IS and Singh S. 2010. *Theory and Application of Biometrical Genetics*. CBS Publications.
- Weller JI. 2016. *Genomic Selection in Animals*. John Wiley and Sons.
- Womack JE. 2012. *Bovine Genomics*. John Wiley and Sons.

- I. Course Title : Advances in Selection Methodology**
II. Course Code : AGB 704
III. Credit Hours : 2+1

IV. Why this course?

To educate about the latest advances in selection theory and their application in animal breeding

V. Aim of the course

To impart knowledge on design of selection experiments, information on single and multiple trait animal models, construction of various selection indices and their relationship with BLUP including the fundamentals of MAS and gBLUP.

VI. Theory

Unit I (8 Lectures)

Fundamental theorem of natural selection; Selection in finite populations; Effect on genetic structure and variance; Design of selection experiments for testing selection theory.

Unit II (6 Lectures)

Measurement of genetic and environmental trends; Advances in selection indices: Multistage, restricted and retrospective selection indices.

Unit III (6 Lectures)

Empirical evaluation of selection theory: genetic slippage, limits to the selection, asymmetry of response, selection experiments, the effect of selection on variance.

Unit IV (10 Lectures)

Selection for threshold traits; Selection under single and multiple trait animal models; Direct and correlated response through various selection indices; Relationship between BLUP and selection index; Selection using markers and entire genome; Methods for analysing GS data like RR-BLUP, Bayes-1, 2 and 3, etc.

VII. Practical (15 Classes)

Determination of culling levels and selection intensity; Estimation of direct and correlated response; Estimation of relative economic values; Construction of various selection indices; Prediction of breeding value using advance methods; QTL analysis using LDMS and LEMAS.

VIII. Teaching methods

Blackboard; PPT; Research article discussion in classroom

IX. Learning outcome

They will be acquainted with all the theoretical techniques of the advanced selection methodology

X. Suggested Reading

- Balakrishnan N, Nagaraja HN and Kannan N. 2007. *Advances in Ranking, Multiple Comparisons and Reliability*. Springer.
- Cameron ND. 1997. *Selection Indices and Prediction of Genetic Merit in Animal Breeding*. CABI.
- Daniel S and Daniel G. 2012. *Likelihood, Bayesian and MCMC Methods in Quantitative*



Genetics. Springer.

- Draper NR and Smith H. 1998. *Applied Regression Analysis*. J Wiley and Sons.
- Henderson CR. 1984. *Applications of Linear Models in Animal Breeding*. CABI.
- Legarra A, Lourenco DAL and Vitezica ZG. 2018. *Bases for Genomic Prediction*. INRA (Free Online).
- Morde RA and Thompson R. 2014. *Linear Models for the Prediction of Animal Breeding Values*, CABI.

I. Course Title : Bioinformatics in Animal Breeding

II. Course Code : AGB 705

III. Credit Hours : 1+1

IV. Why this course?

To educate about basic concepts of bioinformatics and their applications in animal breeding

V. Aim of the course

To impart knowledge on the concepts of bioinformatics, information resources for protein and genome databases, genetic characterization and selection using bioinformatic tools, and modern bioinformatic tools like GWAS.

VI. Theory

Unit I (4 Lectures)

Overview of bioinformatics; Database concepts; Algorithms; Information resources for protein and genome databases: GenBank, EMBL, SWISSPROT, PROSITE.

Unit II (5 Lectures)

Nucleotide and protein sequence analysis; Pair-wise and multiple sequence alignments; Phylogeny; Big SNP data analysis methods; Micro-array processing; Clustering; Software for secondary database search and analysis.

Unit III (6 Lectures)

Genetic characterization; Use of bioinformatics tools for identifying QTL and selection of elite germplasm; GWAS; Development of DNA chips; NGS data analysis.

VII. Practical (15 Classes)

Database development; Algorithms; Nucleotide and protein sequence analysis; Pair-wise and multiple sequence alignments; Phylogeny and dendrogram; Micro-array processing; Clustering; Secondary database search and analysis; Genetic characterization; Identification of QTL; GWAS; NGS data analysis.

VIII. Teaching methods

Blackboard; PPT-animations; Research article discussion in the classroom

IX. Learning outcome

Nucleotide and protein sequence analysis and phylogenetic analysis

X. Suggested Reading

- Attwood TK and Parry-Smith DJ. 2001. *Introduction to Bioinformatics*. Benjamin-Cummings Publishing Company.
- Bishop M. 1999. *Genetics Databases*. Elsevier.
- Jiang R, Zhang X and Zhang MQ. 2013. *Basics of Bioinformatics*. Springer.



- Luke A. 1997. *DNA Sequencing: From Experimental Methods to Bioinformatics*. BIOS Scientific Publishers.
- Ramsden J. 2009. *Bioinformatics: An Introduction*. Springer.
- Stekel D. 2003. *Microarray Bioinformatics*. Cambridge University Press.
- Wu CH and McLarty JW. 2000. *Neural Networks and Genome Informatics*. Elsevier Science.
- Xiong J. 2006. *Essential Bioinformatics*. Cambridge University Press.

I. Course Title : Animal Cytogenetics and Immunogenetics II

II. Course Code : AGB 706

III. Credit Hours : 1+1

IV. Why this course?

To educate about the advances in cytogenetics and their application in animal genetics and breeding

V. Aim of the course

To impart knowledge on somatic cell genetics, stem cell genetics, image analysis of advanced karyotyping techniques, and molecular cytogenetics and gene mapping techniques.

VI. Theory

Unit I (8 Lectures)

Structure of eukaryotic chromosomes; Evolution of karyotype; Various *in-vitro* cell culture techniques; Cell lines and utility; Genotoxicity

Unit II (10 Lectures)

Somatic cell genetics; Stem cell genetics; Molecular cytogenetics and gene mapping; Linkage mapping; ISH; FISH; Radiation hybrid mapping; Fibre-FISH; PRINS; Positional cloning; Spectral karyotyping

Unit III (12 Lectures)

Image analysis; Chromosome painting; Chromosome walking; Micro-dissection of chromosomes; Structure and functions of major histocompatibility complex; T Cell receptor; CD4; Interleukins; Toll-like receptors and their functions

VII. Teaching methods

Blackboard; PPT-animations; Research article discussion in the classroom

VIII. Learning outcome

Students get a good grip on different gene mapping techniques and image analysis

X. Suggested Reading

- Agarwal S and Naik S. 2008. *Fundamentals of Immunogenetics Principles and Practices*. IBD Publisher.
- Christiansen FT and Tait BD. 2012. *Immunogenetics: Methods and Applications in Clinical Practice*. Springer.
- Gersen SL and Keagle MB. 2013. *The Principles of Clinical Cytogenetics*. Springer.
- Litwin SD. 1989. *Human Immunogenetics*. CRC Press.
- Tyagi R. 2009. *Textbook of Cytogenetics*. Discovery Publishers.



- I. Course Title : Statistical Software in Animal Breeding**
II. Course Code : AGB 707
III. Credit Hours : 1+1

IV. Why this course?

To educate about the standard statistical software packages in animal breeding

V. Aim of the course

To impart knowledge on the use of software for computation of different statistical data

VI. Theory

Unit I (4 Lectures)

Data preparation and job control commands for statistical analysis of data; Introduction to statistical and standard software packages.

Unit II (6 Lectures)

Use of software for t-test, Chi-squares test, F-test, ANOVA (CRD, RBD and LSD), correlation and regression (simple, multiple, curvilinear, stepwise) and discriminant analysis.

Unit III (5 Lectures)

Graphic features of the software packages; Linear programming using appropriate software package; Least-squares analysis; Data mining techniques such as neural networks, genetic algorithms and fuzzy logic for predictive modelling.

VII. Practical (15 Classes)

Data preparation and generation; Import and export of data from spreadsheet and database packages; Use of software for t-test, Chi-squares test, F-test, ANOVA (CRD, RBD and LSD), correlation and regression (simple, multiple, curvilinear, stepwise) and discriminant analysis; Graphic features of the software packages; Use of software for linear programming problem; Least-squares analysis; Use of software for neural networks and fuzzy logic models for prediction.

VIII. Teaching methods

Blackboard; PPTs; Research article discussion in the classroom

IX. Learning outcome

Students get an idea on the availability of different statistical and standard software packages and their application in Animal Breeding.

X. Suggested Reading

- Balding DJ, Bishop M and Cannings C. 2001. *Handbook of Statistical Genetics*. J Wiley and Sons.
- Boldman K, Kriese LA, Van Vleck LD, Van Tassell CP and Kachman SD. 1995. *Manual for Use of MTDFREML*. ARS, USDA (Free online).
- Dempfle L. 1990. *Statistical Aspects of Design of Animal Breeding Programs*. Springer.
- Freund RJ, Mohr D and William WJ. 2010. *Statistical Methods*. Academic Press.
- Henderson CR. 1984. *Applications of Linear Models in Animal Breeding*. University Guelph Press.
- Isik F, Holland J and Maltecca C. 2017. *Genetic Data Analysis for Plant and Animal Breeding*. Springer.
- Lynch M and Walsh B. 1990. *Genetics and Analysis of Quantitative Traits*. Oxford.

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Animal Production Sciences

– Animal Nutrition

Preamble

(Animal Nutrition)

As is true for all branches of science, the science of nutrition has seen a lot of progress during the last decade or so in understanding underlying metabolic processes and the application. Accordingly, it has become imperative to update the course curricula of Animal Nutrition to make a student of Animal Nutrition conversant with the latest development in the field. Therefore, a concerted effort was made by the Committee to gather inputs from all concerned, including experts from academics and industry and incorporate the same after thorough deliberations. The followings are the aspects that were taken into consideration while revising the Animal Nutrition syllabi to make it up to date with the aim of making it knowledge-based while at the same time making it rewarding from a career point of view:

- Latest developments in the science of nutrition and food bioscience and integrating the newer concepts from human and laboratory animal nutrition into the curriculum of animal nutrition
- A particular focus was given to the use of molecular biology (nutrigenomics), which has become a key to understanding the outcome of various nutritional interventions in health and more so in diseases including the rumen metabolism.
- Because of the changing perspectives of livestock and environment, greater thrust on the role of feeding and nutrition on minimizing and/ or mitigating the (adverse) environmental impacts of rearing various classes of farm animals
- Sound feeding practices and evolving nutritional concepts for ensuring safe food production for consumers
- The potential use of nutrition (involving specific nutrients and emerging nutraceuticals) for promotion of health: both for preventive and prophylactic use of clinical nutrition for farm, companion and captive and zoo animals
- Greater focus on the industrial application of nutritional concepts in order to make the students more industry-ready. It also aimed to inculcate a sense of entrepreneurship among animal nutrition students.
- Continued focus on making better use of local and alternate feed resources strategically to make livestock production economic and rewarding while maintaining the sustainability for various classes of livestock farmers.

**Summary of Changes Made**

Course	Title	Remarks
M.V.Sc. Courses		
ANN 601	Energy and Protein Nutrition	Contents updated
ANN 602	Minerals and Vitamin Nutrition and Feed Additives	Contents updated
ANN 603	Feed and Fodder Technology	Merging of ANN 603 and ANN 604
ANN 604	Ruminant Nutrition	Contents updated
ANN 605	Non-Ruminant Nutrition	Contents updated
ANN 606	Companion Animal Nutrition	ANN 607 split into two courses (AAN 606 and ANN 607)
ANN 607	Nutrition of Laboratory, Wild and Zoo Animals	
ANN 608	Research Methodology in Animal Nutrition	Contents updated
ANN 609	Non-Conventional Feed Resources	Contents updated
ANN 610	Nutritional Biochemistry	New Course
ANN 611	Clinical Nutrition	New Course
ANN 612	Rumen Biotechnology	New Course
Ph.D. Courses		
ANN 701	Modern Concepts in Feeding of Ruminants	ANN 701 split into two courses (ANN 701 and ANN 702)
ANN 702	Forages in Animal Nutrition	
ANN 703	Modern Concepts in Feeding of Non-Ruminants	Contents updated
ANN 704	Emerging Concepts in Rumen Metabolism	Contents updated
ANN 705	Advances in Mineral and Vitamin Nutrition	Contents updated
ANN 706	Advanced Techniques in Nutritional Research	Contents updated
ANN 707	Recent Trends in Feed Technology	Contents updated
ANN 708	Clinical Nutrition of Farm and Pet Animals	Merging of two courses: ANN 707 and ANN 708
ANN 709	Toxicants and Antimetabolites in Animal Nutrition	Contents updated
ANN 710*	Nutrigenomics in Animal Nutrition	New Course
ANN 711	Equine Nutrition	New Course



Course Title with Credit Load M.V.Sc. in Animal Nutrition

Course Code	Course Title	Credit Hours
ANN 601*	Nutritional Biochemistry	1+0
ANN 602*	Energy and Protein Nutrition	2+0
ANN 603*	Minerals and Vitamin Nutrition and Feed Additives	2+1
ANN 604*	Feed and Fodder Technology	1+1
ANN 605*	Ruminant Nutrition	2+1
ANN 606*	Non-Ruminant Nutrition	2+1
ANN 607*	Research Methodology in Animal Nutrition	0+2
ANN 608	Companion Animal Nutrition	1+0
ANN 609	Nutrition of Laboratory, Wild and Zoo Animals	2+1
ANN 610	Non-Conventional Feed Resources	1+1
ANN 611	Introductory Clinical Nutrition	1+0
ANN 612	Rumen Biotechnology	1+0
ANN 691	Seminar	1+0
ANN 699	Research	30

Course Contents

M.V.Sc. in Animal Nutrition

- I. Course Title** : Nutritional Biochemistry
II. Course Code : ANN 601
III. Credit Hours : 1+0
IV. Why this course?

Biochemistry is the mother of all sciences. To understand the mechanism of nutrient metabolism a clear understanding of the various biochemical events is essential for a student specialising in animal nutrition.

V. Aim of the course

To help to develop the concepts of biochemical pathways involving nutrient metabolism.

VI. Theory

Unit I (12 Lectures)

Classification of carbohydrates and their functions. Digestion and metabolism of carbohydrate in ruminants and non-ruminants. Carbohydrate synthesis.

Unit II (8 Lectures)

Classification and properties of fats and their functions. Digestion and metabolism of fat in ruminants and non-ruminants. Fat synthesis

Unit III (12 Lectures)

Classification, structure, properties and function of proteins, amino acids and nucleic acids. Digestion and metabolism of proteins and other nitrogenous compounds in ruminants and non-ruminants. Protein synthesis. Control of metabolism

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Understanding of biochemical basis of nutrient metabolism.

IX. Suggested Reading

- Cheeke PR and Dierenfeld E. 2010. *Comparative Animal Nutrition and Metabolism*. CAB International.
- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- Leeson S and Summers JD. 2001. *Scott's Nutrition of The Chicken*, 4th ed. University Books.
- Maynard LA, Loosli JK, Hintz HF and Warner RG. 1987. *Animal Nutrition*. Tata McGraw-Hill.
- McDonal P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- Nelson DL and Cox MM. 2017. *Lehninger Principles of Biochemistry*, 7th ed. Macmillan Learning.



- I. Course Title** : **Energy and Protein Nutrition**
II. Course Code : **ANN 602**
III. Credit Hours : **2+0**

IV. Why this course?

Energy and protein constitute the major nutrients driving the maintenance and production in farm animals. A clear understanding of underlying concepts is key to the application of the same under practical feeding situation.

V. Aim of the course

To understand the metabolic pathways involved in energy and protein utilization including their requirements for various classes of animals for different physiological functions.

VI. Theory

Unit I (8 Lectures)

Measures of feed energy. Partitioning of feed energy. Energy balance, Fasting catabolism. Direct and indirect calorimetry. Efficiency of energy and protein utilization.

Unit II (12 Lectures)

Rumen degradable protein (RDP), and rumen undegradable protein (UDP) and fermentation kinetics. Protein turnover. Quantification of microbial protein synthesis. Protein quality determination in ruminants and monogastrics. Supplementary value of amino acids. NPN metabolism, urea fermentation potential and metabolizable protein. Amino acids imbalance, antagonism and toxicity.

Unit III (12 Lectures)

Feeding standards: comparative appraisal and limitations. Determination of energy and protein requirements. Nutrients metabolism with special reference to milk, meat and wool production. Energy and protein requirement for maintenance, growth, pregnancy and lactation in farm animals.

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Development of comprehensive knowledge of basic nutrition involving energy and protein.

IX. Suggested Reading

- Blaxter K. 1989. *Energy Metabolism in Animal and Man*. Cambridge University Press.
- Bondi A. 1987. *Animal Nutrition*. Wiley InterScience.
- Cheeke PR and Dierenfeld E. 2010. *Comparative Animal Nutrition and Metabolism*. CAB International.
- Crampton EW and Harris LE. 1969. *Applied Animal Nutrition*. WH Freeman.
- Dryden GM. 2008. *Animal Nutrition Science*, 1st ed. CAB International.
- Maynard LA, Loosli JK, Hintz HF and Warner RG. 1987. *Animal Nutrition*. Tata McGraw-Hill.
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.



- Pond WG, Church DB, Pond KR and Schoknecht PA. 2004. *Basic Animal Nutrition and Feeding*, 5th ed. Wiley.
- Singh UB. 1987. *Advanced Animal Nutrition for Developing Countries*. Indo-Vision.

I. Course Title : Minerals and Vitamin Nutrition and Feed Additives

II. Course Code : ANN 603

III. Credit Hours : 2+1

IV. Why this course?

Mineral and vitamins are key drivers of intermediary metabolism besides playing an important role in health and production

V. Aim of the course

To impart knowledge on sources, functions, analysis, signs of deficiency and signs of toxicity of various minerals and vitamins

VI. Theory

Unit I (12 Lectures)

General role of minerals, factors affecting mineral requirements. Macro-minerals and micro-minerals, their, distribution, metabolism, physiological functions, deficiencies and excesses, and sources and requirements. Probable essential minerals.

Unit II (6 Lectures)

Mineral interactions. Chelated minerals and concept of nano-minerals. Bioavailability studies in minerals. Impact of minerals on reproduction, fertility, and immunity. Soil-plant-animal-human relationship, development of area-specific minerals. Toxic minerals; their role in health and production of farm animals. Newly recognized trace minerals.

Unit III (10 Lectures)

Definition, history, classification, chemistry, functions, deficiencies and excesses, requirements and sources of water-soluble and fat-soluble vitamins. Role of vitamins in energy metabolism. Vitamin-mineral interrelationship. Vitamin toxicosis. Role of vitamins in reproduction, fertility and immunity.

Unit IV (4 Lectures)

Feed additives and nutraceuticals. Probiotics, prebiotics and synbiotics; eubiotics. Feed enzymes. Phytochemical feed additives; polyphenols and essential oils; organic acids and acidifiers.

VII. Practical (16 Classes)

General principles of mineral estimation. Sampling and processing techniques. Use of atomic absorption spectrometry and ICP in mineral estimation. Estimation of macro- and micro-minerals. Formulation of mineral mixture for various species. Estimation of some important vitamins (vitamin A, E and C). Purified diets for mineral and vitamin studies. Calculation of mineral and vitamin requirements.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions



- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

- Comprehensive knowledge about mineral and vitamin metabolism and their requirements for farm animals
- Capacity for estimation of various minerals and vitamins using advanced analytical techniques

X. Suggested Reading

- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- McDowell RL. 1989. *Vitamins in Animal Nutrition*. Academic Press.
- McDowell RL. 2003. *Minerals in Animal and Human Nutrition*, 2nd ed. Elsevier Science.
- Suttle NF. 2010. *Mineral Nutrition of Livestock*, 4th ed. CAB International.

I. Course Title : Feed and Fodder Technology

II. Course Code : ANN 604

III. Credit Hours : 1+1

IV. Why this course?

Processing of feed and fodder are important means to augment the utilization for efficient animal production.

V. Aim of the course

To understand various technological options available for processing of classes of food, feeds and fodders and their potential application in feeding management of farm animals.

VI. Theory

Unit I (4 Lectures)

Various feed mill equipment and their handling; layout and operations in feed mill (small, medium and large feed plants); automated feed mill: merits and demerits. Procurement of feed ingredients: specification and guidelines. Quality control of feed ingredients and finished feeds. BIS standard.

Unit II (4 Lectures)

Principles and process of material handling, weighing, grinding, mixing, pelleting, packaging and other major processing operations. Crumbling, flaking, popping and extrusion. Premixes. Codex Alimentarius, HACCP.

Unit III (4 Lectures)

Feed and fodder processing and preservation techniques. Densification, chemical and biological treatment of feeds/ fodders. Fodder conservation through hay and silages; Microbiological evaluation of processed and preserved feeds; Effect of preservation on the nutritional value of feed.

Unit IV (4 Lectures)

Feed storage and godown management; goods sanitation and hygiene of go-down. Traditional and modern farm-level storage structures. Factors affecting feedstuffs during storage. Liquid feed ingredients. Storage losses; insect pests and rodents control measures; Mycotoxins in feedstuffs and its control measures.

VII. Practical (16 Classes)

Quality control and inspection of feed materials. Qualitative tests for adulterants urea, urease, thiram. Identification of insect pests and fungi in stored products. Feed microscopy. Formulation and preparation premixes. Quality evaluation of silage and hay, Laboratory preparation of silage. Visit to feed plant: Hands-on training on preparation of feed and mineral mixture. Preparation of project report on plant layout and design, problems related to feasibility, record-keeping in different sections of a feed mill.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

Practical understanding and application of feed processing technologies

X. Suggested Reading

- Dryden G. 2008. *Animal Nutrition Science*. CAB International.
- Kundu SS, Mahanta SK, Singh S and Pathak PS. 2016. *Animal Feed Technology*. Satish Publishers
- Perry TW, Cullison AE and Lowrey RS. 2003. *Feeds and Feeding*, 6th ed. Pearson.
- Pond WG, Church DB, Pond KR and Schoknecht PA. 2004. *Basic Animal Nutrition and Feeding*, 5th ed. Wiley.
- Schofield EK (Ed.). 2005. *Feed Manufacturing Technology V*. American Feed Industry Association, Arlington.

I. Course Title : Ruminant Nutrition

II. Course Code : ANN 605

III. Credit Hours : 2+1

IV. Why this course?

Ruminants possess unique digestive capabilities involving rumen microbes that utilize diverse feed resources which are otherwise not fit for monogastric animals.

V. Aim of the course

To develop an understanding of the rumen metabolism and its manipulation for improving nutrient utilization for enhancing ruminant production.

VI. Theory

Unit I (6 Lectures)

Functional anatomy of the digestive system of ruminants. Introduction to rumen microflora and fauna. Development of rumen. Feeds and fodders for ruminant feeding.

Unit II (12 Lectures)

Water requirements. Nutrient requirements and feeding of calves, heifers, dry, pregnant and lactating cows, buffaloes, sheep and goat. Peculiarities of digestive physiology, nutrition and feeding management of camels.

**Unit III (6 Lectures)**

Voluntary feed intake. Determination of digestibility, factors affecting digestibility. Manipulation of rumen fermentation.

Unit IV (12 Lectures)

Concept of complete feed and total mixed ration. Precision feeding. Phase feeding. Limiting nutrients and strategic feeding of high yielding ruminants. Concept of by-pass nutrients and their impact on production, reproduction and immune status.

Unit V (12 Lectures)

Nutritional approaches for increasing the functional properties of milk: role of CLA, omega fatty acids. Different systems of feeding buffalo for beef production. Feeding during stress and natural calamities. Feeding management of migratory/nomadic small ruminants.

VII. Practical (16 Classes)

Design and planning of feeding experiments. Identification of feed and fodder based on its composition. Ration formulation for large and small ruminants for different physiological stages. Estimation of digestibility and nutritive value of feeds and fodders by metabolism trial in dairy cattle. Determination of nutritive value of pastures by the use of range techniques. Collection and processing of rumen liquor. Estimation of rumen metabolic profile (pH, ammonia, lactate, and TVFA, etc.). Estimation of purine derivatives.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

In-depth knowledge of feeding ruminants in light of their metabolic peculiarities. Feed evaluation based on an assessment of various rumen functions

X. Suggested Reading

- Church DC. 1988. *The Ruminant Animal: Digestive Physiology and Nutrition*, 2nd ed. Prentice-Hall.
- Dehority BA. 2003. *Rumen Microbiology*. Nottingham University Press.
- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- Givens D, Axford R and Owen E. (Ed.). 2000. *Forage Evaluation in Ruminant Nutrition*. CAB International.
- Hynd PI. 2019. *Animal Nutrition: From Theory to Practice*. CAB International.
- McDowell RL. 2012. *Nutrition of Grazing Ruminants in Warm Climates*. Academic Press.
- Moran J. 2005. *Tropical Dairy Farming: Feeding Management for Small Holder Dairy Farmers in the Humid Tropics*. Landlinks Press
- NRC. 2001. *Nutrient Requirements of Dairy Cattle*, 7th rev. ed. National Research Council. National Academies Press.
- NRC. 2016. *Nutrient Requirements of Beef Cattle*, 8th rev. ed. National Academies of Sciences, Engineering, and Medicine. National Academies Press.
- NRC. 2007. *Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids*. National Research Council. National Academy Press.
- Pond WG, Church DB, Pond KR and Schoknecht PA. 2004. *Basic Animal Nutrition and Feeding*, 5th ed. Wiley.
- Shirley RL. 2012. *Nitrogen and Energy Nutrition of Ruminants*. Academic Press. 10.
- Van Soest PJ. 1994. *Nutritional Ecology of the Ruminant*. Cornell University Press.



- I. Course Title : Non-Ruminant Nutrition**
II. Course Code : ANN 606
III. Credit Hours : 2+1

IV. Why this course?

The nutritional attributes of non-ruminants differ among various species as well as their characteristic digestive physiology.

V. Aim of the course

To impart knowledge on the nutrient metabolism of various classes of monogastric animals involving poultry, swine, equines and rabbits under different physiological stages.

VI. Theory

Unit I (20 Lectures)

Feeding of poultry for meat and egg production. Ideal protein concept. Standard ileal digestible amino acids. Nutrient requirements for broilers and layers. Feeding of breeder hens; nutritional factors affecting hatchability. Feeding systems for poultry. Feed additives for poultry. Nutritional approaches for designer egg and meat production. Nutritional disorders in poultry and the role of nutrition in diseases prevention. Water intake and quality in poultry production.

Unit II (16 Lectures)

Nutrition and feeding of swine in different stages of growth and production. Nutritional factors affecting the quality of the products: lean meat production. Water intake and quality in pig production.

Unit III (12 Lectures)

Feeding of equines. Feeding of rabbits. Hindgut fermentation and its importance. Nutrient requirements of equines. Special features of equine feeding management. Nutritional management of colic and other health disorders. Nutrient requirements of rabbits for wool and meat production. Nutrition-related disorders in rabbits.

VII. Practical (16 Classes)

Design and planning for poultry and swine feeding experiments. Calculation of nutrient requirements for broilers and layers. Formulation and compounding of general and least-cost rations, determination of the nutritive value of poultry and swine feeds by balance experiments. Formulation of rations for horses and rabbits. Visit poultry and piggery units, feed and fodder stores. Calculation of different measures of protein quality.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

Knowledge of practical feeding management of various classes of non-ruminant species.



X. Suggested Reading

- Adamo G and Costanza A (Eds.). *Rabbits Biology, Diet and Eating Habits and Disorders*. Nova Biomedical.
- Cheeke PR. 1987. *Rabbit Feeding and Nutrition*. Academic Press, Inc.
- Chiba LI (Ed.). 2012. *Sustainable Swine Nutrition*. Wiley-Blackwell.
- de Blas C and Wiseman J. (Eds.). 2010. *Nutrition of the Rabbit*, 2nd ed. CAB International.
- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- Frape D. 2010. *Equine Nutrition and Feeding*, 4th ed. Wiley-Blackwell.
- Hynd PI. 2019. *Animal Nutrition: From Theory to Practice*. CAB International.
- Leeson S and Summers JD. 2009. *Commercial Poultry Nutrition*, 3rd ed. Nottingham University Press.
- Leeson S and Summers JD. 2019. *Scott's Nutrition of The Chicken*, 4th ed. CBS Publishers and Distributors.
- NRC. 2007. *Nutrient Requirements of Horses*, 6th Rev. ed. National Research Council. National Academy Press.
- NRC. 1994. *Nutrient Requirements of Poultry*, 9th Rev. ed. National Research Council. National Academy Press.
- NRC. 2012. *Nutrient Requirements of Swine*, 11th Rev. ed. National Research Council. National Academy Press.
- Varga M. 2013. *Textbook of Rabbit Medicine*, 2nd ed. Butterworth-Heinemann.

I. Course Title : Research Methodology in Animal Nutrition

II. Course Code : ANN 607

III. Credit Hours : 0+2

IV. Why this course?

Nutritional evaluation involving feed analysis and nutrient metabolism is vital in the interpretation of the outcomes of nutritional studies.

V. Aim of the course

Preparedness in part of the students to understand the basics of various analytical techniques and their application in nutritional research.

VI. Practical

Unit I (6 Classes)

Principles of animal experimentation. Common statistical tools for nutritional research.

Unit II (20 Classes)

Preparation of standard solutions. Proximate analysis of feeds and fodders. Cell-wall partitioning using Van Soest methods. Markers in digestibility determination. *In-vitro* / *in sacco* determination of digestibility and digestion kinetics. Determination of energy content of feed, faeces and urine using bomb calorimeter. Determination of blood metabolic profile. Unit III (6 Classes) Introduction and principles of GC, HPLC, AAS, ICP, tracer technique, flame photometer, NIR, SF₆, rumen-simulation technique, and amino acid analyzer.

VII. Teaching methods/ activities

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on training of laboratory techniques

VIII. Learning outcome

Capacity building of the students to undertake animal nutrition research.

IX. Suggested Reading

- Bate ST and Clark RA. 2014. *The Design and Statistical Analysis of Animal Experiments*. Cambridge University Press.
- Hofmann A and Clokie S (Eds.). *Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology*, 8th ed. Cambridge University Press.
- Maynard LA, Loosli JK, Hintz HF and Warner RG. 1987. *Animal Nutrition*. Tata McGraw-Hill.
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- Pounis G. 2018. *Analysis in Nutrition Research*. Academic Press.

I. Course Title : Companion Animal Nutrition

II. Course Code : ANN 608

III. Credit Hours : 1+0

IV. Why this course?

The philosophy of companion animal nutrition is altogether different from that of the farm animals.

V. Aim of the course

To impart knowledge in the fundamental and applied aspects of the nutrient metabolism for ensuring health and wellbeing of companion animals.

VI. Theory

Unit I (4 Lectures)

Philosophy of companion animal nutrition. Digestion and absorption of nutrients in dogs and cats. Nutrient requirements for dogs and cats during different life stages: energy, protein, fat, minerals and vitamins. Critical nutrients for cats.

Unit II (4 Lectures)

Common feed ingredients and supplements for pets. Homemade diets. Commercial pet foods: types and nutritional profile. Processing techniques in pet food manufacturing. Pet food evaluation and quality control.

Unit III (4 Lectures)

Feeding management for dogs and cats of different age groups, viz., pregnancy, lactation, neonatal puppies and kitten, growth, adult maintenance, stress and geriatrics including feeding behaviour. Water requirements.

Unit IV (4 Lectures)

Deficiencies and excesses of nutrients. Nutritionally responsive disorders: inherited disorders of nutrient metabolism, diabetes mellitus, obesity, urinary tract health and kidney diseases. Parenteral nutrition for hospitalized pets.

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments



VIII. Learning outcome

Understanding of the nutritional concepts for feeding management of companion animals.

IX. Suggested Reading

- Buffington C, Holloway C, Abood S. 2004. *Manual of Veterinary Dietetics*. Elsevier.
- Case LP, Daristotle L, Hayek MG, Raasch MF. 2010. *Canine and Feline Nutrition: A Resource for Companion Animal Professionals*, 3rd ed. Elsevier.
- Case LP. 2005. *The Dog: Its Behavior, Nutrition, and Health*, 2nd ed. Blackwell Publishing.
- McNamara JP. 2013. *Principles of Companion Animal Nutrition*, 2nd ed. Pearson.
- NRC. 2006. *Nutrient Requirements of Dogs and Cats*. National Research Council. National Academy Press.

I. Course Title : Nutrition of Laboratory, Wild and Zoo Animals

II. Course Code : ANN 609

III. Credit Hours : 2+1

IV. Why this course?

The nutrition of laboratory animals is important to ensure their health performance making them ready for use in biomedical research. On the contrary, wild and zoo animals as a part of the ecosystem call for an entirely different approach in terms of their nutritional management.

V. Aim of the course

To understand the mechanism involved in the nutrient metabolism in laboratory and wild animals and their diverse applications for effective health management and wellness.

VI. Theory

Unit I (12 Lectures)

Digestive structure and functions of laboratory animals: rats, mice, and guinea pigs. Nutritional requirements of various species of laboratory animals. Feeding of laboratory animals. Concept of purified diets in laboratory animals. Nutrition of non-human primates.

Unit II (10 Lectures)

Natural dietary habits of zoo animals. Feeding schedules of various classes captive and zoo animals and birds. Feeding orphan and neonates. Role of nutrition in the management of health disorders in zoo animals. Feeding of sick and old animals: parenteral nutrition.

Unit III (10 Lectures)

Feeding habits, and behaviour of wild animals. General aspects of digestive physiology of herbivores and carnivores. Nutrition of semi-wild animals like mithun and yak. Nutritive characteristics of forages for wild animals. Adequacy of forage plants for wild and zoo animals.

VII. Practical (16 Classes)

Formulation and preparation of hygienic, balanced diets and feeding of laboratory animals. Characteristics of ration formulation and feeding schedules wild and zoo animals. Visit zoological parks and wildlife sanctuary, and collection of information on the feeding schedule of different categories of captive animals.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

Understanding of nutritional management of the laboratory, wild and zoo animals

X. Suggested Reading

- Barboza PS, Parker KL and Hume ID. 2008. *Integrative Wildlife Nutrition*. Springer.
- Clemons DJ and Seeman JL. 2011. *The Laboratory Guinea Pig*, 2nd ed. CRC Press/ Taylor and Francis.
- Gordon IJ and Prins HHT. 2008. *The Ecology of Browsing and Grazing*. Springer.
- Lane-Patter W and Pearson AEG. 1971. *The Laboratory Animal: Principles and Practice*, 2nd ed. Academic Press.
- NRC. 1995. *Nutrient Requirements of Laboratory Animals*, 4th rev. ed. National Research Council. National Academy Press.
- NRC. 2003. *Nutrient Requirements of Nonhuman Primates*. National Research Council. National Academy Press.
- NRC. 2011. *Guide for the Care and Use of Laboratory Animals*, 8th ed. National Research Council. National Academy Press.
- Pond WG, Church DB, Pond KR and Schoknecht PA. 2004. *Basic Animal Nutrition and Feeding*, 5th ed. Wiley.
- Robbins C. 1993. *Wildlife Feeding and Nutrition*, 2nd ed. Elsevier.
- Weichbrod RH, Thompson GAH and Norton JN (Eds.). 2018. *Management of Animal Care and Use Programs in Research, Education, and Testing*, 2nd ed. CRC Press/ Taylor and Francis.

I. Course Title : Non-Conventional Feed Resources

II. Course Code : ANN 610

III. Credit Hours : 1+1

IV. Why this course?

Exploration of alternative feed resources for farm animals is a continuous process considering the scarcity of quality feeds and fodders for efficient livestock production.

V. Aim of the course

To build-up concepts involving the availability and potential use of various classes of non-conventional feed resources including ameliorative measures to ensure feed and food safety.

VI. Theory

Unit I (8 Lectures)

Present and future feed requirements and current availability for livestock and poultry. Use of non-conventional feeds; By-products of agricultural, industrial, food processing units and forest by-products. Slaughterhouse by-products, aquatic weeds. Permissible levels of inclusion of various non-conventional feeds in the ration of different kinds of livestock. Formulation of economical rations using the non-conventional feed.

**Unit II (5 Lectures)**

Classification of toxic principles in animal feedstuffs. Chemico-physical properties of various anti-nutritional factors (ANFs). Rumen microbial adaptation to various ANFs. Effect of anti-nutritional factors on health and production indifferent species of livestock.

Unit III (3 Lectures)

Detoxification of toxin principles by various physical, chemical and biological techniques. Insecticide and pesticide residues, heavy metals residues in feeds and fodders.

VII. Practical (16 Classes)

Qualitative methods for the presence/ detection of ANFs in feedstuffs. Estimation of mycotoxins in various feeds and fodders. Estimation nitrates, HCN, oxalates, protease inhibitors, tannins, saponins, gossypol, mimosine and heavy metals.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

Comprehensive knowledge on the integration of alternative feed resources in practical farm animal production.

X. Suggested Reading

- Devendra C. 1985. *Non-conventional Feed Resources in Asia and the Pacific*, 2nd ed. APHCA, FAO.
- FAO. 1995. *Tropical Feeds and Feeding Systems*. Proceedings of the First FAO Electronic Conference. Food and Agriculture Organization of the United Nations, Rome.
- FAO. 2004. *Assessing Quality and Safety of Animal Feeds*. Food and Agriculture Organization of the United Nations, Rome.
- Liner IE. 1980. *Toxic Constituents of Animal Food Stuffs*, 2nd ed. Academic Press.
- Singh UB. 1987. *Advanced Animal Nutrition for Developing Countries*. Indo-Vision.
- Speedy A and Sansoucy R. 1991. *Feeding Dairy Cows in the Tropics*. Food and Agriculture Organization of the United Nations, Rome.
- *Select articles from journals*

I. Course Title : Introductory Clinical Nutrition

II. Course Code : ANN 611

III. Credit Hours : 1+0

IV. Why this course?

Nutrition forms the basis of health and therefore could be strategically used for prevention and/ or therapeutic management of various diseases.

V. Aim of the course

To understand the role of nutrients in the development of various disease processes To elucidate the potential of various nutrients and nutraceuticals in amelioration and management of disease of diverse nature.

VI. Theory

Unit I (8 Lectures)

Metabolic disorders and peri-parturient diseases: milk fever, ketosis, downer cow syndrome, retained placenta, sub-acute ruminal acidosis, laminitis, abomasal displacement, mastitis. Nutrient parasite interaction. Enterotoxaemia

Unit II (8 Lectures)

Nutritional amelioration of biotic and abiotic stress: heat and cold stress, transportation stress. Potential plant toxicity to grazing animals. Toxicity of grazing animals: signs of poisoning. Nitrite poisoning, toxic effects of goitrogens, glucosinolates. Nutritional management of reproductive disorders.

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Understanding of nutritional management of health disorders.

IX. Suggested Reading

- Constable P, Hinchcliff KW, Done S and Gruenberg W. 2016. *Veterinary Medicine*, 11th ed. Saunders Ltd.
- Knight AP and Walter R. 2001. *A Guide to Plant Poisoning of Animals in North America*. Teton NewMedia.
- McDowell RL. 2012. *Nutrition of Grazing Ruminants in Warm Climates*. Academic Press.
- Select articles from Journals

I. Course Title : Rumen Biotechnology

II. Course Code : ANN 612

III. Credit Hours : 1+0

IV. Why this course?

Rumen being a distinctive digestive organ typical to ruminants harbouring diverse microbial communities offers opportunities for their manipulation using molecular biological approaches.

V. Aim of the course

To understand the basics of rumen metabolism employing molecular biology tools

VI. Theory

Unit I (8 Lectures)

Rumen ecology. Manipulation of rumen fermentation for better utilization of fibrous feeds and reduction in methane production. Biotechnological applications for lignin degradation. Role of feed additives, chemicals, antibiotics and probiotics and their effect on rumen metabolism. Degradation of anti-nutritional factors in the rumen.

Unit II (8 Lectures)

Genetic manipulation, DNA recombinant technology for improvement in rumen fermentation. Factors influencing the fate of introduced microbes. Metagenomics for microbial diversity: concept and application.



VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Basic knowledge of molecular biology as applicable to rumen functions.

IX. Suggested Reading

- Dehority BA. 2003. *Rumen Microbiology*. Nottingham University Press.
- Dijkstra J, Forbes J and France J. 2005. *Quantitative Aspects of Ruminant Digestion and Metabolism*. CAB International.
- Kebreab E, Dijkstra J, Bannink A, Gerrits W and France J. 2006. *Nutrient Digestion and Utilization in Farm Animals*. CAB International.
- Millen DD, Arrigoni MDB and Pacheco RDL. (Eds.). 2016. *Rumenology*. Springer Nature.
- Van Soest PJ. 1994. *Nutritional Ecology of the Ruminant*. Cornell University Press.



Course Title with Credit Load

Ph.D. in Animal Nutrition

Course Code	Course Title	Credit Hours
ANN 701*	Modern Concepts in Feeding of Ruminants	2+0
ANN 702*	Forages in Animal Nutrition	1+0
ANN 703*	Recent Concepts in Feeding of Non-Ruminants	1+0
ANN 704*	Advances in Rumen Metabolism	1+1
ANN 705*	Advances in Mineral and Vitamin Nutrition	2+0
ANN 706*	Advanced Clinical Nutrition	1+1
ANN 707	Advanced Techniques in Nutritional Research	1+1
ANN 708	Advances in Feed Technology	1+0
ANN 709	Toxicants and Anti-Metabolites in Animal Nutrition	1+0
ANN 710	Nutrigenomics in Animal Nutrition	1+0
ANN 711	Equine Nutrition	1+0
ANN 791	Seminar-I	1+0
ANN 792	Seminar-II	1+0
ANN 799	Research	75

*Core courses

Course Contents

Ph.D. in Animal Nutrition

I. Course Title : Modern Concepts in Feeding of Ruminants

II. Course Code : ANN 701

III. Credit Hours : 2+0

IV. Why this course?

The feeding management of ruminants is undergoing rapid changes because of scientific and technological advances to augment productivity.

V. Aim of the course

To understand the emerging concepts involving feeding management of high producing ruminant animals.

VI. Theory

Unit I (20 Lectures)

Developments in ruminant digestive physiology. Advanced concepts in the determination of energy and protein requirements. Importance of energy and protein quality for milk and meat production. Recent concepts in protein and energy systems like CNCPS, net energy, metabolizable and available protein. Methods of estimation of energy and protein values of feeds for different physiological functions of livestock. Kinetics of nutrient metabolism. Hindgut fermentation. Efficiency of nutrient utilization for different production purposes. Hormonal regulation of nutrient partitioning.

Unit II (12 Lectures)

Concept of limiting amino acids for high yielders. Strategic feeding of high yielding dairy cows and meat-producing ruminants. Concept of phase feeding and precision feeding. Feeding during the transition period. Bypass nutrient technology. Rumen manipulation to optimize productivity and reduce methanogenesis.

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Knowledge of the newer concepts for its application in the feeding management of ruminants.

IX. Suggested Reading

- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- McDowell RL. 2012. *Nutrition of Grazing Ruminants in Warm Climates*. Academic Press.
- NRC. 2001. *Nutrient Requirements of Dairy Cattle*, 7th rev. ed. National Research Council. National Academies Press.

- NRC. 2016. *Nutrient Requirements of Beef Cattle*, 8th rev. ed. National Academies of Sciences, Engineering, and Medicine. National Academies Press.

- I. Course Title : Forages in Animal Nutrition**
II. Course Code : ANN 702
III. Credit Hours : 1+0

IV. Why this course?

Forages are the principal component of the animal feeding system and therefore their effective utilization is the key for efficient animal production.

V. Aim of the course

To impart knowledge on the fodder management including different forage production systems and their utilization.

VI. Theory

Unit I (10 Lectures)

Forages in ruminant production. Improvement in productivity of fodders and pasture: feed-food crops, silvi-pasture, horti-pasture, shrubs. Use of conserved forages in ruminant feeding. Factors affecting the nutritive value of cultivated and conserved forages. Hydroponics as an alternate to green fodder production. Top feeds, fodder trees and their effective utilization. Tree leaves as a source of condensed tannins: role in protein protection and GI parasite control.

Unit II (6 Lectures)

Methods in forage evaluation: calculated *in-vitro* DOMD and ME by using *in-vitro* gas production technique. Pasture consumption and evaluation studies.

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Understanding of various aspects of forage production, fodder evaluation and their integration into the different animal production system.

IX. Suggested Reading

- Givens D, Axford R and Owen E. (Ed.). 2000. *Forage Evaluation in Ruminant Nutrition*. CAB International.
- McDowell RL. 2012. *Nutrition of Grazing Ruminants in Warm Climates*. Academic Press.
- Minson D. 1990. *Forage in Ruminant Nutrition*. Academic Press.
- Shirley RL. 2012. *Nitrogen and Energy Nutrition of Ruminants*. Academic Press.

- I. Course Title : Recent Concepts in Feeding of Non-Ruminants**
II. Course Code : ANN 703
III. Credit Hours : 1+0

IV. Why this course?

Increased consumer awareness has necessitated a relook into the feeding management of food animals leading to the production of safe and healthy food.



V. Aim of the course

To derive knowledge regarding the nutritional manipulation of food animals for the production of quality food for human consumption.

VI. Theory

Unit I (18 Lectures)

Latest concepts in nutrition and feeding in different phases of broiler, layer and breeder stocks. In-ovo and early chick nutrition. Nutritional disorders in modern poultry production and their amelioration. Nutritional factors affecting egg quality and hatchability in poultry. Feeding strategies for the production of designer eggs and meat. Omega fatty acids. Recent trends in amino acid nutrition. Advances in new generation feed and feed additives.

Unit II (14 Lectures)

Nutrition and feeding of pigs in various stages of production. Modern concepts in amino acids nutrition in swine production. Emerging concepts in feeds and feed additive for pigs. Role of vitamins and minerals in health and disease. Nutritional manipulation for lean meat and designer pork production. Carcass modifiers.

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Comprehensive knowledge on the scope of nutritional management of non-ruminant animals for the production of healthy food.

IX. Suggested Reading

- Chiba LI (Ed.). 2012. *Sustainable Swine Nutrition*. Wiley-Blackwell.
- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- Hendriks WH, Verstegen MWA and Babinszky L. (Eds.). 2019. *Poultry and Pig Nutrition: Challenges of the 21st Century*. Wageningen Academic Publishers.
- Leeson S and Summers JD. 2001. *Scott's Nutrition of The Chicken*, 4th ed. University Books.
- Lewis AJ and Southern LL. 2000. *Swine Nutrition*, 2nd ed. CRC Press.

I. Course Title : Advances in Rumen Metabolism

II. Course Code : ANN 704

III. Credit Hours : 1+1

IV. Why this course?

An in-depth of the understanding of the rumen function is key to devise strategies for augmenting the efficiency of production besides ensuring environmental sustainability.

V. Aim of the course

To understand the metabolic aspects of rumen function and its application for eco-friendly ruminant production.

VI. Theory

Unit I (8 Lectures)

Rumen development. Rumen microflora: classification and their role in fermentation

and digestion, microbial interactions, rumen kinetics, the nutrient requirement of rumen microbes. Dynamics of nitrogen metabolism in the rumen.

Unit II (8 Lectures)

Manipulation of rumen fermentation: physical, chemical and biological approaches. Trans-faunation and defaunation. Concept of metagenomics in rumen manipulation. Green-house gas production from rumen and mitigation strategies

VII. Practical (16 Classes)

Rumen microbial and protozoal count. Estimation of rumen microbial protein. Estimation of nitrogen-fractions in rumen liquor. Volatile fatty acid fractionations. Rumen enzymes assay. Extraction of nucleic acids and quantification of rumen microbes by PCR.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

Comprehensive knowledge of various concepts of rumen metabolism for efficient ruminant production.

X. Suggested Reading

- Dehority BA. 2003. *Rumen Microbiology*. Nottingham University Press.
- Dijkstra J, Forbes J and France J. 2005. *Quantitative Aspects of Ruminant Digestion and Metabolism*. CAB International.
- Kebreab E, Dijkstra J, Bannink A, Gerrits W and France J. 2006. *Nutrient Digestion and Utilization in Farm Animals*. CAB International.
- Millen DD, Arrigoni MDB and Pacheco RDL. (Eds.). 2016. *Rumenology*. Springer Nature.
- Van Soest PJ. 1994. *Nutritional Ecology of the Ruminant*. Cornell University Press.

I. Course Title : Advances in Mineral and Vitamin Nutrition

II. Course Code : ANN 705

III. Credit Hours : 2+0

IV. Why this course?

Molecular mechanisms driving the metabolism of minerals and vitamins have opened up a new vista in the nutrition of farm animals.

V. Aim of the course

To understand advances in mineral and vitamin metabolism for its application in ensuring optimized health and efficient production in farm animals.

VI. Theory

Unit I (18 Lectures)

Role of minerals in nutrient metabolism. Mineral absorption, transport, metabolism and its regulation. Bio-availability of macro and micro minerals: factors affecting the bioavailability; bio-markers for mineral status. Mineral interactions. Dietary cation-anion difference (DCAD). Identification and correction of deficiencies and toxicities of minerals. Mineral tolerance in animals. Mineral requirements for growth,



reproduction and lactation. Mineral toxicities concerning livestock feeding and their amelioration. Methods of mineral supplementation.

Unit II (14 Lectures)

Chemical nature of fat-soluble and water-soluble vitamins. Role of vitamins in nutrient metabolism. Advances in physiological functions and metabolism of vitamins. Vitamin deficiency: clinical signs and their management. Antimetabolites to vitamins. Hypervitaminosis. Vitamins as antioxidants. Role of vitamins in immunity and stress. Dietary supplementation of vitamins: forms, storage and stability.

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Knowledge on the latest understanding of mineral and vitamins and its application in practical feeding conditions.

IX. Suggested Reading

- McDowell RL. 1989. *Vitamins in Animal Nutrition*. Academic Press.
- McDowell LR. 2003. *Minerals in Animal and Human Nutrition*, 2nd ed. Elsevier Science B.V.
- Suttle N. 2010. *The Mineral Nutrition of Livestock*, 4th ed. CAB International.

I. Course Title : Advanced Clinical Nutrition

II. Course Code : ANN 706

III. Credit Hours : 1+1

IV. Why this course?

Approaches involving preventive, therapeutic and convalescent nutrition have been recognized as a sustainable means of ensuring health and wellbeing of animals besides the production of safe and healthy food.

V. Aim of the course

To understand the disease-induced alterations in nutrient metabolism and the potential of select nutrients to prevent and/ or support disease management in prone animals.

VI. Theory

Unit I (12 Lectures)

Metabolic disorders in farm animals. Modern concepts in the metabolic alterations leading to production diseases, viz., milk fever, ketosis, downer cow syndrome, retained placenta, sub-acute ruminal acidosis, laminitis, abomasal displacement and mastitis Optimum nutrition for peri-parturient dairy animals.

Unit II (10 Lectures)

Metabolic effects of infection: metabolism of carbohydrates, fats, protein and amino acids and minerals during various infection and inflammatory diseases. Role of cytokines in nutrient homeorrhesis. Nutrition-immunity interaction: Role of nutrients (fats, amino acids, minerals and vitamins) in the immune response. Metabolic

alterations during abiotic stress and feeding management during stress situations.

Unit III (10 Lectures)

Nutritional manipulation and feeding of sick and hospitalized animals. Preventive and therapeutic nutrition. Optimum nutrition for the management of diseases of the hepatic, renal and gastrointestinal system. Convalescence diet. Feeding management of pre- and post-operated animals.

VII. Practical (16 Classes)

Assessment of immunity: humoral immune response, cell-mediated immune response. Assessment of antioxidant status: Superoxide dismutase, Catalase, Glutathione peroxidase, reduced glutathione (GSH), lipid peroxides. Formulation of diet for sick and diseased animals.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

Understanding the potential of nutrition for prophylaxis and therapeutic purposes.

X. Suggested Reading

- Cheeke PR and Dierenfeld E. 2010. *Comparative Animal Nutrition and Metabolism*. CAB International.
- Constable P, Hinchcliff KW, Done S and Gruenberg W. 2016. *Veterinary Medicine*, 11th ed. Saunders Ltd.
- Naylor JM and Ralston SL. 1991. *Large Animal Clinical Nutrition*. Mosby Inc.
- Walker S, Beckett G, Rae P and Ashby P. 201. *Clinical Biochemistry: Lecture Notes*, 9th ed. Wiley-Blackwell

I. Course Title : Advanced Techniques in Nutritional Research

II. Course Code : ANN 707

III. Credit Hours : 1+1

IV. Why this course?

Cutting edge technologies in analytical science have revolutionized food science research.

V. Aim of the course

To become conversant with the use of advanced techniques in nutritional research.

VI. Theory

Unit I (16 Lectures)

Good laboratory practices. Analytical equipment in animal nutrition research. Estimation of minerals using atomic absorption spectrophotometer and ICP. Principles and applications and of GC, HPLC, amino acid analyzer, SF6, and electron microscopy. Remote sensing and geographic information system (GIS) in animal nutrition research. Analysis of feeds and fodders using NIR. Faecal inoculum as an alternative to rumen liquor for *in-vitro* studies.



VII. Practical (16 Classes)

RUSITEC. Estimation of minerals by atomic absorption spectrophotometer. Estimation of mycotoxins, oxalate, nitrates and tannin. Fatty acid analysis. Vitamin estimation.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

VIII. Learning outcome

Skill development in terms of efficient use of modern analytical techniques related to animal nutrition research.

IX. Suggested Reading

- Kaneko J, Harvey J, Bruss M.(Eds.) 2008. *Clinical Biochemistry of Domestic Animals*, 6th ed. Academic Press.
- Krishna 2012. *Livestock Nutrition- Analytical Techniques*. New India Publishing Agency.

I. Course Title : Advances in Feed Technology

II. Course Code : ANN 708

III. Credit Hours : 1+0

IV. Why this course?

The translation of nutritional knowledge for its wider application involves industrial-scale technological adaptations.

V. Aim of the course

To understand the basic as well as applied aspects of various feed processing technologies.

VI. Theory

Unit I (10 Lectures)

Good manufacturer practices (GMP) in feed plants. Planning and designing of feed plants of different capacities. Recent developments in feed processing: particle size reduction, pelleting, extrusion, expanding, conditioning, micronizing. Post pelleting applications. Automation in feed processing. Flow charts for preparation of feeds for various species. Mixer efficiency test, pellet durability test. Densification of bulk feeds. Silos of various capacity, silage preparation and silage additives. Laws and regulations of the feed manufacturing industry. Introduction to labour laws and standards, planning and production programme. Record-keeping.

Unit II (6 Lectures)

Roughage processing. Whole plant processing. Solid-state fermentation technology. Preparation of complete feeds and its processing. Formulation of premixes. Carriers and diluents. Liquid feed handling. Latest concepts in feed microscopy. Qualitative tests for rancidity.

VII. Teaching methods

- Classroom lectures using audio-visual aids



- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Skill development in terms of increased employment and entrepreneurship

IX. Suggested Reading

- Langham J. 2013. *Recent Advances in Animal Feed Technology*. Random Exports.
- Moughan PJ and Hendricks WH. (Eds.). 2018. *Feed Evaluation Science*. Academic publishers.
- Perry TW, Cullison AE and Lowrey RS. 2003. *Feeds and Feeding*, 6th ed. Pearson.
- Schofield EK (Ed.). 2005. *Feed Manufacturing Technology V*. American Feed Industry Association, Arlington.

I. Course Title : Toxicants and Anti-Metabolites in Animal Nutrition

II. Course Code : ANN 709

III. Credit Hours : 1+0

IV. Why this course?

In-feed anti-metabolites in incriminating factor poses a threat not only to the animal health but also for human health and safe food production.

V. Aim of the course

To impart knowledge on the various toxicants and anti-metabolites in the feeding system and their amelioration.

VI. Theory

Unit I (12 Lectures)

Classification of toxicants in animal feeds. Plant origin toxicants, microbial origin toxicants, acquired toxicants (heavy metals, pesticide residues, drug residues), and their effects on animal health and production. Ameliorative measures. Detoxification of plant origin toxicants. Residual effects on animal products and the environment.

Unit II (4 Lectures)

Anti-metabolites in animal feedstuffs. Effects of anti-metabolites on animal health and production. Anti-vitamins

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Safe use of animal feed resources for ensuring food safety.

IX. Suggested Reading

- Cheeke PR and Shull LR. 1985. *Natural Toxicants in Feeds And Poisonous Plants*. AVI Publishing Company Inc.
- FAO. 2004. *Assessing Quality and Safety of Animal Feeds*. Food and Agriculture Organization of the United Nations, Rome.
- Gremmels JF (Ed.). 2010. *Animal Feed Contamination Effects on Livestock and Food Safety*. Woodhead Publishing Ltd.
- Keeler RF, Van Kampen KR and James LF. 1978. *Effects of Poisonous Plants on Livestock*. Academic Press.



- Knight AP and Walter R. 2001. *A Guide to Plant Poisoning of Animals in North America*. Teton NewMedia.
- Liner IE. 1980. *Toxic Constituents of Animal Food Stuffs*, 2nd ed. Academic Press.
- Osweiler G. (Ed.) 2011. *Ruminant Toxicology. An issue of Veterinary Clinics: Food Animal Practice*. Elsevier.

I. Course Title : Nutrigenomics in Animal Nutrition

II. Course Code : ANN 710

III. Credit Hours : 1+0

IV. Why this course?

The establishment of a functional relationship between nutrition and gene expression has become recognized as a tool to unravel the mechanisms involving the role of nutrition in health and disease.

V. Aim of the course

To impart the knowledge on the basics of nutrigenomics and its application in nutrition.

VI. Theory

Unit I (4 Lectures)

Basic concepts of genetics and molecular biology. Nucleic acid structure and replication, transcription and translation.

Unit II (8 Lectures)

Introduction to nutrigenomics and nutrigenetics. Nutritional regulation of gene expression. Introduction to epigenetics, and its influence on early life nutrition and health.

Unit III (4 Lectures)

Concepts of proteomics and metabolomics. Microbiome and diseases of nutritional importance. Dietary influences on the microbiome.

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Development of concepts on nutrigenomics.

IX. Suggested Reading

- Carlberg C, Ulven SM and Molnár F. 2016. *Nutrigenomics*. Springer
- Caterina RDE, Martinez, JA and Kohlmeier M.(Eds.) 2020. *Principles of Nutrigenetics and Nutrigenomics*. Elsevier Inc.
- Dodds JW and Laverdure DR. 2015. *Canine Nutrigenomics - The New Science of Feeding Your Dog for Optimum Health*. Dogwise Publishing.
- Select articles from Journals



- I. Course Title** : **Equine Nutrition**
II. Course Code : **ANN 711**
III. Credit Hours : **1+0**

IV. Why this course?

Nutrition of equines calls for special attention considering their use for mankind.

V. Aim of the course

To impart a comprehensive knowledge on the nutrition of horses and other equids.

VI. Theory

Unit I (8 Lectures)

Digestive function and metabolism of nutrients. Nutrient requirements of equines in different physiological stages. Feed ingredient for horses. Digestive disorders.

Unit II (8 Lectures)

Feeding foal, yearlings, mares and stallions for production and reproduction. Feeding for performance and nutrient metabolism during exercise. Nutritional management of race-horses. Diet formulation for all classes of horses.

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

In-depth knowledge of equine nutrition including its application.

IX. Suggested Reading

- Frape D. 2010. *Equine Nutrition and Feeding*, 4th ed. Wiley-Blackwell.
- Geor R, Harris P and Coenen M (Eds). 2013. *Equine Applied and Clinical Nutrition*. Saunders, Elsevier.
- NRC. 2007. *Nutrient Requirements of Horses*, 6th Rev. ed. National Research Council. National Academy Press.
- Pagan JD. (Ed.). 2009. *Advances in Equine Nutrition IV*. Kentucky Nutrition Research.

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Animal Production Sciences

– Livestock Production and Management

Preamble

(Livestock Production and Management)

Veterinarians with higher qualifications are increasingly being involved in devising means and methods of production. Temporal aspirations of knowledge seekers ought to be addressed through building knowledge and skill portfolio suiting the job market and thus enhancing the marketability of the veterinary post graduates.

At undergraduate level, veterinary students acquire comprehensive knowledge and skills in basic, para-clinical and clinical subjects required for performing multi-tasking role of a veterinarian. However, at post graduate level, in-depth knowledge of theory, practical aspects and research methodology in each subject is of paramount importance.

In this perspective the proposed course curriculum and syllabus in Livestock Production Management have been developed. There have been unprecedented advancements in all the branches of veterinary sciences including Livestock Production Management. The guiding principle of the proposed new approach is to impart comprehensive and practical knowledge by covering all important aspects of the subject area of study at Master's level. The new and restructured Post-Graduate syllabus in respect of LPM contain several innovative and practically applicable courses and extensively revamped course contents, viz., production aspects, business and entrepreneurship skills, environment and climate change issues, behaviour and welfare aspects of animals, wildlife management and recycling of waste or wealth from waste, etc.

Apart from the existing syllabus 3 new PG course have been incorporated keeping in view of the demand

1. LPM-607 Companion animal production management
2. LPM-613 Livestock farm machinery management
3. LPM-615 Regional animal production management

Salient features of the M.V.Sc. courses

- To acquaint students on basic aspects of dairying in India comparing with developed countries, problems and prospects of dairying, detailed aspects of care and management of different categories of dairy cattle and buffaloes.
- To impart knowledge on various aspects of swine farming in India, principles of housing, breeding, feeding and health care of pigs, management practices at different stages of growth and economic pig production systems.
- To familiarize students on climate, weather, various climatic factors and their role in production and health of animals in both temperate and tropics, micro and macroclimatic conditions of animal house and assessing the heat tolerance of bovines.
- To acquaint students on principles of farm animal behaviour with regard to environmental influence, group formation, social behaviour and behavioural adaptations under domestication.
- To acquaint with dog and cat breeds their feeding, breeding, health management and socialization.
- To acquaint students with the principles and concepts of wild life sanctuaries and national parks, classification of wild animals, role of authorities in conservation and

management of wild animals in captivity

- To familiarize students on principles of air and water hygiene with reference to impurities and inclusions of water, collection and disposal of waste from the animal house, modern techniques in manure disposal and biosecurity measures to be adapted for hygienic production of livestock products.
- To familiarize students on various aspects, viz., scope and limitations of integrated livestock farming system, recent approach and economic feasibility of different integration models for sustainable production
- To familiarize the students with various aspects of lab animals, problems and prospectus, principles of housing, breeding, feeding and health care of rabbits, rats, mice and guinea pigs, measures to reduce the mortality in young ones at different seasons.
- To acquaint students with knowledge in principles, planning, technical approach and preparing financial statement in Livestock Business Management and preparing projects for financing.
- To familiarize the students with different farm machines and milking machine, different parts and their functions for better utilization

New Ph.D. Courses

1. LPM-704 Livestock and Environment
2. LPM-705 Organic livestock production
3. LPM-706 Recent developments in welfare of farm animals
4. LPM-707 Entrepreneurship in livestock production
5. LPM-708 Precision livestock farming

Salient features of Ph.D. Courses

- To impart knowledge related to application of technologies that improve the efficiency of land use and feed use can mitigate the negative effects of livestock production on biodiversity, ecosystems and global warming. Technologies that increase livestock efficiency include improved breeds, improved grazing-land management, improved herd-health management, etc.
- To impart knowledge on key considerations, organic farming standards, certifying agencies, role of organic livestock farming in environmental protection and biodiversity enhancement and economics of organic livestock products.
- To familiarize students with the concept and practice of ethical livestock production and production from content ended animals - Animal Welfare Management
- To understand livestock entrepreneurship, concept, incubation centre, PPP prospective in animal husbandry sector, business communication, inter-personnel skills for establishing an enterprise.
- To educate the students with a concept of precision in livestock farming, implementation of sensor system, automation, use of software and analysis



Course Title with Credit Load

M.V.Sc. in Livestock Production and Management

Course Code	Course Title	Credit Hours
LPM 601*	Cattle and Buffalo Production Management	2+1
LPM 602*	Sheep and Goat Production Management	2+1
LPM 603*	Swine Production Management	1+1
LPM 604*	Climatology and Livestock Production	1+1
LPM 605*	Behaviour and Welfare of Farm Animals	1+1
LPM 606*	Equine Production Management	1+1
LPM 607*	Companion Animal Production Management	1+1
LPM 608	Farm Hygiene and Waste Management	1+1
LPM 609	Integrated Livestock Farming Systems	1+1
LPM 610	Management and Conservation of Wild and Zoo Animals	1+1
LPM 611	Laboratory Animal Production Management	1+1
LPM 612	Livestock Business Management	1+1
LPM 613	Livestock Farm Machinery Management	0+2
LPM 614	Poultry Farm and Hatchery Management	1+1
LPM 615	Regional Animal Production Management	1+1
LPM 691	Seminar	1+0
LPM 699	Research	30

*Core courses

Course Contents

M.V.Sc. in Livestock Production and Management

I. Course Title : Cattle and Buffalo Production Management

II. Course Code : LPM 601

III. Credit Hours : 2+1

IV. Why this course?

Important species of livestock are a source of employment and cater to nutritional demands and socio-economic upliftment of people.

V. Aim of the course

To acquaint students with basic aspects of dairying in India comparing with developed countries, problems and prospects of dairying, detailed aspects of care and management of different categories of dairy cattle and buffaloes.

VI. Theory

Unit I (2 Lectures)

Development of dairy industry in India and the world. Present status and future prospects of dairying in India and the world. SWOT analysis of the dairy sector in different agro-climatic zones. Production systems in vogue under Indian conditions. Breeds of cattle and buffalo with more emphasis on breeds of economic importance.

Unit II (6 Lectures)

Housing/ Shelter management. Housing and equipment requirements for different classes of cattle and buffaloes. Layout plans and construction details for different sized farms in different climatic zones of India. Ventilation and lighting systems in dairy farms.

Unit III (8 Lectures)

Feed and fodder resources used for feeding cattle and buffaloes. Scientific technique and regimen of feeding and watering of different categories of cattle and buffaloes. Feed and fodder requirements of different categories of cattle and buffaloes. Supply of green fodder round the year. Enrichment of poor quality roughages. Non-conventional feeding resources. Pasture management.

Unit IV (8 Lectures)

Traits of economic importance and their inter-relationships. Selection and methods of breeding. Reproduction management - Pre-natal and post-natal care and management of dams. Care of neonates and young calves. Management strategies for reducing mortality in calves, optimizing age at first calving and calving interval. Improving breeding efficiency of dairy animals.

Unit V (8 Lectures)

Farm management - Routine management practices and farm labour management. Milking management - Machine milking and hand milking. Clean milk production- Techniques of harvesting clean milk, cooling and transportation. Different laws



and practices governing the dairy sector to produce quality products on par with international standards. Health management of dairy animals. Summer and winter management of dairy animals. Draughtability and management of draught animals.

VII. Practical (14 Classes)

Visits to different sized dairy farms and assessment of routine managerial practices. Analysis of various farm records for economic evaluation; Computation of practical and economical rations. Layout plans and housing details. Housing, milking, calf, heifer and adult management. Dairy Cattle and Buffalo judging and body condition scoring (BCS). Project preparation for commercial farms.

VIII. Teaching methods

Blackboard, ICTs, success stories, group discussions and farm visits

IX. Learning outcome

By the end of this course, the student will come out with practical knowledge of cattle and buffalo production management aspects, entrepreneurship skills.

X. Suggested Reading

- Arora SP. 1997. *Feeding of Dairy Cattle and Buffaloes*. Kalyani Publication.
- Dutta G. 1994. *Care and Management of Dairy Cattle and Buffaloes*, 3rd ed. ICAR.
- Flanders F and Gillespie J. 2015. *Modern Livestock and Poultry Production*, 9th ed. Delmar Cengage Learning Edition.
- Gupta PR. 2017. *Dairy India-2017*, 7th ed. Dairy India Yearbook, Thomson Press Ltd.
- ICAR. *Livestock Production and Management* - ICAR eCourse PDF eBook (online free).
- Phillips CJC. 2011. *Principles of Cattle Production*. CABI Publishing.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Thomas CK, Sastry NSR and Ravikiran G. 2012. *Dairy Bovine Production*, 2nd ed. Kalyani Publishers.
- Tyler HD and Ensminger ME. 2006. *Dairy Cattle Science*, Pearson Prentice Hall Publishing.
- Selected articles from journals.

I. Course Title : Sheep and Goat Production Management

II. Course Code : LPM 602

III. Credit Hours : 2+1

IV. Why this course?

To know the production and management of small ruminants. Important species of livestock provide employment and supplementary income besides meeting the nutritional demands and are of commercial importance.

V. Aim of the course

To acquaint students on the status of sheep and goat farming in India, principles of housing and feeding, breeding management to improve the reproductive efficiency and detailed account on care and management of different classes of sheep and goat.

VI. Theory

Unit I (2 Lectures)

Population structure and importance. Sheep farming under different systems of management. Advantages and limitations of sheep and goat farming. Genetic resources of sheep and goats with special emphasis on breeds of economic importance.

Unit II (6 Lectures)

Shelter management. Housing and equipment requirements for different classes of sheep and goats. Designing feeders and waterers. Layout plans and construction details for different size farms in different agro-climatic zones of India.

Unit III (8 Lectures)

Feed and fodder resources for small ruminants. Common property resources (CPR's) and their management. Principles and systems of feeding and watering different categories of sheep and goat. Pasture utilization and improvement.

Unit IV (8 Lectures)

Breeding Management, Traits of economic importance and their inter-relationship. Breeding seasons. Selection of breeding animals. Methods of detection of heat, use of teaser, flushing, tugging. Estrous synchronization, Natural Service, artificial insemination and off-season breeding in small ruminants. Care and management of pregnant animals and breeding stock. Culling.

Unit V (4 Lectures)

Disease Management. Prevention and control measures including vaccination, deworming, dipping and spraying, etc. Transportation of small ruminants.

Unit VI (4 Lectures)

Meat, Methods of slaughter, dressing percentage. Wool: Shearing methods. Importance of wool, wool quality. Goat fibers: mohair, pashmina - Marketing of goat fibers/ wool. Milk, Milking, avoidance of goatly odour in milk, clean milk production and its therapeutic uses.

VII. Practical (14 Classes)

Visits to modern sheep and goat farms and critical analysis of various managerial practices under different conditions. Study of practical housing management. Diseases control management. Shearing management. Record keeping and economics of sheep and goat farming for mutton/ chevon, wool/ fibre and milk. Preparation of project for commercial farming. Daily and periodical farm operations. Dipping and vaccination.

VIII. Teaching methods

Blackboard, ICTs, success stories, group discussions and farm visits

IX. Learning outcome

By the end of this course, the students get practical exposure to different aspects of sheep rearing, production and management.

X. Suggested Reading

- Bhat PN and Khan BU. 2009. *Goat Production*. Studium Press (India) Pvt. Ltd.
- Bhatt PN and Arora CL. 2009. *Sheep Production*. Studium Press (India) Pvt. Ltd.
- Devendra C and McLeroy GB. 1982. *Goat and Sheep Production in Tropics*. Longman.
- Devendra C and Burns M. 1983. *Goat Production in the Tropics*. CABI Publishing.
- Gupta JL. 2006. *Sheep Production and Management*. BS Publ.
- ICAR. 2014. *Handbook of Animal Husbandry*, 3rd ed. ICAR.
- Jindal SK. 2013. *Goat Production and Health Management*. New India Publishing Agency.
- Kaushik SK. 2017. *Sheep Production*. ICAR Publ.
- Peacock CP. 1996. *Improving Goat Production in the Tropics: A Manual for Development Workers*, OXFam, UK.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.



- Solaiman SG. 2010. *Goat Science and Production*. Wiley-Blackwell.
- *Selected articles from journals.*

I. Course Title : Swine Production Management

II. Course Code : LPM 603

III. Credit Hours : 1+1

IV. Why this course?

Majority of people are rearing pigs under traditional and small scale production.

V. Aim of the course

To impart knowledge on various aspects of swine farming in India, principles of housing, breeding, feeding and health care of pigs, management practices at different stages of growth and economic pig production systems.

VI. Theory

Unit I (2 Lectures)

Population dynamic, Economic contribution of pigs, Advantages and limitations of swine rearing, Systems of management. Breeds of economic importance.

Unit II (2 Lectures)

Housing and rearing systems. Housing and equipment requirements for different classes of swine, layout plans and construction for different sized farms.

Unit III (3 Lectures)

Feeding principles and nutritional requirement of different classes of swine. Feeding schedule for different classes of swine. Traditional and scientific methods of swine feeding.

Unit IV (4 Lectures)

Traits of economic importance and their interrelationship. Selection of breeding stock. Reproductive parameters of swine. Methods for detection of heat. Mating systems. Care and management of pregnant sows, piglets, growers and boar. Summer management in swine.

Unit V (3 Lectures)

Health Management, Prevention and control measures including sanitation, vaccination, deworming, etc. Piglet anaemia and its management.

Unit VI (2 Lectures)

Methods of slaughter, dressing percentage, Methods of marketing and transportation. Use of by-products from the swine industry

VII. Practical (14 Classes)

Visit modern piggeries and critical analysis of various types of managerial practices. Practical feeding and breeding management, disease control measures, Judging. Record-keeping. Economics of pig production. Formulation of economic rations for different classes of swine. Project formulation of commercial swine production.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

The students will come up with scientific principles, production and management techniques in swine production.

X. Suggested Reading

- Acharya RM and Puneet Kumar. 2017. *Pig Production*. Satish Serial Publishing, Delhi
- Beyno N. 2014. *Pigs: A Guide to Management*, 2nd ed. Replika Press Ltd.
- Boden E. 1995. *Swine Practice*. WB London.
- ICAR. 2014. *Hand Book of Animal Husbandry*, 3rd ed. ICAR
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Sharda DP. 2000. *Swine Production*. ICAR publication
- *Selected articles from journals.*

I. Course Title : Climatology and Livestock Production

II. Course Code : LPM 604

III. Credit Hours : 1+1

IV. Why this course?

This course is important to know the climatic changes that affect the health and production of livestock and vice versa.

V. Aim of the course

To familiarize students on climate, weather, various climatic factors and their role in production and health of animals in both temperate and tropics, micro and macroclimatic conditions of the animal house and assessing the heat tolerance of bovines.

VI. Theory

Unit I (4 Lectures)

Climatology and agro-climatic regions of India. Study of climatic factors and their measurement. Climatic stress in livestock (heat stress/ cold stress): effects, measurement and amelioration. Temperature-humidity index and thermo-neutral zone. Adaptation and acclimatization.

Unit II (4 Lectures)

Light: natural and artificial, photoperiod, mechanism of light action and responses. Application in livestock production.

Unit III (4 Lectures)

Performance of livestock introduced in different climates. Micro-climate modification in animal houses. Livestock and global warming.

Unit IV (4 Lectures)

Climate-resilient livestock production systems. Natural disasters-effects on livestock and mitigation measures.

VII. Practical (14 Classes)

Visit modern weather forecast stations. Assessment of climate: Microclimatic conditions within the animal house, Measurement of Temperature, Relative humidity, wind velocity and intensity of light. Ambient temperature. Construction of climographs and hythergraphs. Heat tolerance test in bovines.



VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits.

IX. Learning outcome

The student is expected to know the different climatic conditions and adaptations for better production and managing livestock.

X. Suggested Reading

- Collier RJ and Collier JL. 2012. *Environment Physiology of Livestock*. Wiley-Blackwell Co.
- Lal DS. 1998. *Climatology*. Sharda Pustak Bhavan, Allahabad.
- McDowell RE. 1972. *Improvement of Livestock Production in Warm Climates*. WH Freeman.
- Payne WJ and Wilson RT. 1999. *An Introduction to Animal Husbandry in the Tropics*. Blackwell Publishing, USA.
- Rainwater MCF. 1962. *Animal Climatology*. Indian Veterinary Research Institute, Izatnagar.
- Sejian V, Gaughan J, Baumgard L and Prasad C. 2015. *Climate Change Impact on Livestock: Adaptation and Mitigation*, 5th ed. Springer.
- Siddhartha K and Roger B. 1996. *Atmosphere, Weather and Climate*. ELBS.
- *Selected articles from journals.*

I. Course Title : Behaviour and Welfare of Farm Animals

II. Course Code : LPM 605

III. Credit Hours : 1+1

IV. Why this course?

Improving the behaviour of livestock for better productivity and welfare.

V. Aim of the course

To acquaint students on principles of farm animal behaviour concerning environmental influence, group formation, social behaviour and behavioural adaptations under domestication.

VI. Theory

Unit I (4 Lectures)

Introduction to Animal behaviour. Evolution of animal behaviour: Theories of animal behaviour. Importance of animal behaviour studies. Physiological basis of behaviour. Natural selection, proximate and ultimate causes, fitness, optimality theory, selfish genes, kin selection, and game theory. Influence of genetic, environmental and physiological influence. Daily and seasonal cycles of behaviour. Patterns of behaviour. Favourable and unfavourable behaviours of domestication.

Unit II (4 Lectures)

Ethogram construction for general behaviour management – interpretation - behaviour assisted animal management - flight zone, Animal learning and training- conditioning- operant and classical, animal behaviour based housing designs – Methods of studying animal behaviour- Vices – causes and prevention.

Unit III (2 Lectures)

Group formation. Social relationships like hierarchy and aggression, the process of socialization, locality and behaviour. Behavioural characters for management practices.

Unit IV (6 Lectures)

Animal welfare – concepts – animal rights – animal freedoms – animal welfare



organizations Measurement of animal welfare: - indicators of animal welfare- improvement of animal welfare through selection- the welfare of livestock in commercial farms and captivity, environmental enrichment- Welfare of livestock during various management activities such as handling, transportation, etc., Legislation and regulations of animal welfare – welfare and economics.

VII. Practical (14 Classes)

Behavioural characters for managerial practices. Behavioural adaptations under domestication. Analysis of behaviour in relation to climate. Analysis of social behaviour. Preparation of ethogram (time budgeting).

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

The student will apply the understanding of animal behaviour to draw conclusions about animal welfare, Consider how common management practices for livestock influence behaviour and welfare, Interpret and critically evaluate scientific literature in the field of animal behaviour

X. Suggested Reading

- Agarwal VK. 2013. *Animal Behaviour* (Ethology) S. Chand and Company
- Albright JL and Arave CW. 1997. *The Behaviour of Cattle*. CAB International.
- Arora MP. 1995. *Animal Behaviour*. WB London.
- Benson BJ and Rollin BE. 2004. *The Well-being of Farm Animals: Challenges and Solutions*. Blackwell Publishing, USA.
- Bouenger EG. 1994. *Animal Behaviour*. WB London.
- Broom DM and Fraser AF. 2007 *Domestic Animal Behaviour and Welfare*, 4th ed. CABI.
- Fraser AF and Broom DM. 1990. *Farm Animal Behaviour and Welfare*. CAB international
- Hafez ESE. 1969. *The Behaviour of Domestic Animals*, 2nd ed. Balliere, Timdall and Cassell.
- Houpt KA. 2018. *Domestic Animal Behavior for Veterinarians and Animal Scientists*. 6th ed. Wiley Blackwell.
- Kumar V. 1996. *Animal Behaviour*. WB London.
- Selected articles from journals.

I. Course Title : Equine Production Management

II. Course Code : LPM 606

III. Credit Hours : 1+1

IV. Why this course?

Equines are important sports and pack animals

V. Aim of the course

To make the students become familiarize with principles of housing, breeding, feeding and health care of different classes of horse, stable routines and measures to reduce the mortality in young ones at different seasons.

VI. Theory

Unit I (2 Lectures)

Scope of equine husbandry in India. Equine population dynamics. Types and classes in equines. Breeds of economic importance.

Unit II (2 Lectures)

Housing and stable management, behaviour, stable vices and their management



Unit III (4 Lectures)

Feeding and breeding of equines. Care and management of stallion, broodmare, pregnant mare and foal.

Unit IV (2 Lectures)

Stud farms, Race clubs, Race-horses and their care, training, exercising, doping and horsemanship.

Unit V (4 Lectures)

Foot care and dental care in equines. General health management and diseases control. Colic, equine azoturia - prevention and management. Regulatory acts in equine disease control and welfare.

Unit VI (2 Lectures)

Transportation, Laws governing the import and export of equines, Horse passport and trading

VII. Practical (14 Classes)

Visit institutional stables. Identification, ageing, soundness and selection. Passing of nasogastric tube, Shoeing and covering. Saddle fitting, Gaits of horses and horse colours.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

By the end of the course, the student gains knowledge on management practices of equine production

X. Suggested Reading

- Blanchard T, Varner D, Love C, Brinsko S, Rigby R and Schumacher J. 2002. *Manual of Equine Reproduction*. Mosby.
- Brown JH and Powell-Smith V. 1984. *Horse and Stable Management*. Blackwell Science.
- Frapé D. 1986. *Equine Nutrition and Feeding*. Blackwell.
- Kacker RN and Panwar BS. 1996. *Text Book of Equine Husbandry*. Vikas Publ.
- Mills DS and Nankervis KJ. 1998. *Equine Behaviour: Principles and Practice*. Blackwell.
- Panwar BS and Yadav KN. 2010. *Equine Husbandry and Equestrian Sports*. IBDC Publishers.
- Pilliner S. 1994. *Care of the Competition Horse*. BT Batsford.
- Rose RJ and Hodgson DR. 2000. *Manual of Equine Practice*. WB Saunders.

I. Course Title : Companion Animal Production Management

II. Course Code : LPM 607

III. Credit Hours : 1+1

IV. Why this course?

To know the different practices of dog and cats

V. Aim of the course

To acquaint with dog and cat breeds their feeding, breeding, health management and socialization.



VI. Theory

Unit I (4 Lectures)

Various companion animals, evolutionary history, the process of domestication of dog and cat. Breeds of dogs and cats. Ownership. Selection of dog, cat and other companion animals. Dogs/ cat body: structure, movement and special senses.

Unit II (4 Lectures)

Reproduction and breeding management, care of newborn, weaning, reproductive problems of bitch/ queen, Socialization.

Unit III (4 Lectures)

Principles of the feeding of dog and cat, Feeding during different life stages and disease conditions, feeding behaviour, common nutritional problems and their preventive measures.

Unit IV (4 Lectures)

Basic Kennel and health management. Principles of training of dogs/ cats. Dog shows. Preparation for the shows, kennel clubs, important characters for judgment. Vaccination/ deworming schedules.

VII. Practical (14 Classes)

Recognizing various breeds. Handling and Restraining of dogs/ cats, Routine management practices of dogs/ cats. Detection of oestrus, mating, whelping/ kittening (through demonstration). Kennel/ cattery design and management. Hygiene of kennel/ pens. Licensing and identification of companion animals. Visit dog hostels and dog park/ shows.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and visits to kennels

IX. Learning outcome

By the end of the course, the student will be able to gain knowledge on different aspects of breeds and management of companion animals.

IX. Suggested Reading

- Case LP, Daristotle L, Hayek MG and Raasch MF. 2011. *Canine and Feline Nutrition: A Resource for Companion Animal Professionals*. 3rd ed. Mosby Elsevier Publishing.
- Chakrabarti A. 2006. *Train Your Dog: At Work and Show*, 2nd ed. Kalyani Publishers.
- Chakrabarti A. 2014. *Dogs their Care and Treatment*, 4th ed. Kalyani Publishers.
- Sharma MC, Pathak NN and Bhat PN. 1993. *Dogs, Breeding, Nutrition, Diagnosis, and Health Management*. CBS Publishers and Distributors.
- Smith FWK. 2012. *Veterinary Medical Guide to Dog and Cat Breeds*. Teton New Media, NY.
- Selected articles from journals.

- I. Course Title : Farm Hygiene and Waste Management**
II. Course Code : LPM 608
III. Credit Hours : 1+1
IV. Why this course?

Maintenance of farm hygiene and proper waste management promotes animal health



V. Aim of the course

To familiarize students on principles of air and water hygiene concerning impurities and inclusions of water, collection and disposal of waste from the animal house, modern techniques in manure disposal and biosecurity measures to be adapted for hygienic production of livestock products.

VI. Theory

Unit I (4 Lectures)

Animal air hygiene. Measure air pollutants and their sources. Factors affecting outdoor and indoor pollution. Methods to control these factors.

Unit II (4 Lectures)

Water Hygiene. Sources of drinking water-Impurities and inclusions. Hygienic requirements and standards for drinking water. Purification of water. Water conservation.

Unit III (4 Lectures)

Manure, Quantity of manure voided by domestic animals. Animal excreta a factor in the spread of disease. Hygienic and economic disposal of farm wastes. Drainage in livestock farms. Lagoons, Sewers, septic tanks, drains and traps.

Unit IV (2 Lectures)

Environmental protection act: Air (Prevention and control of pollution) act and water (Prevention and control of pollution) act.

Unit V (2 Lectures)

Factors affecting environmental pollution and their effect on livestock and livestock products for human consumption. Controlling measures thereof.

VII. Practical (14 Classes)

Assessment of air pollutants on animal health and production. Collection of water samples: Physical, chemical, bacteriological and microscopic examination. Bio-security measures. Modern techniques used in the disposal of farm wastes. Value-added products from farm wastes. Visit water filtration plants and study of filtration systems (rapid and slow-sand, etc.). Testing of drains in livestock farms.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

By the end of the course, the students know the practical knowledge and experiences in hygiene and waste management and control methods.

X. Suggested Reading

- Baba MD. 2007. *Environmental Changes and Natural Disasters*. New India Publ.
- Overcash MR. 1983. *Livestock Waste Management*. CRC Press.
- Thapliyal DC and Misra DS. 1996. *Fundamentals of Animal Hygiene and Epidemiology*. International Book Distr. Co.



- I. Course Title : Integrated Livestock Farming Systems**
II. Course Code : LPM 609
III. Credit Hours : 1+1

IV. Why this course?

To know the Integration of livestock farming systems which in turn helps improves the overall profitability of the livestock system.

V. Aim of the course

To familiarize students on various aspects, viz., scope and limitations of integrated livestock farming system, recent approach and economic feasibility of different integration models for sustainable production

VI. Theory

Unit I (4 Lectures)

Classification of livestock-based farming systems. Principles, Scope, drivers and tradeoffs in integrated livestock farming systems. Sustainability and ecological advantages of integrated livestock farming systems and their economic importance.

Unit II (4 Lectures)

Integration of various components of farming systems. Livestock-fish, arable farming, plantation crops and different livestock enterprises (cattle, buffalo, sheep, goat, pig, rabbit, poultry, beekeeping, silkworm, etc.) along with the bio-gas plant, FYM, vermicompost, solar and wind energy utilization

Unit III (4 Lectures)

New approach for changing farming systems in the light of global warming, carbon sequestration and mitigation of GHGs (reducing carbon and water footprints)

Unit IV (4 Lectures)

Project formulation and evaluation of various integrated livestock enterprises in light of reducing poverty, livelihood diversification, environmental sustainability and resource conservation.

VII. Practical (14 Classes)

Visit modern integrated livestock farming units. Critical analysis of different subunits, economic analysis and preparation of feasibility reports

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

By the end of the course, the students are expected to know with different integrated farming systems and their application in the field of their study.

X. Suggested Reading

- Ghosh B. 2007. *Integrating Crops and Livestock*, 1st ed. Gene-Tech Books.
- Little DC and Edwards P. 2003. *Integrated Livestock-fish Farming Systems*. FAO.
- Mukherjee TK, Moi PS, Panandam JM and Yang YS. (Eds.) 1992. *Integrated Livestock Fish Production Systems*. FAO/IPT Workshop on Integrated Livestock-Fish Production Systems, University of Malaya, Kuala Lumpur.
- Raman KV and Balaguru T. (Eds.). 1992. *Farming Systems Research in India: Strategies for Implementation*. NAARM, Hyderabad.



- Rana SS. 2015. *Recent Advances in Integrated Farming Systems*. CSK HPKV, Palampur.
- Rangasamy A and Annadurai K. 2002. *Farming System in the Tropics*. Kalyani Publishers.
- Renard C. (Ed.). 1997. *Crop Residues in Sustainable Mixed Crop/ Livestock Farming Systems*. CABI.
- Speirs M and Opsen O. 1992. *Indigenous Integrated Farming System in the Sahel*. World Bank.
- Sunil Kumar and DR Palsaniya DR and Kiran Kumar T. 2017. *Farming systems: Issues and Strategies*. Satish Serial Publishing, New Delhi.
- Selected articles from journals.

I. Course Title : Management and Conservation of Wild and Zoo Animals

II. Course Code : LPM 610

III. Credit Hours : 1+1

IV. Why this course?

The course is useful to know about the zoo, wild animals and their biodiversity conservation

V. Aim of the course

To acquaint students with the principles and concepts of wildlife sanctuaries and national parks, classification of wild animals, the role of authorities in conservation and management of wild animals in captivity.

VI. Theory

Unit I (2 Lectures)

Taxonomy and distribution of important Indian wild animals and birds – Ecology of wildlife sanctuaries and National parks - Principles and concepts of Zoo and captive wild animals- Status of forest in India - Biological and ecological basis of management of wildlife

Unit II (2 Lectures)

Rules and regulations of Zoo Authority of India - Wildlife protection act - Conservation of wild animals – feeding of captive animals and birds- Habitat Components-Cover, food, water, space and their development and conservation

Unit III (6 Lectures)

Wildlife health control - Population dynamics- and its manipulation Movements – Corridors, – Mortality - Predator and prey relationship - Human-animal conflict - Refuge rehabilitation

Unit IV (6 Lectures)

Principles for the protection of wild and zoo animals - Breeding seasons - Breeding characteristics – puberty - pregnancy - parturition - postnatal survival of the young. Social factors among various species. Miscellaneous management procedures. Wildlife Census methods- captive animal breeding

VII. Practical (14 Classes)

Visit wildlife sanctuary/ national park/ biosphere reserves/ conservation breeding centre and zoo. Restraining methods. Funding agencies for wildlife research and preparation of project proposals, Habitat analysis and design.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

By the end of the course, the students gain knowledge in zoo animals and wildlife management and conservation methods.

X. Suggested Reading

- Agrawal KC. 2000. *Wildlife of India: Conservation and Management*. Nidhi Publishers.
- Berwick SH and Saharia VB. (Eds.). 1995. *The Development of International Principles and Practices of Wildlife Research and Management*. Oxford University Press.
- Bobbins CT. 1983. *Wildlife Feeding and Nutrition*. Daya Publ. House.
- Giles RH, Jr. 1978. *Wildlife Management*. WH Freeman.
- Giles RH, Jr. 1984. *Wildlife Management Techniques*, 3rd ed. Wildlife Society, Washington, DC.
- Hosetti BB. 2005. *Concepts in Wildlife Management*, 2nd ed. Daya Publ. House.
- Saha GK and Mazumdar S. 2017. *Wildlife Biology: an Indian Perspective*. PHI Learning Pvt. Ltd.
- Santra AK. 2008. *Handbook on Wild and Zoo Animals: A Treatise for Students of Veterinary, Zoology, Forestry and Environmental Science*. International Book Distributing Co.
- Sinclair ARE, Fryxel JM and Caughley G. 2006. *Wildlife Ecology, Conservation and Management*, 2nd ed. Blackwell.
- Singh SK. 2005. *Text Book of Wildlife Management*. International Book Distributing Co.
- Wildlife (Protection) Act 1972 (as amended up to 1991). Natraj Publ.
- *Selected articles from journals*.

I. Course Title : Laboratory Animal Production Management

II. Course Code : LPM 611

III. Credit Hours : 1+1

IV. Why this course?

Laboratory animals are important components of research for conducting animal experiments.

V. Aim of the course

To familiarize the students with various aspects of lab animals, problems and prospectus, principles of housing, breeding, feeding and health care of rabbits, rats, mice and guinea pigs, measures to reduce the mortality in young ones at different seasons.

VI. Theory

Unit I (2 Lectures)

Importance of rabbit, rats, mice, hamster and guinea pigs as laboratory animals.

Unit II (4 Lectures)

Systems of housing, layout and design for laboratory animals house. Feeding management of laboratory animals. Feeding regimen, Types of diets.

Unit III (6 Lectures)

Production of laboratory animal models for various experiments. Management of specific pathogen-free, gnotobiotic and germ-free animals. Concepts related to the welfare of laboratory animals. Sanitary and hygienic measures. Common diseases and their control measures. Biosecurity measures. Transportation.



Unit IV (4 Lectures)

Breeding, growth, sexual maturity, mating, gestation, parturition, litter size, weaning. Selection of breeding stock for replacement.

VII. Practical (14 Classes)

Visit to laboratory animal house and critical analysis of various types of managerial practices. Handling and restraining of laboratory animals. Practical breeding methods. Disease control and special management. Ageing and identification. Economics of production.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and experimental lab visits

IX. Learning outcome

By the end of the course, the students get practical exposure on different experimental laboratory animals, their production and management.

X. Suggested Reading

- Anonymous.1993. *Rabbit Management*. IBH and Oxford
- Bandy MT, Shrivastava HP and Hamdani H. 2014. *Rabbit Production and Management*. New India Publishing Agency.
- Chakrabarti A and Biswas S. 2014. *Rabbit Health and Production*. Kalyani Publishers.
- Hau J and Van Hoosier GL, Jr. 2002. *Handbook of Laboratory Animal Science*, 2nd ed. CRC Press.
- ICAR. 2014. *Hand Book of Animal Husbandry*, 3rd ed. ICAR, New Delhi.
- NRC. 2011. *Committee for the Update of the Guide for the Care and Use of Laboratory Animals. Guide for the Care and Use of Laboratory Animals*, 8th ed. National Research Council, National Academy Press, Washington, DC.
- Rao TKS, Chauhan IS and Chauhan A. 2018. *Handbook of Laboratory Animal Production Management*. Kalyani Publishers.
- Reddy DV. 2007. *Applied Nutrition: (Livestock, Poultry, Human, Pet, Rabbit and Laboratory Animal Nutrition)*. IBH and Oxford.
- Ronald N and Penman S. 1991. *A Manual for Small Scale Rabbit Production*. South Asia Publ.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Selected articles from journals.

I. Course Title : Livestock Business Management

II. Course Code : LPM 612

III. Credit Hours : 1+1

IV. Why this course?

Study of livestock business management will improve marketing of livestock and livestock products and enhance the profitability

V. Aim of the course

To acquaint students with knowledge in principles, planning, technical approach and preparing financial statement in Livestock Business Management and preparing projects for financing.



VI. Theory

Unit I (3 Lectures)

Management principles, Planning Techniques, strategic planning, organization structure, co-ordination and controlling techniques, Approaches to management.

Unit II (5 Lectures)

Key economic concepts, factors of production, farm enterprises, cost of production, opportunity cost, value of production, gross margin, farm profit, net farm family income, substitution, and efficiency: return to scarce resources, risk. SWOT analysis for different livestock species and products, Livestock production economics, theory of supply and demand, production relationships, production function, cost input variables, profit maximization.

Unit III (4 Lectures)

Economics and the market, market intelligence, newer concepts in marketing, market research and opinion polling, advertising research, market surveillance, etc.

Unit IV (3 Lectures)

Marketing channels, Marketing of livestock and livestock products and laws governing them, Pricing strategies, supply chain management, marketing agencies.

VII. Practical (14 Classes)

Accounting records, fund flow statement, Cost and benefit analysis. Budgeting and control. Preparation of financial statements, depreciation accounting methods, trend and variance analysis, cost-volume profit analysis. Financial planning and forecasting. Estimation of working capital requirement. Break even analysis. Visit to livestock business firms and banks. Preparing projects for financing.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

By the end of course the students gain knowledge in planning and handling business records.

X. Suggested Reading

- Acharya RM and Kumar P. 2013. *Dairy Production and Business Management*. Satish Serial Publishing, New Delhi.
- Bardhan D. 2013. *Textbook on Livestock Economics, Marketing and Business*. Satish Serial Publishing House.
- Bhaskaran S and Mohanty S. 2007. *Marketing of Livestock and Livestock Products in India*. ICFAI University Press.
- Das N. 2009. *Forage for Sustainable Livestock*. Satish Serial Publishing House.
- Gangadhar KS. 2009. *Livestock Economics: Marketing, Business Management and Accountancy*. New India Publishing Agency.
- George RP and Raj Kamal PJ. 2015. *Farm Economics, Entrepreneurship and Marketing*. Satish Serial Publishing, New Delhi.
- Kahan D. 2008. *Economics for Farm Management Extension*. FAO, Rome.
- Koontz H and O'Donnel C. 1999. *Essentials of Management*. Tata McGraw Hill.
- Kotler P. 2000. *Marketing Management - Analysis, Planning and Control*. Prentice Hall of India.
- Maheswari SN. 1998. *Management Accounting*. Tata McGraw Hill.
- Massie JL. 1995. *Essential of Management*. Prentice Hall of India.



- Moran J. 2009. *Business Management for Tropical Dairy Farmers*. Land Links Publishing.
- Srinivasan NP. 1998. *Management Accounting*. Sterling Publications.
- Selected articles from journals.

I. Course Title : Livestock Farm Machinery Management

II. Course Code : LPM 613

III. Credit Hours : 0+2

IV. Why this course?

The course will facilitate effective utilization and maintenance of farm machinery with their practical knowledge.

V. Aim of the course

To familiarize the students with different farm machines and milking machine, different parts and their functions for better utilization

VI. Theory

Unit I (2 Lectures)

Visit to Instructional Livestock Farm Complex, Identification of various livestock farm machineries

Unit II (2 Lectures)

Familiarization with different parts and their functions of tractor and power tiller (for tillage implements for fodder land development).

Unit III (2 Lectures)

Irrigation of fodder field. Familiarization with different electric motors and diesel engines, use of sprinkler for irrigation.

Unit IV (2 Lectures)

Non-conventional energy source-Wind energy and its utilization in livestock farm.

Unit V (2 Lectures)

Post-harvest equipment/ machineries. Common terms used in harvesting of fodder crops; hay and forage harvesting equipment, mowers, field choppers, chaff cutters for silage making, different types of silos, forage harvesters, mechanical hay driers, conventional balers, hay stackers, straw combine.

Unit VI (2 Lectures)

Familiarization with different parts of milking/ shearing machines, handling, operation and cleaning after use, instruments used for milk packaging. Automatic feeders and waterers

Unit VII (2 Lectures)

Milk storing equipment, pasteurization equipment and transportation of milk, handling of equipment for preparation traditional milk products.

Unit VIII (2 Lectures)

Forage densifying machine/ Feed block machine and its use- preparation of complete feed block (CFB).

Unit IX (2 Lectures)

Visit to feed mill- use and maintenance of feed grinder and mixture machines in

the farms. Visit milk processing unit

VII. Teaching methods

Practical demonstration of prescribed machinery in different farms/ processing plants

VIII. Learning outcome

By the end of course the students get knowledge on different farm machineries including milking machine.

IX. Suggested Reading

- Kutz M. 2007. *Handbook of Farm, Dairy, and Food Machinery*. William Andrew Inc.
- Malhotra K. 2012. *Handbook of Farm, Dairy, and Food Machinery*. Centrum Press.
- Selected articles from journals.

I. Course Title : Poultry Farm and Hatchery Management

II. Course Code : LPM 614

III. Credit Hours : 1+1

IV. Why this course?

Poultry rearing provides employment opportunities and is an important component of food security

V. Aim of the course

To impart knowledge on housing, flooring and management of poultry. They also learn incubation and hatching of eggs.

VI. Theory

Unit I (4 Lectures)

Poultry housing systems - cage vs floor system, litter management and lighting for poultry, rearing turkey, duck and quails, backyard poultry.

Unit II (4 Lectures)

Management of chicks, growing, laying and breeding flocks, broiler production, selection and culling of laying flocks. Health management. Management of birds during disease outbreaks.

Unit III (3 Lectures)

Procuring, care and pre-incubation storage of hatching eggs - Method of incubation, sanitation disinfection and management of hatchery. Biosecurity in poultry farms

Unit IV (2 Lectures)

Embryonic development and factors affecting fertility and hatchability of eggs.

Unit V (3 Lectures)

Chick sexing, packing and hatchery business - Transporting management of farm and hatchery waste.

VII. Practical (14 Classes)

Observation and recording of Poultry Farm management - Brooding of chicks; selection of laying flocks - Disease preventive measures - Selection and care of hatching eggs; incubator operation, fumigation and candling setting and hatching, packaging of chicks - Waste management - Marketing of products.



VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

By the end of the course, the students gain knowledge on poultry farm management, brooding and hatching management including health.

X. Suggested Reading

- Ensminger ME. 1992. *Poultry Science*. International Book Distr. Co.
- Hued LM. 2003. *Modern Poultry Farming*. Greenworld.
- Powell-Owen W. 2008. *Poultry Farming and Keeping*. Daya Books.
- Prasad J. 2005. *Poultry Production and Management*. Kalyani Publication
- Singh RA. 1996. *Poultry Production*. 3rd ed. Kalyani Publication

I. Course Title : Regional Animal Production Management

II. Course Code : LPM 615

III. Credit Hours : 1+1

The course content will be developed as per the need of the university



Course Title with Credit Load

Ph.D. in Livestock Production and Management

Course No.	Course Title	Credits
LPM 701*	Recent Developments in Large Ruminants Production Management	2+1
LPM 702*	Recent Developments in Small Ruminants Production Management	2+1
LPM 703*	Recent Developments in Swine Production Management	1+1
LPM 704*	Livestock and Environment	1+0
LPM 705*	Organic Livestock Production	1+0
LPM 706	Recent Developments in Welfare of Farm Animals	1+0
LPM 707	Entrepreneurship in Livestock Production	1+1
LPM 708	Precision Livestock Farming	1+1
LPM 709	Recent Developments in Poultry Production Management	2+1
LPM 791	Seminar-I	1+0
LPM 792	Seminar-II	1+0
LPM 799	Research	75

*Core courses



Course Contents

Ph.D. in Livestock Production and Management

- I. Course Title** : Recent Developments in Large Ruminants Production Management
- II. Course Code** : LPM 701
- III. Credit Hours** : 2+1

IV. Why this course?

Large ruminants are a source of employment and cater to nutritional demands and socio-economic upliftment of people.

V. Aim of the course

To know modern trends on housing, feeding, health and milking management in dairy bovines.

VI. Theory

Unit I (2 Lectures)

Present status of dairying in India *vis-à-vis* Global and south Asian scenarios, Production dynamics, Recent policy initiatives in dairy development. Conservation of indigenous germplasm

Unit II (4 Lectures)

Advances in housing management, viz., design, layout, construction materials, cost of construction suits to various agro-climatic zones of India. Low-cost houses for large ruminants. Ideal shelter management practices for better productivity, Advances in manure and waste disposal.

Unit III (6 Lectures)

Recent approaches in breeding and reproductive Management of dairy animals, Optimization of reproductive traits, Estrus synchronization, MOET, Sexed semen, Cloning and IVF.

Unit IV (4 Lectures)

Recent approaches in Feeding, Phased feeding, Transition period, Hydroponic fodder, Eco-feeding, standards for drinking water and water hygiene.

Unit V (4 Lectures)

Advances in health management of dairy animals, preventive measures for production-related diseases, bio-security measures, etc.

Unit VI (4 Lectures)

Milking management, automation, Sanitary and phytosanitary standards for the production of quality milk, post-harvest processing.

Unit VII (4 Lectures)

Establishing a Dairy Enterprise suitable for various economic strata with different sizes, SWOT analysis. Computerization of dairy enterprises, Best management practices.

**Unit VIII (4 Lectures)**

Advances in herd management and data analysis, Advances in the management aspects of buffaloes, salvaging of buffalo calves, Advances in work animal management.

VII. Practical (14 Classes)

Critical analysis of various types of managerial practices at farms. Preparation of layout and designs for construction of sheds of various sizes in different agro-climatic zones. Cost analysis of dairy bovine housing. Organization of milking machines. Dairy Cattle and Buffalo judging – BCS. Farm record analysis. Project report preparation for commercial dairy farms.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

By the end of the course, the student gain knowledge and experience in different aspects of advanced methods of large ruminants management in different fields of housing, feeding, breeding and milking of dairy animals.

X. Suggested Reading

- Clarence HE. 2007. *Dairy Cattle and Milk Production*. Daya Publ. House.
- Moran J and Chamberlain P. 2017. *Blueprints For Tropical Dairy Farming: Milk Production in Developing Countries*. CSIRPO Publishing.
- Moran J. 2013. *Tropical Dairy Farming: Feeding Management for Small Holder Dairy Farmers in the Humid Tropics*. Landlinks Press.
- Singh U, Kumar S, Kumar A, Deb R and Sharma A. 2013. *Advances in Cattle Research*. Satish Serial Publishing House, New Delhi.
- Thomas CK, Sastry NSR and Ravi Kiran. 2012. *Dairy Bovine Production*, 2nd ed. Kalyani Publishers.

I. Course Title : Recent Developments in Small Ruminants Production Management

II. Course Code : LPM 702

III. Credit Hours : 2+1

IV. Why this course?

Small ruminants are an important source of livelihood security to rural masses and study/ application of recent advances will improve the profitability of small ruminant rearing.

V. Aim of the course?

To familiarize the students with advanced methods of housing, feeding, breeding, reproduction and health management.

VI. Theory**Unit I (4 Lectures)**

Relevance of small ruminants in the Indian economy. Population and production dynamics of small ruminants. Systems of rearing. Needs and possibilities for research in future.

Unit II (8 Lectures)

Recent approaches in breeding and reproductive management. Management during



the breeding season, Mating seasons and their control. Recent approaches in reproductive biotechnologies, MOET, Cloning, transgenic, genomics and accelerated lambing.

Unit III (6 Lectures)

Recent approaches in feeding management, Pasture and grazing management, Phase feeding, Feed resources and feeding techniques under different systems.

Unit IV (6 Lectures)

Recent approaches in housing systems with reference to different agro-climatic zones and rearing systems.

Unit V (6 Lectures)

Prospects of management under stall-fed conditions, management of small ruminates during scarcity periods, Migratory pattern and flock management. Recent approaches in exploiting goat's, milk quality, safety and production aspects of dairy goats. Wool/ fibre production and its quality.

Unit VI (2 Lectures)

Recent approaches in health care management, Parasitic control in present ecological and environmental changes.

VII. Practical (14 Classes)

Critical analysis of various farm practices, Preparation of layout and designs for construction of sheds of various sizes in different agro-climatic zones. Cost analysis of housing. Organization of shearing. Sheep and goat judging – BCS. Farm record analysis. Disease control management. Scorecard and grading of wool. Project report preparation for commercial sheep and goat units.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

The students gain knowledge and experience on different advance management aspects of small ruminants.

X. Suggested Reading

- Devendra C and McLeroy GB. 1983. *Goat and Sheep Production in the Tropics*. Agrodok.
- Gupta JL. 2006. *Sheep Production and Management*. CBS.
- Jansen C and van den Burg K. 2004. *Goat Production in the Tropics*. 4th ed. © Agromisa Foundation, Wageningen.
- Karim SA. 2008. *Small Ruminant Production in India*. Satish Serial Publishing, New Delhi.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Selected articles from journals

I. Course Title : Recent Developments in Swine Production Management

II. Course Code : LPM 703

III. Credit Hours : 1+1

IV. Why this course?

Study of recent developments will facilitate their application for better growth of the swine industry

**V. Aim of the course**

To impart knowledge on recent advances in the improvement of swine housing, feeding, reproduction and health management.

VI. Theory**Unit I (2 Lectures)**

Trends in population and production in India and world, Production systems followed in developed countries.

Unit II (6 Lectures)

Recent approaches in improvement of economic traits, Prenatal and postnatal development, care of newborn, Growth, breeding and reproduction, analysis of mating systems, Farrowing and lactation.

Unit III (3 Lectures)

Strategic management measures in feeding, Phase feeding, Split sex feeding and individual feeding. Automatic feeding and watering techniques, Feed resources and feeding systems.

Unit IV (2 Lectures)

Recent approaches in housing, environmental physiology, summer management, approaches in manure management.

Unit V (2 Lectures)

Strategies to reduce mortality in different classes, common diseases, health management, Biosecurity measures.

VII. Practical (14 Classes)

Critical analysis of various types of managerial practices at farms. Preparation of layout and designs for construction of sties for the backyard and commercial piggeries. Judging and BCS, Farm record analysis. Preparation of Project report for commercial and backyard piggeries. Marketing Analysis

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

By the end of the course, the students will gain knowledge on modern aspects swine practices and management including health.

X. Suggested Reading

- Katingi E. 2012. *Raising Pigs – Manuals and Other Useful Resources*. ICARDA and ILRI Publications.
<https://livestockfish.cgiar.org/2012/06/13/raising-pigs-manuals-and-other-useful-resources/>
- Selected articles from journals.

I. Course Title : Livestock and Environment

II. Course Code : LPM 704

III. Credit Hours : 1+0

IV. Why this course?

There is an urgent need for governments and institutions to develop and enact appropriate policies, at the national and international levels, that focus more on



and account for livestock–environment interactions.

V. Aim of the course

To impart knowledge related to the application of technologies that improve the efficiency of land use and feed use can mitigate the negative effects of livestock production on biodiversity, ecosystems and global warming. Technologies that increase livestock efficiency include improved breeds, improved grazing-land management, improved herd-health management, etc.,

VI. Theory

Unit I (4 Lectures)

Effect of livestock on the environment- Role of ruminants in global warming, Slaughterhouse waste, Tannery waste, Stray and fallen animal impact. Strategies for mitigation of methane emission from the livestock sector, animal waste management. A life cycle assessment of the environmental impacts of livestock in different production systems.

Unit II (4 Lectures)

Effect of environment on livestock and quality of products: Heat and cold stress, Pollution, Heavy metals, Pesticide residues, etc., Management of micro and macro-environment with respect to animal well-being,

Unit III (4 Lectures)

Concept of Water, Carbon footprints and carbon sequestration of farm animals and products. Thermal load indices, Livestock comfort zones. Carbon trading, mechanisms and opportunities in the livestock sector.

Unit IV (4 Lectures)

Selection of breeds of livestock for hot climate. Recent advances in shelter management practices under the impending climate change scenario. Climate and reproduction. Environment and diseases.

VII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions.

VIII. Learning outcome

By the end of the course, the students gain knowledge about the interaction between livestock and the environment. They also acquire knowledge of the greenhouse effect and mitigation.

IX. Suggested Reading

- Cheeke PR. 1993. *Impacts of Livestock Production on Society, Diet/ health, and the Environment*. Interstate Publishers.
- FAO. 2009. *Livestock in the Balance*, FAO, Rome.
- ICAR. 2014. *Handbook of Animal Husbandry*. ICAR, New Delhi.
- Mudgal VD, Singhal KK and Sharma DD. 2003. *Advances in Dairy Animal Production*, 2nd ed. International Book Distributing Co.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Sejain V, Naqvi SMK, Ezeji T, Lakritz J and Lal R. 2012. *Environmental Stress and Amelioration in Livestock Production*. Springer
- Sirohi SK, Walli TK, Singh B and Singh N. 2013. *Livestock Greenhouse Gas: Emissions and Options For Mitigation*. Satish Serial Publishing, New Delhi.
- Selected articles from journals

- I. Course Title : Organic Livestock Production**
II. Course Code : LPM 705
III. Credit Hours : 1+0
IV. Why this course?

Organic livestock production offers an effective means of satisfying consumer demand for healthy and safe foods and reducing the environmental pressure of agricultural production. There is a need to know the organic production of livestock products and by-products.

V. Aim of the course

To impart knowledge on key considerations, organic farming standards, certifying agencies, the role of organic livestock farming in environmental protection and biodiversity enhancement and economics of organic livestock products.

VI. Theory

Unit I (2 Lectures)

Historical background and origin, Organic livestock farming vis-a-vis conventional livestock farming, the current status of organic farming in India and world- objectives and importance of organic livestock farming. Opportunities and Problems of organic livestock farming in India.

Unit II (6 Lectures)

Key consideration, selection of animals, housing, feeding, breeding, health care, record keeping, processing and labelling and marketing. Conversion of livestock farm into an organic farm. ITKs used in organic livestock production.

Unit III (4 Lectures)

Organic farming standards in India and the world. IFOAM basic standards, WHO/FAO Codex Alimentarius, NSOP of India, etc. Role of organic livestock farming in environmental Protection and biodiversity enhancement.

Unit IV (4 Lectures)

Accreditation of inspection and certification agencies. Organic certification mark. Guidelines for organic certification of livestock modalities in the certification of organic products. The economic value of organic livestock products, pricing strategy and marketing of organic products.

VII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions

VIII. Learning outcome

By the end of the course, the student will be acquainted with organic livestock production, economics and marketing of organic products.

IX. Suggested Reading

- Balasubramaniam R, Balakrishnan K and Sivasubramaniam K. 2013. *Principles and Practices of Organic Farming*. Satish Serial Publishing House, New Delhi.
- ICAR. 2014. *Handbook of Animal Husbandry*. ICAR, New Delhi.
- Paajanen T. 2011. *The Complete Guide to Organic Livestock Farming*. Atlantic Publishing Group Inc.
- Katherine M. 2009 *The Organic Dairy Handbook*. Northeast Organic Farming Association.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.



- Singh M, Sharma DK and Mishra UK. 2011. *Organic Dairy Farming*. Satish Serial Publishing House, New Delhi.
- Selected articles from journals

I. Course Title : Recent Developments in Welfare of Farm Animals

II. Course Code : LPM 706

III. Credit Hours : 1+0

IV. Why this course?

Now there are big movements on ethical animal production all over the World. Hence a doctoral student of LPM has to be prepared on this issue too.

V. Aim of the course

To familiarize students with the concept and practice of ethical livestock production and production from content ended animals - Animal Welfare Management;

VI. Theory

Unit I (2 Lectures)

Ethology: species-specific behaviour, changing with the season, physiological condition of animals, as a guide to animal welfare; not driving animals beyond their natural capacity, for better performance;

Unit II (6 Lectures)

Amelioration of climatic stress and avoidance of unnecessary injury, pain and stress to animals in animal houses, during handling, before and during slaughter, carting bullocks, feeding, milking, shearing, transportation, etc., including deprival of quality feeds and water; this being a common feature;

Unit III (4 Lectures)

Providing safety, healthcare, feed and water to unproductive animals let off to free roam and injured or orphaned pets, birds and others; monkeys being common – Good management of goshalas and safe shelters for such animals – Conversion of their wastes into VAP to meet part costs of running shelters; Education of the general public, especially children to avoid wanton harm to animals via *Lectures* in schools, TV and radio talks, leaflets, etc.

Unit IV (4 Lectures)

Evaluation of animal welfare measures as an 'instrument' of good animal husbandry, production of quality products and enhanced income to farmers.

VII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

VIII. Learning outcome

By the end of this course, the student will be familiarized with species-specific behaviour, amelioration of climatic stress and evaluation of animal welfare measures.

IX. Suggested Reading

- *Animal Rights and Animal Welfare Publications* 1896-2009. <https://www.lib.ncsu.edu/findingaids/mc00440>
- Appleby MC, Mench JA, Anna Olsson I and Hughes BO. 2018. *Animal Welfare*. CABI.
- AWBI. Animal Protection Laws, Newsletters, etc. of Animal Welfare Board of India; <http://www.awbi.org/section/4/publications/2>

- GoI Gazzete. *Order on Animal Welfare* - <http://www.moef.nic.in/legis/awbi/awbi18.html>
- Phillips C. 2009. *The Welfare of Animals: The Silent Majority*. Springer.
- Webster J. 2005. *Animal Welfare: Limping Towards Eden*. Blackwell Publishing.
- Selected articles from journals.

- I. Course Title : Entrepreneurship in Livestock Production**
II. Course Code : LPM 707
III. Credit Hours : 1+1

IV. Why this course?

Livestock production has huge scope vis a vis income generation. Study of concepts of entrepreneurship will ensure awareness towards the possibilities of taking livestock production as a business unit.

I. Aim of the course

To understand livestock entrepreneurship, concept, incubation centre, PPP perspective in the animal husbandry sector, business communication, inter-personnel skills for establishing an enterprise.

II. Theory

Unit I (2 Lectures)

Understanding livestock entrepreneurship, Concept and characteristics of Entrepreneurship, Role of entrepreneur in relation to enterprise, Functions of the entrepreneur in the economy,

Unit II (4 Lectures)

Process of entrepreneurship development. Barriers in entrepreneurship. The institutional interface in the development of entrepreneurship, incubation centres, startups, PPP Prospective in the animal husbandry sector.

Unit III (6 Lectures)

Essential criteria for the development of entrepreneurship in livestock sector - basic requirements for entrepreneurship initiatives in livestock and allied sectors (i.e. techno-economic feasibility of the enterprises under different conditions, training and management skills, business acumen, business communication, inter-personnel skills for establishing an enterprise, etc.).

Unit IV (4 Lectures)

Entrepreneurial training/ development programmes at the State and National level, Livestock Insurance, Bank and Government support for entrepreneurship, Financial credit and financial management: general principles and practices, analyzing project appraisals and reports, capital, expenditure decisions, reinvestment and payback.

Unit V (2 Lectures)

Preparing projects for bank appraisal, banking requirements, Assessing project profits, Procurement management quality issues, standardisation, grading and packaging.

III. Practical (14 Classes)

Visit incubation centres, extrapolation of existing financial models in livestock entrepreneurship, Approach to the preparation of Entrepreneurial Project on livestock, Bankable project for a dairy enterprise (small/ large dairy unit), Bankable



project for a sheep/ goat/ Ram lamb enterprise, Bankable project for a pig-enterprise, Bankable project for a Broiler enterprise (small/ medium/ large unit), Bankable project for a layer-enterprise

IV. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

V. Learning outcome

The student acquires knowledge in entrepreneurship initiatives in livestock and allied sectors, financial management and assessment of project profit.

VI. Suggested Reading

- George RP and Raj Kamal PJ. 2015. *Farm Economics, Entrepreneurship and Marketing*. Satish Serial Publishing, New Delhi.
- Kahan D. 2012. *Entrepreneurship in Farming*. FAO, Rome.
- Zama MMS, Rashid M and Kumar S. 2014. *Handbook of Livestock Entrepreneurship*. Narendra Publishing House.
- *Selected articles from journals*.

I. Course Title : Precision Livestock Farming

II. Course Code : LPM 708

III. Credit Hours : 1+1

IV. Why this course?

Precision Livestock Farming is a combination of developing animal sensing (sensors) tools and decision-making process at the farm level. This information is very much needed for the students in the present technology of the world.

V. Aim of the course

To educate the students with a concept of precision in livestock farming, implementation of the sensor system, automation, use of software and analysis

VI. Theory

Unit I (2 Lectures)

Concepts of Precision Livestock Farming-Scope and limitations. Utilities of Precision tools in Livestock Farming, the present level of usage of precision tools in India

Unit II (6 Lectures)

Implementation of sensor systems and ICTs in animal health, productivity and welfare, Animal identification and tracking- Radio frequency identification (RFID), Livestock identification and traceback system (LITS), etc. Geo-tagging, Virtual fencing, GPS and GIS in the exploration of feeding resources and grasslands.

Unit III (6 Lectures)

Automation in water resource management. Development and evaluation of early warning and disease support systems for animal health and welfare.

Unit IV (2 Lectures)

Use of software's for database creation of the livestock farms, computation and analysis.

VII. Practical (14 Classes)

GPS/ GIS Application in the exploration of breeding tracts of livestock, forage and



grassland profiles. Exposure visit to precision livestock farms with automation, use of tools in reproduction and health care, use of different software in farm routines.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

By the end of this course, the students will gain knowledge in precision livestock farming.

X. Suggested Reading

- Halachmi I. 2015. *Precision Livestock Farming Applications*. Wageningen Academic Pub.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- *Selected articles from journals*.

I. Course Title : Recent Developments in Poultry Production Management

II. Course Code : LPM 709

III. Credit Hours : 2+1

IV. Why this course?

The poultry industry is growing at a very fast rate. Students have to remain aware of the recent developments in the sector

V. Aim of the course

To educate the students on recent developments on the management of farms and hatcheries, egg, meat and policy developments in poultry.

VI. Theory

Unit I (8 Lectures)

Planning, organization, executive and management of poultry farms and hatcheries of various sizes - an alternative in poultry production

Unit II (4 Lectures)

Demand, supply, the present status of poultry production in India.

Unit III (10 Lectures)

Problems and new management techniques in poultry for egg and meat in India vis-à-vis in other countries of the world - Automation in poultry houses, management of specific pathogen-free flocks.

Unit IV (10 Lectures)

Poultry development policies and planning for higher production constraints in development and solutions, Ethology in relation to avian welfare in intensive poultry production.

VII. Practical (14 Classes)

Planning and preparation of research and commercial projects on broiler and layer production management.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits



IX. Learning outcome

By the end of this course, the student acquires knowledge in advances of modern poultry farm and hatchery management

X. Suggested Reading

- DAHD. 2015. *Poultry Farm Manual: A Reference Guide for Central and State Poultry Farms*. 2014-15. Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India.
- FAO. 2003. Live bird marketing. In: *Egg Marketing - A Guide for the Production and Sale of Eggs*. <http://www.fao.org/3/Y4628E/y4628e09.htm#bm9>
- Sreenivasaiah PV. 2006. *Scientific Poultry Production: A Unique Encyclopaedia*. International Book Distribution Co.
- *Selected articles from journals.*

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Animal Production Sciences

– Livestock Products Technology

Preamble

(Livestock Products Technology)

Salient features of revised courses

- Changed course numbers to bring desired sequence in the courses for better understanding. Revised and updated all courses to ensure practical and latest knowledge covering processing quality control and other aspects of livestock products.
- To give more emphasis on processing, packaging, quality control and marketing of livestock products, separate courses have been developed for processing, packaging and marketing, and quality control (earlier course no. was LPT 602, Now LPT 603, LPT 605, LPT 606). Many latest topics have been included in the revised courses.
- Topics related to poultry meat (earlier course no. LPT 603) are included along with other meat topic in LPT 601, LPT 603, LPT 605 and LPT 606). Separate course has been developed for Fish and Fish Products (LPT 613, optional).
- In abattoir course (LPT 605), contents related to meat plant operations are included as per requirement of industry, so that students get practical knowledge. Course number is changed to LPT 601 to bring desired change in sequence.
- In slaughter house byproducts course (earlier course no. was LPT 606, now LPT 607), all updated/ latest technologies/ processes have been included.
- Courses specifically related to milk, are re-casted. Separate course (LPT 604) is developed on Milk and milk products processing (after deleting processing content from old course - LPT 610). This ensures more emphasis on Market milk and dairy plant operations (LPT 610).
- Updated, revised and changed In-plant training course (LPT 612) to Industrial and Entrepreneurial Training course (LPT 608) and made it as a credit course.
- Advances in Fresh and Processed Meat Products Technology (LPT 702), is divided into two courses (LPT 702 and 703). Topics related to Meat production are also included in LPT 702.
- Contents of these two related courses (LPT 705 and 706, quality control and biotechnological tools) are merged and given in new course LPT 705. Topics are revised, updated and rearranged in other courses.
- Considering the entrepreneurship importance, changing trends of consumer preference for novel animal food products and requirement of the industry, and also to provide practical exposure and training to students, following new courses are proposed:
 1. LPT 706- Ethnic and Organic Meat and Milk Products (1+1)
 2. LPT 707- Industrial and Entrepreneurial Training (0+2)
 3. LPT 708- Current trends in Disposal and Utilization of Waste from Meat and Dairy Industry (1+1)
 4. LPT 709 Advances in Egg and Egg Products Technology (1+1)

Course Title with Credit Load

M.V.Sc. in Livestock Products Technology

Course No.	Course Title	Credits Hours
LPT 601*	Abattoir Practices and Meat Plant Operations	2+1
LPT 602*	Fresh Meat Technology	1+1
LPT 603*	Processing and Preservation of Meat	2+1
LPT 604*	Processing of Milk and Milk Products	1+1
LPT 605*	Packaging and Marketing of Livestock Products	1+1
LPT 606*	Microbiology and Quality Control of Livestock Products	1+1
LPT 607*	Slaughterhouse By-products Technology	1+1
LPT 608	In-Plant Training	0+2
LPT 609	Egg and Egg Products Technology	1+1
LPT 610	Market Milk Processing and Dairy Plant Practices	1+1
LPT 611	Processing and Marketing of Wool	1+1
LPT 612	Biotechnology of Foods of Animal Origin	1+1
LPT 613	Fish and Fish Products Technology	1+1
LPT 691	Seminar	1+0
LPT 699	Research	30

*Core courses



Course Contents

M.V.Sc. in Livestock Products Technology

- I. Course Title** : Abattoir Practices and Meat Plant Operations
II. Course Code : LPT 601
III. Credit Hours : 2+1

IV. Why this course?

Human Resource Development (Manager, Supervisor, Meat inspector and other Technocrats) for Slaughterhouses and Meat processing plants.

V. Aim of the Course

To impart knowledge about the handling of meat animals, layout and design of abattoir, sanitation and basics of slaughterhouse practices and meat plant operations.

VI. Theory

Unit I (12 Lectures)

Handling and transportation of meat animals including poultry - Pre-slaughter handling and care of food animals – Ante-mortem inspection - Humane slaughter - Principles and methods of stunning - Ritual methods of the slaughter of food animals and poultry - Machinery for slaughter and dressing of food animals - Post-mortem inspection - Handling, disposal and condemnation of unfit materials.

Unit II (11 Lectures)

Abattoir - layout, designing, organization and operation - Maintenance of meat and poultry processing plants - Record keeping - Legislations and regulations for establishment and operation of slaughterhouses and meat processing plants.

Unit III (11 Lectures)

Sanitation of slaughterhouse - Sanitary practices in meat plant and its benefits - Solid and liquid waste management of slaughterhouse - Different methods of effluent treatment and designs of effluent treatment plants - State and Central Pollution Control Board norms.

VII. Practical (17 classes)

Design and outlay of modern abattoir including poultry processing and effluent treatment plants for different capacities - Judging and grading of food animals - Procedure for the slaughter of food animals and poultry - Ante-mortem and post-mortem inspection - Recording of carcass data - carcass yield, meat bone ratio, etc. - Measurement of effluent characteristics - pH, BOD, COD, suspended solids, etc. - Visit slaughterhouse, poultry processing and effluent treatment plants - DPR for the establishment of an abattoir.

VIII. Teaching methods

- Classroom teaching, practical demonstration in Divisional laboratory/ slaughter unit.
- Visit municipal slaughterhouse and meat plants.
- Demonstration of charts, video films and models.

IX. Learning Outcome

Gaining knowledge of abattoir practices and operations to be carried out in meat plants.

X. Suggested Reading

- Collins DS and Huey RJ. 2015. *Gracey's Meat Hygiene*, 11th Ed. John Wiley and Sons Ltd., UK.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences* Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing- Improving Quality*. Woodhead Publishing Ltd., UK.
- Sahoo J, Sharma DK and Chatli M. 2011. *Practical Handbook on Meat Science and Technology*, 1st ed., Daya Publishing House.
- Swatland HJ. 2004. *Meat Cuts and Muscle Foods*. Nottingham Univ. Press.
- Warriss P. 2010. *Meat Science: An Introductory Text*, 2nd ed. Oxford Press.

I. Course Title : Fresh Meat Technology

II. Course Code : LPT 602

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development for Meat processing Sector

V. Aim of the Course

To impart knowledge about the status of the meat industry, muscle structure and composition, carcass handling, grading and fabrication.

VI. Theory

Unit I (10 Lectures)

History, current development and prospects of meat and poultry industry in India – Skeletal muscle development – pre- and post-natal- Structure and chemistry of muscle including poultry – Muscle Proteins - sarcoplasmic and myofibrillar proteins – Stromal proteins – Types of muscle fibres - Post mortem changes – Rigor mortis - Conversion of Muscle to meat - Pre and post-slaughter factors affecting meat quality – Defects during the conversion of muscle to meat – PSE/ DFD/ Cold Shortening – Off odour development.

Unit II (7 Lectures)

Composition and nutritive value of meat and poultry - Qualities of fresh meat – pH, WHC, colour, odour, juiciness, texture/ tenderness and firmness - Chilling, ageing and conditioning of meat - Electrical stimulation - Carcass evaluation, grading and fabrication- Tenderization of meat.

VII. Practical (17 Classes)

Evaluation/ estimation of physicochemical properties of fresh meat pH, colour, water holding capacity, ERV, shear force value, glycogen, R-value and myoglobin - Proximate analysis of meat - Estimation of drip loss - Determination of sarcomere length, fibre diameter and myofibrillar fragmentation index - Fractionation of sarcoplasmic, myofibrillar and stromal proteins - Carcass evaluation and grading - Meat cutting, retail and wholesale cuts.



VIII. Teaching methods

- Classroom teaching, practical demonstration and analysis in Divisional laboratory/ slaughter unit.
- Visit slaughterhouses, meat plants and retail units
- Use of Audio-visual Capsules.

IX. Learning Outcome

Acquiring knowledge on quality attributes of fresh meat, factors affecting these attributes, composition and nutritive value of meat.

X. Suggested Reading

- Aberle ED, Forest JC, Gerrard DE and Mills E. 2013. *Principles of Meat Science*, 5th ed., Kend All/ Hunt Publishing Company, IOWA.
- Bender A. 1992. *Meat and Meat Products in Human Nutrition in Developing Countries*. FAO, Rome.
- Carlson CW, Greaser ML and Jones KW. 2001. *The Meat We Eat*, 14th ed. Interstate Publishers, INC.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences* Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Lawrie RA and Ledward DA. 2006. *Lawrie's Meat Science*, 7th ed. Woodhead Publishing Limited, Cambridge, England.
- Pearson AM. 1994. *Quality Attributes and their Measurement in Meat, Poultry and Fish Products*. Springer, New York.
- Swatland HJ. 2004. *Meat Cuts and Muscle Foods*. Nottingham University Press.

I. Course Title : Processing and Preservation of Meat

II. Course Code : LPT 603

III. Credit Hours : 2+1

IV. Why this course?

Human Resource Development for Meat and Poultry Processing Industry and Entrepreneurship development

V. Aim of the Course

To impart knowledge about processing and preservation of meat including poultry meat, fundamentals of sensory evaluation and techniques for sensory evaluation of meat products.

VI. Theory

Unit I (8 Lectures)

Basic principles of meat preservation – dehydration, chilling, freezing, freeze-drying, thermal processing, direct microbial inhibition, irradiation, use of chemicals and antimicrobials - Curing and smoking - Hurdle technology concept.

Unit II (17 Lectures)

Principles of Meat Processing - Meat and non-meat ingredients and their roles - Additives - Processing techniques - comminution, chopping, blending, marination, massaging, tumbling, etc. - Cooking methods including microwaving – Development of meat products including ham, bacon, tandoori and barbeque - Emulsion formation – factors affecting emulsion formation - Emulsion based meat products - sausages, nuggets and patties - Enrobed, restructured, fermented and intermediate moisture meat products – Ready-to-cook, ready-to-eat and shelf-stable meat products - Canned

and retort meat products – Traditional and ethnic meat products - Functional meat products.

Unit III (9 Lectures)

Sensory evaluation – Sensory physiology, types, methods, quality attributes - Factors influencing sensory measurements - Types of sensory panels - Selection of sensory panellists- Sensory evaluation tests- Layout and designing of sensory evaluation laboratory.

VII. Practicals (17 Classes)

Estimation of tyrosine value, nitrite content, TBARS value, peroxide value - Preparation of Meat Products - Minced meat products - Emulsion based meat products – sausages, nuggets and patties - Ham and Bacon - Meat Pickles – Enrobed, restructured, fermented and shelf-stable meat products - Canned/ retorted Meat Products - Traditional and ethnic Meat Products - Kebabs - Sensory evaluation of meat products - Subjective and objective method of sensory evaluation - differential, descriptive, training tests, etc. – Test practices and training in the sensory lab - Determination of emulsion stability - Cooking yield - Texture Profile Analysis.

VIII. Teaching methods

- Classroom teaching, practical performance in Divisional Pilot Processing Plant.
- Visit of Meat and Poultry Processing Unit.
- Demonstration videos

IX. Learning Outcome

Theoretical and practical understanding of meat preservation, processing and sensory evaluation of the meat products.

X. Suggested Reading

- Aberle ED, Forest JC, Gerrard DE and Mills E. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Amerine MA, Pangborn RM and Roessler EB. 1965. *Principles of Sensory Evaluation of Food*. Academic Press, New York.
- Barbut S. 2005. *Poultry Products Technology*. CRC Press.
- Carlson CW, Greaser ML and Jones KW. 2001. *The Meat We Eat*, 14th ed. Interstate Publishers, INC.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing- Improving Quality*. Woodhead Publishing Ltd., UK.
- Lawless HT and Heymann H. 2010. *Sensory Evaluation of Food - Principles and Practices*, 2nd ed, Springer-Verlag, New York Inc.
- Mountney GJ and Parkhurst CR. 2017. *Poultry Products Technology*, 3rd ed. Food Products Press, New York.
- Pearson AM and Gillett TA. 1996. *Processed Meats*, 3rd ed. Chapman and Hall, Inc, New York.
- Sharma BD, Wani S and Sharma N. 1997. *Sensory Evaluation Manual for Meat and Meat Products*. IVRI Publication.
- Toldrá F. 2010. *Handbook of Meat Processing*. Wiley-Blackwell.



- I. Course Title : Processing of Milk and Milk Products**
II. Course Code : LPT 604
III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development (Manager, Supervisor and other Technocrats) for Milk Processing Industry, Cooperatives, etc.

V. Aim of the Course

To impart knowledge about the organization of dairy plants, basic milk operations, cleaning and sanitization of milk processing plants, milk products processing and applications of membrane technologies in dairy industries.

VI. Theory

Unit I (6 Lectures)

Basic concepts of dairy plant organization and operation - collection, chilling, transportation - Heat treatments of Milk - Cleaning and sanitization of Dairy plants - Composition, nutritional, physico-chemical and functional properties of milk - Standards for milk and milk products.

Unit II (7 Lectures)

Manufacture of milk products - Flavoured Milk - Drying of milk and milk products - Evaporated and condensed milk - Milk powders – Butter - Ice cream and other frozen desserts - Manufacture of different fermented milk products - Manufacture of cheddar, mozzarella, cottage and processed cheese - Manufacture of indigenous milk products – paneer, channa, khoa, ghee, dahi and shrikhand - Rheology of milk products - Dairy by-products.

Unit III (4 Lectures)

Membrane filtration technology- principles and concepts - Manufacturing and functional properties of casein - Caseinates- Co-precipitates - Whey protein concentrates (WPC) - Lactose- Dairy whiteners.

VII. Practical (17 Classes)

Platform tests - Determination of fat, SNF, TS, protein, lactose and ash contents of milk - Preparation of butter, ice cream, cheese – cheddar, mozzarella and cottage cheese, khoa, paneer, channa, ghee, dahi, yoghurt, casein, caseinate, co-precipitate, flavoured milk - Determination of degree of browning - Measurement of rheological properties of different milk products - Evaluation of sensory quality of milk and milk products - Visit dairy plants.

VIII. Teaching methods

- Classroom teaching and laboratory practical.
- Visit the milk processing plant.
- Use of Audio-visual Capsules

IX. Learning Outcome

Gaining knowledge of handling and processing of milk and milk products.

X. Suggested Reading

- Aneja RP, Mathur BN, Banerjee AK and Chandan RC. 2002. *Technology of Indian Milk Products*. Dairy India.



- Chandan RC, Kilara A and Shah NP. 2008. *Dairy Processing and Quality Assurance*, 1st ed. Willey–Blackwell.
- Davis JG. 2010. *Milk Testing: A Laboratory Control of Milk*. Agribios.
- MIF. 2005. *Analysis of Milk and its Products: A lab Manual*, 2nd ed. Milk Industries Foundation. Biotech Books, Delhi
- Singh S. 2014. *Dairy Technology*, Vol. 1 and 2. New India Publishing Agency.
- Spreer E. 1993. *Milk and Dairy Products*. Marcel Dekker.
- Varnam AH and Sutherland JP. 1994. *Milk and Milk Products Technology*. Chapman and Hall, UK.
- Walstra P, Wouters JTM and Geurts, TJ. 2006. *Dairy Science and Technology*, 2nd ed. Taylor and Francis Group.
- Web BH, Johnson AH and Alford JA. 1987. *Fundamental of Dairy Chemistry*, 3rd ed. Westport AVI Publ.

I. Course Title : Packaging and Marketing of Livestock Products

II. Course Code : LPT 605

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development (Manager, Supervisor, Marketing Executives and other Technocrats) for Packaging Industry and Business Planning.

V. Aim of the Course

To impart knowledge about properties of different packaging material, techniques used in packaging of different livestock products, marketing channels and value chain of processed products.

VI. Theory

Unit I (10 Lectures)

Principles of packaging - objectives and functions - Product characteristics affecting packaging requirements - Packaging materials and their characteristics - Different packaging systems for fresh, cured, dehydrated, freeze-dried and shelf-stable products of milk, meat and chicken - Aseptic packaging of milk - UHT milk - Vacuum packaging – MAP and role of different gases - Retort pouch processing - Active and intelligent/ smart (biosensors) packaging - Edible and biodegradable packaging - Nanotechnology for food packaging - Recycling of packaging materials - Labelling requirements – Barcoding and its importance - Packaging standards and regulations – Economics of different packaging systems.

Unit II (7 Lectures)

Marketing of Livestock Products - Types of markets - Marketing channels of live meat animals and Poultry - Existing systems - constraints and possible solutions - Value Chain of meat, poultry and processed products - strategies and interventions for better profitability – Meat retailing and establishment of retail outlets for meat and poultry - FSSAI, APEDA, EIA, GOI/ WTO regulations for the domestic market, import and export of livestock products.

VII. Practical (17 Classes)

Different packaging materials and their properties - Determination of thickness, bursting strength, piercing strength, water vapour transmission rate, gas transmission rate, headspace gas analysis - Vacuum, shrink, MAP and retort



packaging of meat and milk products - Visit milk and meat processing plants - Study of the value chain of livestock products including online marketing.

VIII. Teaching methods

- Classroom teaching, Practical demonstration in the laboratory.
- Visit market and packaging units.
- Demonstration using video films and models.

IX. Learning Outcome

Developing an understanding of packaging and marketing of livestock products.

X. Suggested Reading

- Aberle ED, Forrest JC, Gerrard DE and Mills EW. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed., Elsevier Academic Press, UK.
- Robertson GC. 2012. *Food Packaging- Principles and Practices*, 3rd ed. CRC Press.
- *Selected Articles from Journals.*

I. Course Title : Microbiology and Quality Control of Livestock Products

II. Course Code : LPT 606

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development for Quality Control of Livestock Products

V. Aim of the Course

To develop an understanding about microbial spoilage of different livestock products, quality control and legal standards.

VI. Theory

Unit I (9 Lectures)

Microorganisms associated with spoilage of livestock products - Factors affecting microbial growth - Contamination of livestock products - Microbial spoilage of meat, poultry, eggs, milk and their products - Physical and chemical changes produced by microbes in milk, meat, eggs and their products - Meat and milk-borne infections and intoxications - Control of microbial growth in livestock products - Antimicrobial resistance (AMR).

Unit II (8 Lectures)

Introduction to Good Laboratory Practices (GLP), Good Hygienic practices (GHP) and Good Manufacturing Practices (GMP), Sanitary and Phytosanitary measures (SPS) and Food Safety System Certification (FSSC) - Quality Control – Quality Assurance - principles and practices - Quality Management Systems – Food Safety and Standards Act (FSSAI, 2006 Act) - Codex regulation for food products safety - ISO 9001 - ISO 22000 - HACCP concepts - Risk-based quality assessment - Microbial quality control - FSSAI/ BIS standards for milk, meat and poultry, Chemical residues in livestock products and their effects on the health of the consumer.



VII. Practical (17 Classes)

Basic requirements for setting up of quality control laboratory - Sampling methods for the microbiological examination of different processing plants, products and equipment - Development of HACCP plan for milk and meat processing plants - Microbial evaluation of market samples of milk, meat and egg – Total Viable Count, coliform, etc. - Pathogens of Public Health importance - *E. coli*, *Salmonella*, *Staphylococcus aureus*, *Campylobacter* - Rapid detection methods of food pathogens.

VIII. Teaching methods

- Classroom teaching with laboratory analysis.
- Sampling and survey of market, butchers shop, milk and meat processing plants.
- Visits to units having HACCP and ISO certification.

IX. Learning Outcome

Acquiring knowledge on microbiology, quality control and legal standards for different livestock products.

X. Suggested Reading

- Aberle ED, Forrest JC, Gerrard DE and Mills EW. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Bell C, Neaves P and Williams AP. 2005. *Food Microbiology and Laboratory Practices*, 1st ed. Blackwell Publishing.
- Collins DS and Huey RJ. 2015. *Gracey's Meat Hygiene*, 11th ed. John Wiley and Sons Ltd., UK.
- Frazier WC and Westhoff DC. 2013. *Food Microbiology*, 5th ed. McGraw Hill Publication.
- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Jay JM, Loessner MJ and Golden DA. 2006. *Modern Food Microbiology*, 7th ed. Springer.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed., Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing-Improving Quality*. Woodhead Publishing Ltd., UK.
- Pearson AM and Dutson TR. 1995. *Quality Attributes and their Measurement in Meat, Poultry and Fish Products*. Aspen Publishers, Inc, Maryland, USA.

I. Course Title : Slaughterhouse By-products Technology

II. Course Code : LPT 607

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development for better utilization of animal by-products and pollution control

V. Aim of the Course

To impart knowledge about the utilization and processing of animal by-products.

VI. Theory

Unit I (6 Lectures)

Status and scope of slaughterhouse by-products utilization - Trade practices - Planning, design and layout of by-products plant - Classification of by-products - edible and inedible - Rendering methods and products - Yield and characteristics of rendered fat and meat cum bone meal.



Unit II (6 Lectures)

Utilization of blood, horns and hooves, intestine, bones, feathers, bristles, glandular by-products and ruminal contents - Value-added by-products from slaughterhouse and poultry processing plants - Processing of animal by-products for pet foods - High-value low volume by-products – collagen sheets, scaffolds, bone morphogenic proteins, biopeptides, biodiesel, etc.- Legislation and regulations related to animal by-products.

Unit III (5 Lectures)

Flaying - Classification and factors affecting the quality of hides and skin - Physical and chemical characteristics of hide and skin - Grading and processing of hide and skin for the manufacture of leather - Preparation and quality control of gelatine and glue.

VII. Practical (17 Classes)

Preparation of casing, neatsfoot oil, gelatin and glue - Demonstration of preparation of carcass meal, meat meal, bone meal, blood meal, feather meal, slime meal - Grading of casings - Collection and preservation of glandular by-products - Preparation of pet foods -Visit local by-products processing units - Quality evaluation of rendered animal fat.

VIII. Teaching methods

- Classroom teaching, practical demonstration of different by-products preparation in the Divisional laboratory/ slaughter unit
- Visit of municipal slaughterhouse and tanneries.
- Use of Audio-visual Capsules.

IX. Learning Outcome

Gaining knowledge on proper utilization of slaughterhouse by-products

X. Suggested Reading

- Aberle ED, Forrest JC, Gerrard DE and Mills EW. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed., Elsevier Academic Press, UK.
- Mann I. 1962. *Animal By-products: Processing and Utilization*. FAO, Rome. Ockerman HW and Hansen CL. 1999. *Animal By-product Processing and Utilization*. CRC Press.

I. Course Title : In-Plant Training

II. Course Code : LPT 608

III. Credit Hours : 0+2

IV. Why this course?

Development of Entrepreneurial Skill and Human Resources for Meat and Milk Industry

V. Aim of the Course

To impart industrial exposure and develop entrepreneurial skill among postgraduate students.

VI. Practical (34 sessions/ Hours equivalent to 34 credit hours of practical)

LPT students shall undergo in-plant training in any one of the specialized area of



Livestock Products Technology in an institute/ industry – private or public sector. After completion of the training, the student will submit a training report. The evaluation will be based on attendance, report submission and viva-voce examination.

VII. Teaching methods

- Deputation to slaughterhouse/ meat/ milk processing plants
- Use of Audio-visual Capsules.

VIII. Learning Outcome

Students after undergoing training will have a good understanding of the functioning of the industry and capable of starting their own enterprises.

IX. Suggested Reading

- Interaction with Industry Persons.
- *Selected articles from Journals.*

I. Course Title : Egg and Egg Products Technology

II. Course Code : LPT 609

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development for Egg Processing Industry/ Plants

V. Aim of the Course

To impart knowledge about the status of egg production, composition, nutritive value, preservation, grading, processing packaging and marketing of eggs and egg products.

VI. Theory

Unit I (9 Lectures)

Status of egg production and processing in India - Structure, composition, nutritive value and functional properties of eggs - Grading, preservation, packaging and marketing of shell eggs - Quality evaluation of shell eggs and factors influencing egg quality - Defects and Spoilage of eggs.

Unit II (8 Lectures)

Layout and design of egg processing Unit - Principles and procedures involved in pasteurization, chilling, freezing, desugarization and drying of egg products - Quality standards of egg products - Packaging of egg products - Designer egg products.

VII. Practical (17 Classes)

Evaluation of physical, chemical, functional and microbial quality of egg and egg products - Preservation of eggs - Preparation of value-added egg products - Visit egg-processing plant.

VIII. Teaching methods

- Classroom teaching, practical demonstration in Divisional laboratory.
- Visit egg processing plant.

IX. Learning Outcome

Gaining knowledge on composition, nutritive value, preservation and marketing of eggs. Quality maintenance and development of designer egg products.



X. Suggested Reading

- Romanoff AL and Romanoff AJ. 1949. *Avian Egg*. John Wiley and Sons.
- Stadelman WL and Cotterill OJ. 2002. *Egg Science and Technology*, 4th ed. CBS.
- *Selected articles from Journals*.

I. Course Title : Market Milk Processing and Dairy Plant Practices

II. Course Code : LPT 610

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development (Manager, Supervisor and other Technocrats) for Milk Processing Industry and Dairy Plants.

V. Aim of the course

To impart knowledge about procurement of milk, assessment of milk quality, legislation for quality control, milk processing techniques, the layout of milk processing and dairy effluent plants and preparation of special milk.

VI. Theory

Unit I (5 Lectures)

Organization of procurement and pricing plans of raw milk - Operation of automatic milk collection stations - Reception of milk at Raw Milk Reception Dock (RMRD) - Assessing raw milk quality - Sanitary handling of milk - Milk standards and legislations.

Unit II (6 Lectures)

Unit operations in milk processing plants - Clarification – Bactofugation - Different chilling methods - Standardization - Homogenization (theories, methods and effects) - Heat treatments (thermization, boiling, pasteurization, sterilization (UHT and In-container) - Separation technologies (Microfiltration, Ultrafiltration, reverse osmosis, diafiltration, nanofiltration etc).

Unit III (2 Lectures)

Distribution methods for liquid milk - Consumer pricing - Traceability - Handling of unsold and returned milk- - Adulteration of milk and detection - Residues in milk and preventive steps

Unit IV (4 Lectures)

Fortified, special and functional market milk - A1 and A2 milk Design and layout of dairy plants of different capacities - Dairy by-products - Treatment of Dairy Effluents.

VII. Practical (17 Classes)

Platform tests - Principles of rapid milk analyzers including milko-tester and operation of automatic milk collection stations - Raw milk quality, somatic cell count, bacteriological count - Estimation of homogenization efficiency - Assessment of efficiency of pasteurization, sterilization and boiling- Detection of adulterants.

VIII. Teaching methods

- Classroom teaching and laboratory analysis.
- Visit milk processing plants.

IX. Learning Outcome

Acquaintance with the processing of market milk and other dairy plant practices.

X. Suggested Reading

- FAO. 2013. *Milk and Dairy Products in Human Nutrition*. FAO, Rome.
- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Walstra P, Wouters JTM and Geurts, TJ. 2006. *Dairy Science and Technology*, 2nd ed., Taylor and Francis Group.

I. Course Title : Processing and Marketing of Wool

II. Course Code : LPT 611

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development (Manager, Supervisor and other Technocrats) for Wool Processing Industry

V. Aim of the Course

To impart knowledge about the growth and structure of wool and fibres and their use. Grading, processing, marketing and specifications of wool and speciality fibres.

VI. Theory

Unit I (10 Lectures)

Status and prospects of wool industry - Wool types and their uses - Growth and molecular structure of wool fibre - physical and chemical properties of wool - Grading of wool, Characteristics of speciality hair fibres and their uses- factors influencing the quality of wool and speciality hair fibres - principles and steps involved in the processing of wool and speciality hair fibres, Impurities in wool and their removal, Defects in wool.

Unit II (7 Lectures)

Physical, chemical and mechanical testing of wool - by-products of wool industry - Trade and Marketing of wool, specification and regulation for quality control - Characteristics of natural and synthetic fibres

VII. Practical (17 Classes)

Physical, chemical and mechanical testing of wool and speciality hair fibres - Characterization of wool - grading of wool - Identification of natural and synthetic fibres - Visit the wool processing industry and acquaintance with various steps in the processing of wool and speciality hair fibres.

VIII. Teaching methods

- Classroom teaching and laboratory analysis.
- Visit wool processing units.

IX. Learning Outcome

Gaining knowledge on the quality and processing of wool.

X. Suggested Reading

- Bergen WV. 1963. *Wool Hand Book*, Vols. I and II. Interscience.
- Houck MM. 2009. *Identification of Textile Fibres*. Woodhead Publishing Limited, Cambridge, England.



- Johnson NAG and Russell IM. 2009. *Advances in Wool Technology*. Woodhead Publishing Limited, Cambridge, England.

- I. Course Title** : **Biotechnology of Foods of Animal Origin**
II. Course Code : **LPT 612**
III. Credit Hours : **1+1**

IV. Why this course?

Human Resource Development for meat and milk processing Industry with understanding of the latest biological techniques

V. Aim of the Course

To impart knowledge about new biotechnological techniques and tools for improving livestock productivity, quality control and food value.

VI. Theory

Unit I (10 Lectures)

Role of Biotechnology in improving productivity and quality of Meat, Milk and their products - Application of biotechnological tools in food preservation and packaging - Transgenic meat animal production - techniques - Genes influencing meat quality traits – Production of meat and milk with the desired composition - Application of enzymes in dairy and meat industry - Genetically modified enzymes - Biotechnologically produced food flavours and colours for animal products.

Unit II (7 Lectures)

Starter cultures in Meat and milk - Pre and probiotics, and their supplementation in animal origin foods - Biopreservation- Bacteriocin - Fermentation technology - Upstream and Downstream processing - Biosensors - Antimicrobial Peptides - Meat Species Identification- Molecular tools.

VII. Practical (17 Classes)

Introduction of basic biotechnological techniques such as western blotting, enzyme isolation and identification, DNA extraction, amplification, different types of PCR, Acquaintance with RT-PCR, Multiplex PCR, gene identification and characterization - Biotechnological techniques for meat species identification and meat quality - Electrophoresis, Chromatography for fatty acids- Operation of Fermenters.

VIII. Teaching methods

- Classroom teaching.
- Use of Audio-visual capsules.

IX. Learning Outcome

Gaining knowledge on utilization of biotechnology as a tool to improve production, shelf life and nutritive value of livestock products.

X. Suggested Reading

- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing - Improving Quality*. Woodhead Publishing Ltd., UK.
- Kowale BN, Kulkarni VV and Keshava Rao V. 2008. *Methods in Meat Science*. Jaypee Brothers Medical Publishers, New Delhi.
- Sahoo J, Sharma DK and Chatli MK. 2011. *Practical Handbook on Meat Science and Technology*, Daya Publishing House, New Delhi.

- Toldra F. (Ed). 2008. *Meat Biotechnology*, Springer Science, New York
- Webb BH, Johnson AH and Alford JA. 2005 *Fundamentals of Dairy Chemistry*, 2nd ed. CBS Publishers and Distributors Pvt. Ltd.
- Selected articles from Journals.

I. Course Title : Fish and Fish Products Technology

II. Course Code : LPT 613

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development (Manager, Supervisor and other Technocrats) for Fish Processing Industry

V. Aim of the Course

To impart knowledge about fish resources, structure and composition of fish muscles, preservation and processing of fish, marketing of fish products, deterioration of quality and legislations for quality control.

VI. Theory

Unit I (9 Lectures)

Fishery resources, marine and freshwater fishes- Transportation and hygienic handling of fish - Fish Muscle structure, composition and nutritive value - Processing of fish - gutting, filleting, beheading, peeling, deveining, etc. - Preservation - chilling, freezing, etc. - Principles and procedure of canning, curing, smoking, dehydration - Surimi and other Fish based products.

Unit II (8 Lectures)

Quality control- identification of freshness of fish - Chemical and Microbial spoilage of fish, labelling and marketing of fish and fish products, utilization of fish processing waste. National and international regulations, standards, quality control and marketing of fish and fish products.

VII. Practical (17 Classes)

Visit fish processing plant - Grading of live fish for freshness - Filleting and other techniques for the processing of fish - Proximate Composition of Fish - Physico-chemical and Microbial evaluation of fish quality - Preparation of Value added fish products.

VIII. Teaching methods

- Classroom teaching.
- Practical demonstration in the laboratory.

IX. Learning Outcome

Acquiring knowledge on the structure of fish muscle, preservation, processing and quality control of fish and fish products.

X. Suggested Reading

- Pearson AM. 1994. *Quality Attributes and their Measurement in Meat, Poultry and Fish Products*. Springer, New York.
- Suzuki T. 1981. *Fish and Krill: Protein Processing Technology*. Applied Science Publ.
- Selected articles from Journals.



Course Title with Credit Load

Ph.D. in Livestock Products Technology

Course No.	Course Title	Credits
LPT 701*	Modern Abattoir Practices and Animal By-Products Technology	1+1
LPT 702*	Advances in Meat Production and Fresh Meat Technology	1+1
LPT 703*	Developments in Processed Meat Technology	1+1
LPT 704*	Current Trends in Processing of Milk And Milk Products	1+1
LPT 705	Biotechnological Techniques and Quality Control of Livestock Products	1+1
LPT 706	Ethnic and Organic Meat and Milk Products	1+1
LPT 707	Industrial and Entrepreneurial Training	0+2
LPT 708	Current Trends in Disposal and Utilization of Waste From Meat and Dairy Industry	1+1
LPT 709	Advances in Egg and Egg Products Technology	1+1
LPT 791	Seminar I	1+0
LPT 792	Seminar II	1+0
LPT 799	Research	75

*Core courses

Course Contents

Ph.D. in Livestock Products Technology

I. Course Title : **Modern Abattoir Practices and Animal By-Products Technology**

II. Course Code : **LPT 701**

III. Credit Hours : **1+1**

IV. Why this course?

Human Resource Development (Manager, Supervisor and other Technocrats) for Slaughterhouses, Tanneries and other by-products industries.

V. Aim of the Course

To impart knowledge about advances in abattoir practices and animal by-products utilization.

VI. Theory

Unit I (5 Lectures)

Current scenario of slaughterhouses and processing plants in India - Establishment and operation of a modern abattoir - Basic machinery and tools of slaughterhouse - Automation/ Robotics in meat and by-product processing – Latest developments in the evaluation of carcass quality – Chilling and freezing of carcass - Maintenance of cold storages.

Unit II (8 Lectures)

Latest machinery and tools used in by-products processing plant - New technologies for utilization of animal by-products as food, feed, pharmaceuticals and other miscellaneous products - Leather chemistry and processing technology - Latest Techniques in handling, preservation, tannery procedure, manufacture and testing of leather - Value addition in leather processing - Developments in gelatin, glue and natural casings production - Characterization, processing, yield and quality control of rendered fat and meat cum bone meal.

Unit III (4 Lectures)

Organization, layout and operation of dry and wet rendering plants. Latest trends in the disposal of slaughterhouse effluents and control of environmental pollution. Designs and function of effluent treatment plants.

VII. Practical (17 Classes)

Plan and outlay of various components of a modern abattoir. Designs of ETP. Estimation of TS (suspended and dissolved) BOD and COD from abattoir effluents. Ante-mortem inspection of food animals, methods of stunning, stunning instruments. Slaughter and dressing of food animals. Electrical stimulation of carcasses. Post mortem inspection of carcasses of food animals - Visit municipal slaughterhouse, by-product processing plant, Effluent treatment plant and tanneries.



VIII. Teaching methods

- Classroom teaching, practical demonstration in laboratory/ slaughter unit.
- Visit municipal slaughterhouse and tanneries.
- Demonstration through charts, video films and models.

IX. Learning Outcome

Understanding of latest techniques employed in abattoir practices and slaughterhouse by-products utilization.

X. Suggested Reading

- Biswas A and Kondaiah N. 2014. *Meat Science and Technology*, 1st ed. Jaya Publishing House.
- Collins DS and Huey RJ. 2015. *Gracey's Meat Hygiene*, 11th ed. John Wiley and Sons Ltd., UK.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing- Improving Quality*. Woodhead Publishing Ltd., UK.
- Swatland HJ. 2004. *Meat Cuts and Muscle Foods*. Nottingham University Press.
- Warriss P. 2010. *Meat Science: An Introductory Text*, 2nd ed. Oxford Press.
- *Selected articles from Journals.*

I. Course Title : Advances in Meat Production and Fresh Meat Technology

II. Course Code : LPT 702

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development (Manager, Supervisor and other Technocrats) for Meat Industry

V. Aim of the Course

To impart knowledge about the latest trends in meat production, the ultrastructure of muscle fibres, strategies for improving meat production and traceability of meat products.

VI. Theory

Unit I (7 Lectures)

Current status of meat production trends in India - Government policies - economics and viability – Traceability in the meat industry – Strategies for augmenting meat production - Salvaging male buffalo calf - Non-conventional meat resources.

Unit II (10 Lectures)

Pre- and Post-natal development of Muscle fibres - Genetic, nutritional and physiological aspects of muscle development - Ultrastructure of skeletal muscle - Modern tools for fibre typing of muscle - Chemical and biochemical aspects of rigor mortis and fresh meat quality – Odour, colour, water holding capacity - Texture profile - Artificial tenderization - Myofibrillar, sarcoplasmic and connective tissue proteins - Cytoskeletal proteins - Lipid profile - Meat in human nutrition - Meat and health issues.



VII. Practical (17 Classes)

Economics of establishing commercial meat animal production Unit - Extraction of sarcoplasmic and myofibrillar proteins and their fractionation - Estimation of Collagen content of Meat - Histochemistry of muscle tissues - Muscle fibre typing - Meat tenderization techniques.

VIII. Teaching methods

- Classroom teaching, practical demonstration in laboratory/ slaughter unit
- Visit municipal slaughterhouse and meat plants
- Use of Audio-visual capsules.

IX. Learning Outcome

Knowledge of latest trends in meat production and fresh meat technology.

X. Suggested Reading

- Aberle ED, Forest JC, Gerrard DE and Mills E. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Carlson CW, Greaser ML and Jones KW. 2001. *The Meat We Eat*, 14th ed. Interstate Publishers, Inc.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Lawrie RA and Ledward DA. 2006. *Lawrie's Meat Science*, 7th ed. Woodhead Publishing Limited, Cambridge, England.
- Pearson AM and Dutson TR. 1997. *Advances in Meat Research. Healthy Production and Processing of Meat, Poultry and Fish Products*, Vol. 11. Springer.
- Swatland HJ. 2004. *Meat Cuts and Muscle Foods*. Nottingham Univ. Press.
- *Selected articles from Journals.*

I. Course Title : Developments in Processed Meat Technology

II. Course Code : LPT 703

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development (Manager, Supervisor and other Technocrats) for Meat Processing Industry

V. Aim of the Course

To impart knowledge about the advances in the technology for processing of meat and development of value-added meat products.

VI. Theory

Unit I (5 Lectures)

Current trends in meat processing techniques - Functional properties of the tissue component in meat processing - Approaches for new product development - Latest equipment used for processing of meat products - Indigenous and heritage meat products - Curing and smoking - purpose, composition and methods of smoking - Liquid smoke - Processing of Ham, bacon, sausages, patties, meatloaves and tandoori chicken- Novel meat products - Non-thermal processing - Irradiation techniques - Canning/ retorting.

Unit II (8 Lectures)

Marination, massaging, tumbling and flaking techniques - Restructured/ reformed,



intermediate moisture, fermented, enrobed, shelf-stable and dried meat products - Meat analogues and substitutes - Thermal processing of meat- Enzymatic and non-enzymatic browning reactions - Protein changes in processed meat products - Lipid changes - Protein and lipid interaction - Protein and carbohydrate interaction - Bioactive peptides.

Unit III (4 Lectures)

Functional and designer meat products - Role of omega-3 fatty acids in animal foods - Role of n-3 in PUFA enriched and CLA enriched meat and eggs - Packaging of meat and meat products - smart, active, intelligent packaging - Developments in sensory evaluation of meat products.

VII. Practical (17 Classes)

Evaluation of textural characteristics of meat products – Estimation of emulsifying capacity, emulsion stability- Estimation of Nitrosamines and PAHs - Preparation of emulsion-based, restructured, enrobed, cured and smoked, dried, fermented, intermediate moisture, ready to eat, and shelf-stable meat products-objective and subjective evaluation of meat products.

VIII. Teaching methods

- Classroom teaching, practical performance in Divisional Pilot Processing Plant.
- Visit Meat Processing Unit.
- Demonstration by videos.

IX. Learning Outcome

Acquaintance with the knowledge of the latest techniques used in meat processing and packaging and development of functional meat products.

X. Suggested Reading

- Aberle ED, Forest JC, Gerrard DE and Mills E. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Barbut S. 2005. *Poultry Products Technology*. CRC Press.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing- Improving Quality*. Woodhead Publishing Ltd., UK.
- Pearson AM and Gillett TA. 1996. *Processed Meats*, 3rd ed. Chapman and Hall, Inc, New York.
- Toldrá F. 2010. *Handbook of Meat Processing*. Wiley-Blackwell.
- *Selected articles from Journals*.

I. Course Title : Current Trends in Processing of Milk And Milk Products

II. Course Code : LPT 704

III. Credit Hours : 1+1

IV. Why this course?

Human resource development (Manager, Supervisor and other Technocrats) for the milk processing industry

V. Aim of the Course

To impart knowledge about current trends in the processing of milk and milk products and their effect on physico-chemical and nutritional quality of milk, the



scope of mechanization in the production of indigenous milk products and advances in the utilization of dairy by-products.

VI. Theory

Unit I (8 Lectures)

Principles and practices of production of quality raw milk - Advances in methods of chilling of milk - Thermal processing of milk – Principles and methods - types of UHT processing plants - Advances in the packaging of milk and milk products - Rheology of milk products - Preservatives, antioxidants, antibiotics and different toxic residues in milk - Advances in bacteriological and physico-chemical analysis of milk and milk product – Different legal and voluntary standards for milk and milk products - A1 and A2 milk and their significance.

Unit II (4 Lectures)

Bacteriological, physical, chemical and nutritional effects of processing on milk - New concepts in milk processing – radiation, microwave processing and conduction heating of milk – By-products from the dairy industry and their utilization.

Unit III (5 Lectures)

Innovative mechanization in the manufacture of Indigenous dairy products - Advances in the utilization of dairy by-products - preservation of milk products - Application of immobilized enzymes in dairy products – Latest trends in cleaning and sanitation of dairy plant

VII. Practical (17 Classes)

Quality evaluation of milk and milk products - Preparation of novel and indigenous milk products and their economics of production, quality and sensory evaluation - Use of Starter cultures - Maintenance of cultures - Demonstration of membrane processing technology - Preparation of DPR for Dairy plants of different capacities.

VIII. Teaching methods

- Classroom teaching and laboratory analysis.
- Visit the milk processing plant.
- Use of Audio-visual Capsules.

IX. Learning Outcome

Gaining knowledge of advances in the processing of milk and milk products.

X. Suggested Reading

- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Herrington BL. 2000. *Milk and Milk Processing*. Green World Publishers.
- Walstra P, Wouters JTM and Geurts, TJ. 2006. *Dairy Science and Technology*, 2nd ed. Taylor and Francis Group.
- *Selected articles from Journals*.

I. Course Title : Biotechnological Techniques and Quality Control of Livestock Products

II. Course Code : LPT 705

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development (Manager, Supervisor and other Technocrats) for



production of high-quality livestock products and their quality assurance.

V. Aim of the Course

To impart knowledge about advances in the application of biotechnological techniques for improving the production and quality of livestock products. To familiarize with the agencies responsible for maintaining the quality of livestock products, quality standards and legislations

VI. Theory

Unit I (10 Lectures)

Biotechnological tools for microbial testing of food - Industrial cell culture – Bioreactor types and design – Upstream and downstream processing - Bacterial food additives and supplements - Characteristics and application of microbial starters in milk and meat fermentation - Biotechnology in production of designer livestock products - Bio-production of flavours and colour and their application in dairy products - Enzyme applications in dairy technology. - Utilization of nanotechnology in livestock products - Biotechnology for food safety - Cultured meat - Biotechnology in meat species identification.

Unit II (7 Lectures)

Importance of quality control for livestock products - Concept and application of HACCP - BIS, FSSAI and AGMARK standards - GMP and total quality management in the processing of livestock products - ISO-9000, ISO-14000 and ISO-22000 - Codex regulations of food product safety.

VII. Practical (17 Classes)

Demonstration of the latest biotechnological techniques including DNA and protein-based techniques. Operation of bioreactors - Gene identification and characterization. Visit Milk/ Meat processing plants for an understanding of HACCP and other quality management systems.

VIII. Teaching methods

- Laboratory analysis.
- Visit of ISO and HACCP certified food processing plant.
- Use of Audio-visual Capsules.

IX. Learning Outcome

Gaining knowledge on the application of biotechnology for augmenting production and quality assurance.

X. Suggested Reading

- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing-Improving Quality*. Woodhead Publishing Ltd., UK.
- *Selected articles from Journals*.



- I. Course Title : Ethnic and Organic Meat and Milk Products**
II. Course Code : LPT 706
III. Credit Hours : 1+1

IV. Why this course?

Improving the production, processing and marketing of ethnic and organic meat and milk and their products.

V. Aim of the Course

To impart knowledge about the production of ethnic and organic meat and milk products.

VI. Theory

Unit I (9 Lectures)

Historical developments, present scenario and prospects of ethnic meat and milk products in various parts of India - Ethnic meat products - haleem, biryani, chettinad recipe, pork vindaloo, Kebab, Goan sausages, Kashmiri wazwan and meat products of North Eastern Region (NER) - Ethnic milk products – churpi, kalari, kunda, etc. - Constraints in promoting ethnic meat products - Approaches for development and commercialization of ethnic meat products - Fermented and non-fermented ethnic milk and meat foods – Impact of Globalization and role of WTO in promoting ethnic meat and milk products from India.

Unit II (5 Lectures)

Entrepreneurship Development for Ethnic meat and milk Products – Formulation, composition, quality, safety and shelf life of ethnic meat and milk products of India - Geographical indicators for recognition of ethnic meat and milk products.

Unit III (3 Lectures)

Organic meat and milk products - introduction, registration, certification, marketing and scope.

VII. Practical (17 Classes)

Preparation of ethnic meat products - haleem, biryani, chettinad recipe, pork vindaloo, Kebab, Goan sausages, Kashmiri wazwan and meat products of NER/ local region, Preparation of Ethnic milk products – churpi, kalari, Kunda, etc. - Composition, physico-chemical and microbial quality of ethnic milk and meat products - Packaging and marketing of ethnic milk and meat products.

VIII. Teaching methods

- Classroom teaching, practical demonstration in the laboratory
- Through the study of reports published by Govt. agencies time to time

IX. Learning Outcome

To acquaint with the knowledge for the production of ethnic and organic meat and milk products.

X. Suggested Reading

- Books on Indian Food.
- *Selected articles from Journals*



- I. Course Title : Industrial and Entrepreneurial Training**
II. Course Code : LPT 707
III. Credit Hours : 0+2

IV. Why this course?

Human Resource Development for catering to livestock products and related industry.

V. Aim of the Course

To prepare students to venture into various start-ups for self-reliant enterprises.

VI. Practical (34 Classes)

Preparation of basic feasibility report including raw material availability, marketing potential, economic viability and regulatory requirements for different livestock products related industry. Entrepreneurial training in an industrial establishment related to livestock products (17 sessions/ Hours equivalent to 17 credit hours of practical).Preparation of Detailed project reports (DPR) for the establishment of livestock products enterprises, viz. slaughterhouses, milk and meat processing plants, effluent treatment and byproducts utilization plants, etc..

VII. Teaching methods

- Visiting processing units
- Web surfing

VIII. Learning Outcome

Students envisioned having adequate knowledge and skills for setting up livestock products enterprises.

IX. Suggested Reading

- *Selected articles from Journals.* Through Interaction with Industry personnel.

- I. Course Title : Current Trends in Disposal and Utilization of Waste From Meat and Dairy Industry**
II. Course Code : LPT 708
III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development (Manager, Supervisor, Meat inspector and other Technocrats) for better utilization of animal wastes and effluent treatments.

V. Aim of the Course

To impart knowledge about disposal and handling of wastes from the meat and dairy industry, Agencies involved and their norms for pollution control from meat and dairy industries.

VI. Theory

Unit I (8 Lectures)

Terminologies used in solid and liquid waste management systems - Public health significance - Classification, composition, functional elements and sources of solid waste from Meat and Dairy Processing plants and their management - Aerobic and anaerobic systems of liquid waste management.

**Unit II (9 Lectures)**

Waste handling, separation, storage, processing and utilization of Solid waste - Common solid waste disposal methods like rendering, composting, deep burial and incineration - Scope for zero waste management - Properties of dried sludge and its utilisation as manure - Economical aspects of waste treatment and disposal - Utilization of meat and dairy processing wastes - Application of nanotechnology in waste management - State and Central Pollution Control Board norms.

VII. Practical (17 Classes)

Visit Sewage and Effluent Treatment Plants - Estimation of pH, dissolved oxygen, TSS, BOD and COD - Estimation of micronutrients in treated effluents - Design and schematic layout of various solid and liquid waste treatment plants.

VIII. Teaching methods

- Classroom teaching
- Visit Sewage Treatment Plant

IX. Learning Outcome

Gaining knowledge on advances in the utilization of wastes from the meat and dairy industry.

X. Suggested Reading

- *Selected articles from Journals.* Through Interaction with personnel of Municipal Corporation and Pollution Control Board.

I. Course Title : Advances in Egg and Egg Products Technology

II. Course Code : LPT 709

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development for Egg Processing Industry and Egg Processing Plants

V. Aim of the Course

To impart knowledge about the status of egg production, composition, nutritive value, preservation, grading, processing packaging and marketing of eggs and egg products.

VI. Theory**Unit I (5 Lectures)**

Advanced preservation techniques for egg and egg products - Maintenance of quality of eggs - Microbiology of egg - Spoilage of eggs and its prevention.

Unit II (8 Lectures)

Preparation of fast foods and role of egg in fast foods chains - Egg breaking and processing plants - lay-out and organization Preservation methods viz pasteurization, desugarization, freezing, dehydration, etc. – process and methods - Quality estimation of egg and egg products - Designer egg and egg products.

Unit III (4 Lectures)

Specifications, Standards and marketing of egg and egg products - Quality control of egg products.



VII. Practical (17 Classes)

Evaluation of physical, chemical and functional quality of egg and egg products - Detection of egg rots - Evaluation of microbiological quality of egg and egg products - Preservation techniques of eggs - Preparation of convenient, dehydrated and value-added egg products - Visit a modern egg processing plant

VIII. Teaching methods

- Classroom teaching, practical demonstration in the laboratory.
- Visit the egg processing plant.

IX. Learning Outcome

Gaining knowledge on composition, nutritive value, preservation and marketing of eggs. Quality maintenance and development of designer egg products.

X. Suggested Reading

- Romanoff AL and Romanoff AJ. 1949. *Avian Egg*. John Wiley and Sons.
- Stadelman WL and Cotterill OJ. 2002. *Egg Science and Technology*, 4th ed. CBS.
- *Selected articles from Journals*.

Restructured and Revised
Syllabi of Post-graduate Programmes

Vol. 3

Animal Production Sciences

– Poultry Science

Preamble

(Poultry Science)

Poultry industry in India has made a remarkable growth ever since its inception and is presently emerging as a sunrise sector with a growth rate of 8.51 and 7.52 percent in egg and broiler production respectively (BAHS, 2019) as against 2.5 percent for agricultural crops. Within the poultry sector, broiler and layer segment constitutes about 65.3 and 34.7 percent with the monthly turnover of 400 million chicks and 8400 million eggs, respectively (ICRA, 2020). In poultry farming activities around one million farmers are engaged with 85 percent of them having less than 2 ha of land or the landless. With the annual poultry production of 851.8 million, poultry in India has emerged as the most dynamic and diversified subsector with third largest egg producing and fourth largest broiler producing country in the world with an estimated production of 103.3 billion eggs and 4.1 million metric tons (MMT) of broiler meat (BAHS, 2019).

Indian poultry industry has witnessed a radical and robust transformation from backyard poultry farming in villages to environmental controlled house coupled with high end automation. Industry is continuously updating with the evolvement and enrichment of newer technologies for achieving maximum efficiency in poultry at production and post-harvest levels. These developments demand the requirement of poultry veterinarians experts and managers for optimized production practices. In order to keep pace in the race of advancing poultry farming technology, a realistic update at academic level in poultry science is highly mandatory and demands of the hour. Hence, an academic curriculum of poultry science involving the industrial visits, automation in poultry farms, market research skills and winning bankable project reports for poultry startups can shape and equip poultry veterinarians so as to cater the needs of the poultry industry. The current designed syllabus provides the students regarding working knowledge in farms, decision making and troubleshooting analytical skills at different stages of poultry production.

Recently, waste disposal from poultry farms is emerged as an alarming issue for which knowledge on efficient wealth from waste technological intervention is required to pave a way for Go Green Poultry and the current syllabus has been designed to include the course on this emerging and much needed requirement to train veterinary post graduates to tackle this problem. Since waste recycling is very important to address environmental concerns and also to reduce use of energy sources used in disposal of waste. Hence, the course on waste recycling has also been designed so as to teach newer and innovative techniques of waste recycling for production of useful end products with concept of waste to wealth.

As changing environmental scenario is also posing problems in disease incidence and survivability of pathogens leading to constant threat of emerging and re-emerging diseases in poultry, the contents has been designed in such a way to impart knowledge on the sensitive and precise aspects of disease detection and also the segment has been incorporated to gain an knowledge on disease preventive measure including designing vaccination programme. Since biosecurity measures remains the cheap and effective means of disease preventive measures and it becomes essential to teach the basic concept of disease prevention so the poultry industry is helped with trained veterinarians with knowledge and skills in prevention of disease incidence.

The syllabus has also been designed in such a way so that the students can get practical exposure with farm/ lab/ field visits to the advanced environmentally controlled houses, feed manufacturing units, processing plants, advanced disease diagnostic labs on-filed poultry farms so that they can learn the practices being followed in these units so that they can think and plan to get more knowledge in the problems faced in the field conditions and can think of devising mechanisms to solve the problems.

Emphasis has been given to include the courses on commercial poultry nutrition. As nutrition in poultry production remains important segment and constitutes around 60-70% costs of production. Hence, emphasis has been laid to teach more basic aspects related to commercial aspects so that the cost of production can be minimized with knowledge in estimating the precise nutrient requirements in different poultry species, commercial uses of feed ingredients and use of non-conventional feed ingredients in poultry. Further practical emphasis has also been given to standardize the seasonal changes in feeding practices, use of advanced analytical techniques for estimating the feed nutrient content and also to learn other feeding practices for better poultry production and profitability.

Since diversified poultry species like quails, duck, guinea fowl, geese, ostrich and emu which are also important poultry species and these contribute to the economy of our country. In some segment of the country the diversified poultry species remains important for poor farmers due to geographical conditions of those regions. So it becomes imperative to train the veterinarians on all aspects of these species for optimum production and profitability. As breeding, feeding, health requirement are different chickens and thus, the contents of newly added course have been focused on different aspects related breeding, feeding, housing and health care management.

Emphasis has also been given on new scientific techniques, value-addition, post-harvest management, methods of organic poultry production, formulation of bankable projects with minimal expenditure in poultry production and also on utilizing the by-products from poultry processing and waste. Overall the course has been designed in such a way so as to focus to enhance skills for tackling emerging problems in this sector, increase employment and also focus has been given to cope up the post-covid-19 challenges. The newly designed syllabus will greatly enhance the capacity of the veterinarians in the areas of emerging nature and will meet new education policy requirement

Summary of changes in syllabus

Old courses	New course title	Changes
M.V.Sc. courses		
1. PSC-603: Commercial layer production 2+1 PSC-604: Commercial broiler production 2+1	PSC-603: Commercial layer and broiler management [2+1]	Two courses (PSC-603 and PSC-604) merged
2. PSC-605: Breeder stock, flock health and hatchery management	PSC-605: Poultry health and biosecurity	Health aspect delinked from old PSC-605 and title modified
3. PSC-607: Poultry products technology and marketing	PSC-607: Poultry products technology	Title changed
4.	PSC-610: Commercial poultry nutrition	New course added
5.	PSC-611: Poultry welfare and waste management	New course added
Ph.D. courses		
1. PSC-703: Developments in poultry products technology	PSC-703: Developments in poultry processing and products technology	Title modified
2. PSC-704: Emerging diseases of poultry and flock health	PSC-704: Emerging and re-emerging diseases of poultry and health management	Title modified
3. PSC-705: Advanced poultry breeding methods	PSC-705: Applied poultry breeding	Title merged
4.	PSC-707 Diversified poultry production	New course added



Course Title with Credit Load

M.V.Sc. in Poultry Science

Course Code	Course Title	Credit Hours
PSC 601*	Poultry Breeding and Genetics	2+1
PSC 602*	Poultry Nutrition and Feeding	2+1
PSC 603*	Commercial Layer and Broiler Management	2+1
PSC 604*	Breeder Stock and Hatchery Management	2+1
PSC 605	Poultry Health and Biosecurity	2+1
PSC 606	Management of Other Avian Species	3+1
PSC 607*	Poultry Products Technology	2+1
PSC 608	Poultry Economics, Project Formulation and Marketing	2+1
PSC 609*	Physiology of Poultry Production	1+1
PSC 610	Commercial Poultry Nutrition	1+1
PSC 611	Poultry Welfare and Waste Management	2+0
PSC 691	Seminar	1+0
PSC 699	Research	30

*Core courses



Course Contents

M.V.Sc. in Poultry Science

- I. Course Title** : Poultry Breeding and Genetics
II. Course Code : PSC 601
III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge on different systems of breeding, selection methods, design and implementation of the breeding programme in developing egg-type and meat-type birds. Modern tools in poultry breeding.

V. Theory

Unit I (12 Lectures)

Genetic classification of Poultry – Origin and breed characteristics of poultry- Mendel's laws of inheritance related to poultry - Qualitative and Quantitative traits in Poultry breeding – Additive and Non-additive – Dominance, Incomplete dominance, Epistasis and complementary gene actions – Lethals and mutations in poultry – Sex-linked, Sex limited and Sex influenced traits – Economic traits – Partitioning of variance - Heritability – Quantitative inheritance – Phenotype, Genotype and environment interactions.

Unit II (10 Lectures)

Systems of Breeding – Systems of Mating – Selection methods – Breeding programme for developing egg-type, meat type and rural poultry strains - Developing hybrids - Breeding and management of other species of Poultry- Formation and Management of inbred pure lines, grandparent and parent stock - Industrial breeding.

Unit III (12 Lectures)

Artificial insemination in chicken –Autosexing–Random Sample Test - Use of molecular genetics in poultry breeding-Quantitative trait loci and marker-assisted selection- Conservation of poultry genetic resources.

VI. Practical (17 Classes)

Breeds of poultry – Estimation of qualitative and quantitative traits in poultry – Exercises on individual and family selection – Constructing multi-traits selection index and Osborne index-Estimating heritability – Breeding program for developing commercial hybrid layers, broilers and Japanese quail– Breeding programmes for rural poultry - Semen collection, evaluation, dilution and insemination in chicken and turkey – Breeding records –Use of computers to maintain breeding records and for selection– Estimation of effective population size, rate of inbreeding, response to selection and genetic and phenotypic responses.

VII. Teaching methods

- Classroom teaching with laboratory support and farm visits
- Use of computers for quantitative genetic analysis

**VIII. Learning outcome**

Gaining knowledge on poultry breeding and genetics

IX. Suggested Reading

- Crawford RD. 1990. *Poultry Breeding and Genetics*. Elsevier.
- Falconer DS. 1997. *Introduction to Quantitative Genetics*. Benjamin Cummings.
- Hutt FB. 1949. *Genetics of the Fowl*. McGraw-Hill
- Muir WM and Aggrey SE. 2003. *Poultry Genetics, Breeding and Biotechnology*. CABI.
- Singh RP and Kumar J. 1994. *Biometrical Methods in Poultry Breeding*. Kalyani Publications

I. Course Title : Poultry Nutrition and Feeding

II. Course Code : PSC 602

III. Credit Hours : 2+1

IV. Aim of the course

Teaching about nutrients and their functions, nutrient requirements of poultry and factors influencing the same. Imparting knowledge of different types of feeds and feeding methods.

V. Theory**Unit I (8 Lectures)**

Digestive system, digestion, metabolism and absorption of nutrients in poultry – Factors influencing the feed consumption in birds – Macro and micro-nutrients – Protein and amino acids - Nutrient requirements for various species of poultry – Factors influencing the nutrient requirements - Partitioning of energy - Calorie: protein ratio – Nutrient interrelationships.

Unit II (12 Lectures)

Feed ingredients composition - Feed storage techniques - Milling and quality control- Processing of feed – Types and forms of feeds and feeding methods - Commonly occurring antinutrients and toxicants in poultry feed ingredients – Mycotoxins and their prevention – Feeding chicks, growers, layers, broilers and breeders – Principles of computing feed – Balanced feeds - Least cost feed formulation and programming – Feeding in different seasons and stress conditions - Nutritional and metabolic disorders in poultry.

Unit III (8 Lectures)

Systems of feeding – restricted, forced, controlled and phase feeding -Use of Additives and Non-additives- enzymes, probiotics, prebiotics, antibiotics, herbs and other performance enhancers – Utilization of non-conventional feedstuff - Feeding of ducks, turkeys, Japanese quails and Guinea fowls.

Unit IV (6 Lectures)

Organic, functional, designer and SPF feed production - Production of feeds free from drug residue, pesticide residue and toxins – Regulations for Import and Export of feed and feed supplements.

VI. Practical (17 Classes)

Physical and sensory evaluation of feed ingredients- sampling techniques for ingredients and compounded feed-Estimation of proximate principles of feed and feed ingredients – Computing various poultry feed formulae based on commonly



available feed ingredients – Computer applications in feed formulations - Estimation of Aflatoxin, Calcium, Phosphorus, Sand, Silica and Salt – Mash, pellet and crumble feed preparation – Feeding procedures. Visit to feed mills –Hands-on training in feed analytical lab.

VII. Teaching methods

- Classroom teaching with laboratory support and feed mill visits
- Use of computers in feed formulations

VIII. Learning outcome

Gaining knowledge on poultry nutrition and feeding

IX. Suggested Reading

- Bell DD and Weaver WD JR. 2002. *Commercial Chicken Meat and Egg Production*, 5th ed. Kluwer Academic Publishers.
- ICAR. 2013. *Nutrient Requirements of Poultry*. ICAR Publication.
- Leeson S and Summers JD. 2001. *Scott's Nutrition of the Chicken*. University Books.
- Leeson S and Summers JD. 2008. *Commercial Poultry Nutrition*, 3rd ed. University Books.
- Singh RA and Panda B. 1992. *Poultry Nutrition*. Kalyani Publishers.

I. Course Title : Commercial Layer and Broiler Management

II. Course Code : PSC 603

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge on different systems of rearing and management of commercial layer and broilers for maximum egg and meat production

V. Theory

Unit I (10 Lectures)

Development of Poultry Industry in India and the World – Systems of layer and broiler farming – Location and layout of the farm – Systems, types and design of houses – Poultry farm equipment - Automation in poultry houses and its maintenance - Environmentally controlled houses and their management -Deep litter and cage system of management- Litter materials -All in All out and Multiple batch systems of rearing layers and broilers –Brooding management - Lighting programme for egg-type and meat-type birds- Water quality standards, watering and water sanitation - Biosecurity and health management – Production indices for broilers and layers – Integration in broiler and layer production.

Unit II (12 Lectures)

Cages and modified cages for egg-type birds – Feeding management in layers - Medication and vaccination schedules and procedure for layers –Brooder, grower, pre-layer, layer and cockerel management – Management of layers during peak egg production and maintaining the persistency in production – Strategies to prolong the egg production beyond 72 weeks of age - Factors causing uneven growth and low egg production - Monitoring egg production curve - Culling of unproductive birds – Record keeping –Management during different seasons – Induced moulting.

Unit III (10 Lectures)

Management of broilers during different seasons -Mash, crumble and pellet feeding of Broilers – Weekly growth rate, feed conversion and livability in broilers- Sex

separate feeding – Feeding broilers for optimum growth rate and feed efficiency – Broiler farm records - Broiler farm routine, medication and vaccination schedule – Transport of broilers - Regulations and specifications for the production of export quality broilers.

VI. Practical (17 Classes)

Layer farm layout– Design of different chick, grower and layer houses, their specifications – Selection and culling of layers, debeaking, dubbing, deworming, delicing, vaccination and other farm routines and operations – Farm sanitation, disinfection and waste disposal – Visit commercial layer farms including environmental controlled houses – Record keeping – Calculating Hen day egg production, Hen housed egg production and other economic traits – Calculating the cost of production of eggs and meat and economics–Location and layout for a broiler farm – Broiler house design – Visit to commercial broiler farms including environmental controlled houses – Broiler brooding, Medication, vaccination, transportation and farm routines - Record keeping - Calculating the cost of production of broilers – Feeding of broilers at different ages – Working-out feed efficiency.

VII. Teaching methods

- Classroom teaching with farm visits
- Using different housing models
- Using Audio-visual capsules
- Demonstration of different management practices at farms

VIII. Learning outcome

Gaining knowledge of commercial broiler and layer production

IX. Suggested Reading

- Bell DD and Weaver WD, Jr. 2002. *Commercial Chicken Meat and Egg Production*, 5th ed. Kluwer Academic Publishers.
- Narahari D. 1997. *Commercial Broiler Production*. Emkay Publishers.
- Rajini RA. 2012. *Simply Poultry Science*. Alpha Publishers.
- Sapkota D, Narahari D and Mahanta JD. 2017. *Avian Poultry Production*, 2nd rev ed. New India Publishing Agency.
- Scanes CG, Brant G and Ensminger ME. 2003. *Poultry Science*, 4th ed. Prentice-Hall.
- Sreenivasaiah PV. 2015. *Textbook of Poultry Science*. Write and Print Publications.

I. Course Title : Breeder Stock and Hatchery Management

II. Course Code : PSC 604

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge about care and management of breeders and hatchery operations.

V. Theory

Unit I (9 Lectures)

Different types of commercial breeder flocks –Special care of breeder chicks – Breeder male and female management – Feeding the breeder flocks: Separate sex feeding, feed restriction in broiler breeders. Management for improving fertility



and hatchability, Management of parent and grandparent farms - Management of pure lines – Artificial Insemination - Care and management of Hatching eggs.

Unit II (4 Lectures)

Vaccination of layer and broiler parents - Nutrient supplementation – Seasonal management of breeders – Lighting management in breeder farms - Flock testing and culling.

Unit III (12 Lectures)

Natural and Artificial incubation –Stages of embryonic development -Incubation principles – Location of hatchery – Layout and design of hatchery - hatchery equipment– Hatchery management - Ventilation and temperature control –Pre-incubation storage, Fumigation and sanitation – Hatchery operations, routine and schedule – Egg candling -Packaging and transportation of hatching eggs and chicks, hatchery troubleshooting- Factors affecting fertility and hatchability - Biosecurity and hatchery waste disposal – Control of vertically transmissible and hatchery borne diseases – Special incubator management during hot summer – Hatch analysis.

Unit IV (9 Lectures)

SPF egg production - Import and export regulations – Maintaining Salmonella and Mycoplasma free breeding flock –Application of HACCP and Good Management Practices (GMP) in hatchery management for better chick quality.

VI. Practical (17 Classes)

Layout and blueprints for breeder farm and hatchery –Incubator management – Candling - Hatchery sanitation, fumigation procedures and hatchery hygiene – Pedigree hatching – Hatchery waste disposal and recycling – Calculating the cost of production of hatching eggs and day-old-chicks, management of bangers– Attending breeder farm routines and operation – Flock testing and culling of reactors – Analyzing hatchability results – Use of computers in hatchery operations - Economics of setting up of layer and broiler hatchery. Vaccinating day-old chicks and concept of in-ovo vaccination, visit to commercial breeder farm and hatchery.

VII. Teaching methods

- Classroom teaching with breeder farm and hatchery visits
- Using Audio-visual capsules

VIII. Learning outcome

Gaining knowledge of breeder flock and hatchery management

IX. Suggested Reading

- Bell DD and Weaver WD, Jr. 2002. *Commercial Chicken Meat and Egg Production*, 5th ed. Kluwer Academic Publishers.
- Leeson S and Summers JD. 2009. *Broiler Breeder Production*. Context Products.
- Sreenivasaiah PV. 2006. *Scientific Poultry Production: A Unique Encyclopaedia*. International Book Distributing Co.
- Taylor LW. 2003. *Fertility and Hatchability of Chicken and Turkey*. John Wiley and Sons.



- I. Course Title : Poultry Health and Biosecurity**
II. Course Code : PSC 605
III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge about common diseases and disorders of poultry, diagnosis, vaccination, prevention, control and treatment. Biosecurity measures in the control of common poultry diseases.

V. Theory

Unit I (7 Lectures)

Common bacterial diseases: *Salmonella*, *Pasteurella*, *E.coli*, Fowl typhoid, Mycoplasma, Infectious *Coryza*, *Gallibacterium*, *Clostridium*

Unit II (9 Lectures)

Common Viral diseases: Newcastle, Infectious bronchitis, Infectious laryngotracheitis, Marek's, Fowl pox, Infectious Bursal disease, Egg drop syndrome-76, Avian Encephalomyelitis, Avian influenza, Duck viral hepatitis, Chicken Infectious Anaemia, etc.

Unit III (8 Lectures)

Common Fungal, parasitic and metabolic diseases: Aspergillosis, Mycotoxicosis, Fatty liver haemorrhagic syndrome (FLHS), Gout, Ascites, leg weakness - Coccidiosis, Ecto- and endo-parasitic infestation of poultry, etc.

Unit IV (5 Lectures)

Diagnosis, vaccination, prevention, treatment and control of various poultry diseases.

Unit V (5 Lectures)

Principles of biosecurity - Locational, structural and operational biosecurity in Poultry farms – Water sanitation and control of water-borne diseases – Quarantine of poultry - Farm sanitation and disinfection procedures.

VI. Practical (17 Classes)

Ante-mortem and Post-mortem examination of birds – Sample collection – Despatch of samples – Processing of samples and detection of pathogens/ etiological agents -Different sanitizers and disinfectants available and their uses. Care and contraindication of using different products. Personal hygiene and isolation – Different vaccines and routes of administration – Methods of medication – Water quality analysis, Field visit to poultry diagnostic lab.

VII. Teaching methods

- Classroom teaching with laboratory diagnosis
- Post-mortem examination
- Using Audio-visual capsules

VIII. Learning outcome

Gaining knowledge on poultry health and bio-security

IX. Suggested Reading

- Gordon RF and Jordan FTW. 1982. *Poultry Diseases*. ELBS
- Pattison M, McMullin P, Bradbury JM and Alexander D. 2008. *Poultry Diseases*, 6th ed. Elsevier.



- Saif YM. 2008. *Diseases of Poultry*. Blackwell Publishing House.
- Thyagarajan D. 2011. *Diseases of Poultry*, Satish Serial Publishing House.
- Vegad JL. 2015. *Poultry Diseases Farmers. A Guide for Farmers and Poultry Professionals*. International Book Distributing Co.

I. Course Title : Management of Other Avian Species

II. Course Code : PSC 606

III. Credit Hours : 3+1

IV. Aim of the course

Care and management of different breeds, varieties of poultry other than chicken, methods of rearing and common diseases affecting them and their control measures.

V. Theory

Unit I (15 Lectures)

Breeds and varieties of Turkey, Duck, Goose, Guinea fowl, Japanese quail, Emu and Ostrich – Incubation periods and incubation procedure for different species – Production standards - Housing, cage and equipment for other avian species under different systems of rearing.

Unit II (15 Lectures)

Management and rearing of Turkey, duck, goose, Guinea fowl, Japanese quail, emu and ostrich- Feeding standards and feeding, watering and rearing systems and procedure for different species of poultry - Breeding programmes for egg and meat production in different species.

Unit III (10 Lectures)

Different types of pet birds - Management and rearing of pet birds of regional importance (Pigeon, budgerigar, parakeets, love birds, macaws, doves, parrots, etc.) – Housing for pet birds, their habitat, feeding and breeding under captivity.

Unit IV (8 Lectures)

Common diseases affecting other avian species and their control – Regulations for import and export of different species of poultry – Prevention of exotic diseases through the import of live birds.

Unit V (3 Lectures)

Concept and definition of organic poultry – status, certification and guidelines for organic poultry production – Government policies on organic poultry farming.

VI. Practical (17 Classes)

Layout and design of housing and cages for other species of poultry. Visit commercial Japanese quail, turkey and duck farms. Incubation and care of hatching eggs and young ones – Rearing practices followed by duck, quails and turkey farmers under field conditions - Sexing of pet birds – Preparing project reports for different species and calculating the cost of production – Feeding pet birds and their chicks.

VII. Teaching methods

- Classroom teaching with farm visits
- Visit pet bird farms
- Using Audio-visual capsules

VIII. Learning outcome

Gaining knowledge on rearing different poultry species other than chicken

IX. Suggested Reading

- Cherry P and Morris T. 2011. *Domestic Duck Production: Science and Practice*. CABI
- CPDO. *Duck – Management Guide*. Central Poultry Development Organization Publication (online resource)
- CPDO. *Turkey – Management Guide*. Central Poultry Development Organization Publication (online resource)
- Mayer J and Donnelly TM. 2012. *Clinical Veterinary Advisor: Birds and Exotic Pets*. Elsevier.
- Pathak N. 2013. *Poultry and Ratite Nutrition*. Narendra Publishing House.
- Sapkota D, Narahari D and Mahanta JD. 2017. *Avian Poultry Production*, 2nd rev ed. New India Publishing Agency.
- Scanes CG, Brant G and Ensminger ME. 2003. *Poultry Science*, 4th ed. Prentice-Hall.

I. Course Title : Poultry Products Technology

II. Course Code : PSC 607

III. Credit Hours : 2+1

IV. Why this course?

V. Aim of the course

Composition and nutritive value of eggs and chicken meat, grading and preservation methods of eggs and meat, functional and value-added poultry products.

VI. Theory

Unit I (15 Lectures)

Physical and chemical composition and nutritive value of eggs and meat – Grading of eggs and meat by different standards - Egg quality deterioration - Factors affecting egg quality – Handling, processing, packaging materials, packaging, transport and marketing of eggs.

Unit II (8 Lectures)

Quality control of poultry meat – Preservation of egg and meat-Functional and value-added egg and meat products – Further processing of eggs and meat – Various egg and meat fast foods.

Unit III (11 Lectures)

Sanitary and phytosanitary measures to ensure food safety – Pre and Post oviposition value addition to the eggs and Post-processing value addition to the meat for export–Microbial safety of poultry products – Import and export of poultry products – Further processing of poultry for export – Implementation of GMP and HACCP procedures for food safety – Codex regulations for poultry products safety – Traceability and branding of poultry products.

VII. Practical (17 Classes)

Measuring internal and external egg qualities – Measurement of meat quality - Preservation of table eggs, grading of eggs – Processing of chicken – Further processing of poultry – Preservation of poultry meat – Preparation of various eggs and poultry meat products and fast foods – Preservation, packaging and transport – Quality control of value-added poultry products – Measures of microbial safety of poultry products for export, visit to poultry processing plant.



VIII. Teaching methods

- Classroom teaching with laboratory analysis
- Visit egg and meat processing plants
- Using Audio-visual capsules

IX. Learning outcome

Gaining knowledge of poultry products technology

X. Suggested Reading

- Biswas A and Kondaiah N. 2014. *Meat Science and Technology*. Jaya Publishing House.
- Mead G. 2004. *Poultry Meat Processing and Quality*. Elsevier
- Mountney GJ and Parkhairst CR. 1995. *Poultry Products Technology*, 3rd ed. AVI Publ.
- Romanoff AL and Romanoff AJ. 1949. *The Avian Egg*. CAB international
- Sim JS and Nakai S. 1994. *Egg Use and Processing Technologies: New Developments*. CAB International.
- Stadelman WJ and Cotterill OJ. 1995. *Egg Science and Technology*, 4th ed. CRC Press.

I. Course Title : Poultry Economics, Project Formulation and Marketing

II. Course Code : PSC 608

III. Credit Hours : 2+1

IV. Aim of the course

To study about measures of performance efficiency in poultry farms and its allied sector, components of project reports and preparation of viable projects related to poultry Industry.

V. Theory

Unit I (10 Lectures)

Glossary of terms used in poultry economics and projects – Measures of performance efficiency in the broiler, layer, breeder and other poultry species, hatcheries and other poultry-related operations – Production standards and goals for layer, broiler and breeders.

Unit II (12 Lectures)

Planning poultry enterprise – Minimum viable units - Bank norms for poultry projects – Poultry insurance– Methods to improve the production efficiency and reduce the production cost - Components of project reports and preparing projects and return on investment.

Unit III (12 Lectures)

Integration in Poultry production and marketing – Marketing channels for eggs and meat - Cost of production of the egg, broiler, hatching egg, day-old chick and compounded feed –New regulations on cage rearing of layers. Traceability and branding of poultry products. Export norms for poultry products.

VI. Practical (17 Classes)

Preparing different poultry projects for bank finance – Calculating the cost of production of various products under various systems-case study – Preparation of Balance sheet, break-even points, Cost: Benefit ratio and other farm economic indices- Preparation of feasibility and viability reports.

**VII. Teaching methods**

- Classroom teaching with calculations
- Using Audio-visual capsules

IX. Learning outcome

Gaining knowledge of poultry marketing and project preparations.

X. Suggested Reading

- Bell DD and Weaver WD, Jr. 2002. *Commercial Chicken Meat and Egg Production*, 5th ed. Kluwer Academic Publishers.
- Narahari D and Asha Rajini R. 2005. *Poultry Economics and Projects*. Pixie Publication India (P) Ltd.

I. Course Title : Physiology of Poultry Production

II. Course Code : PSC 609

III. Credit Hours : 1+1

IV. Why this course?**V. Aim of the course**

To study the basic principles of physiology of poultry production in relation to egg production, incubation, stress and role of environment.

VI. Theory**Unit I (7 Lectures)**

Skeletal system of poultry – Comb pattern and plumage - Physiology of poultry digestive system- Digestion, metabolism and absorption of feed and water – Role of enzymes – Poultry circulatory system – Respiratory system – Physiology of growth.

Unit II (7 Lectures)

Poultry nervous system and its function – Excretory system – Male and female reproductive system - Semen production-semen characteristics- Semen extenders – Egg formation- Egg laying pattern-photo periodic responses – Role of endocrine glands and their functions - Neuroendocrine control of egg production - Ovulation and Oviposition – Clutch and Pause.

Unit III (3 Lectures)

Thermoregulatory mechanism – Stress due to adverse environmental factors – Acid-base balance

VII. Practical (17 Classes)

Demonstration of various systems of birds – the structure of feather - Identification of endocrine glands and demonstration of hormones estimation in poultry production and reproduction - Haematology of poultry species - SGOT, SGPT, free fatty acids - Morphology of Poultry spermatozoa. Demonstration of artificial insemination in poultry.

VIII. Teaching methods

- Classroom teaching with laboratory techniques
- Using Audio-visual capsules

IX. Learning outcome

Gaining knowledge on the physiology of poultry production

**X. Suggested Reading**

- Etches RJ. 1995. *Reproduction in Poultry*. CAB International.
- Scanes CG. 2014. *Sturkie's Avian Physiology*. Elsevier.

I. Course Title : Commercial Poultry Nutrition

II. Course Code : PSC 610

III. Credit Hours : 1+1

V. Aim of the course

To impart knowledge on advanced poultry nutrition with respect to commercial egg and meat production

VI. Theory**Unit I (7 Lectures)**

Breed specific nutrient requirements. Factors influencing the digestibility of nutrients – Reasons to assist the birds for digestion – Gut health management.

Unit II (4 Lectures)

Commercial use of feed ingredients by the industry – their drawbacks - Use of different feed additives and supplements: Enzymes, prebiotics, probiotics, postbiotics, phytobiotics, nucleotides, acidifiers, emulsifiers, and essential oils, etc. – Trace minerals: organic, inorganic and nanoparticles – Pre-digested proteins.

Unit III (6 Lectures)

Unconventional feed ingredients: Merits and demerits – Measures to counteract the demerits – Responsible use of them for reducing the cost of production – Least cost feed formulation – Phase feeding for layers and broilers – Juvenile nutrition.

VII. Practical (17 Classes)

Analytical methods for quick estimation of proximate principles and other nutrients – Use of latest technologies like NIR – Force-feeding, Challenge feeding – Factors preventing the birds from optimum feeding: Particle size, feed milling technologies, etc.– Seasonal variations in feeding practices, in-ovo feeding, visit to commercial poultry nutrition lab and feed mill.

VIII. Teaching methods/ activities

- Classroom teaching with laboratory support and feed mill visits
- Use of computers in feed formulations

IX. Learning outcome

Gaining knowledge on advances in poultry nutrition

X. Suggested Reading

- ICAR. 2013. *Nutrient Requirements of Poultry*. ICAR Publication.
- Leeson S and Summers JD. 2001. *Scott's Nutrition of the Chicken*. University Books.
- Leeson S and Summers JD. 2008. *Commercial Poultry Nutrition*, 3rd ed. University Books.
- Singh RA and Panda B. 1992. *Poultry Nutrition*. Kalyani Publishers.



- I. Course Title** : Poultry Welfare and Waste Management
II. Course Code : PSC 611
III. Credit Hours : 2+0

IV. Aim of the course

To provide knowledge on the concept of poultry welfare and safe disposal of wastes generated from poultry farms

V. Theory

Unit I (14 Lectures)

Concept of poultry welfare – Different freedoms to the birds – Present housing systems with relation to the welfare – Welfare and productivity – Feed restriction – Economics - Welfare cages – Welfare in relation to country's requirement. Precautions and requirements before, during and after transport of birds from one place and another, thermal imaging, assessment of welfare in poultry

Unit II (20 Lectures)

Waste generated from poultry farms and hatcheries – Male chicks disposal - Hazards of waste for humans and environment – Spread of diseases – Fly problems – Leaching of toxic substances in groundwater – Emission of gases – Dust and smell problem – Disposal of carcasses – Means to mitigate the hazardous effects of wastes – Composting of manure and dead birds - Generation of biogas, electricity, rendering plant products for feeding other species – Wastewater recycling – Usage of slurry – Preparation of bio-fuel pellets, methods of recycling poultry feathers.

VI. Teaching methods

- Classroom teaching
- Visit various waste disposal units

VII. Learning outcome

Gaining knowledge on the welfare of poultry and methods for safe disposal of poultry wastes

VIII. Suggested Reading

- Collins E (Ed.). 1999. *Poultry Waste Management Handbook*. NARES Series 132. Natural Resources.
- DAHD. 2015. *Poultry Farm Manual*. Department of Animal Husbandry, Dairy and Fisheries, GOI.
- Mench JA. 2017. *Advances in Poultry Welfare*. Woodhead Publishing
- Overcash MR, Humenik FJ and Miner RJ. 1983. *Livestock Waste Management*. CRS Press.



Course Title with Credit Load Ph.D. in Poultry Science

Course Code	Course Title	Credits Hours
PSC 701*	Applied Poultry Nutrition	2+1
PSC 702*	Recent Trends in Commercial Poultry Production	2+1
PSC 703	Developments in Poultry Processing and Products Technology	2+1
PSC 704	Emerging Diseases of Poultry and Health Management	2+1
PSC 705	Applied Poultry Breeding	1+1
PSC 706	Poultry Economics, Marketing and Integration	2+1
PSC 707	Diversified Poultry Production	2+1
PSC 791	Seminar I	1+0
PSC 792	Seminar II	1+0
PSC 799	Research	75

*Core courses

Course Contents

Ph.D. in Poultry Science

- I. Course Title** : Applied Poultry Nutrition
II. Course Code : PSC 701
III. Credit Hours : 2+1

IV. Aim of the course

Teaching about nutrients and their functions, nutrient requirements of poultry and factors influencing the same. Different methods and forms of feeds and feeding of poultry.

V. Theory

Unit I (10 Lectures)

Developments in the nutrient requirement for egg and meat-type chicken - Concepts in various poultry feeding procedures and methods for optimal production - Factors influencing the nutrient requirements, feed intake and feed efficiency in poultry - Nutritional deficiencies - Protein and energy utilization – Digestibility of nutrients – Ileal digestibility of amino acids - Vitamins, minerals and their interactions in poultry rations.

Unit II (10 Lectures)

In ovo - juvenile nutrition for optimal growth rate and feed efficiency – Care in grower and pre-layer feeding - Nutrition and feeding of layers/ breeders during peak egg production - Nutritional requirements for higher egg production, broiler meat production, fertility and hatchability and other special purposes.

Unit III (10 Lectures)

Feeding of broilers for uniform growth and feed efficiency – Feeding to enhance egg quality and nutrients – Nutritive and non- nutritive feed additives in feed production – organic, functional and designer feed. Advances in feed milling technology – Specialty feed production to produce microbial safe foods, SPF eggs and organic foods.

Unit IV (4 Lectures)

HACCP implementation in feed quality control – Production of feed free from antibiotics, mycotoxins and pesticide residues.

VI. Practical

Computation of specific and functional feeds – Estimation of available carbohydrate/ Metabolizable energy, Aflatoxin, anti-nutritional factors and other toxins in the feed. Evaluation of various feeds for its quality – Field methods of feed quality control including feed microscopy – Estimation of carotenes, cholesterol and peroxides. Quality control of functional poultry feeds – Maintaining the feed quality from production to consumption.

VIII. Teaching methods

- Classroom teaching with laboratory support and feed mill visits
- Use of computers in feed formulations

**IX. Learning outcome**

Gaining advanced knowledge in poultry nutrition.

X. Suggested Reading

- Bell DD and Weaver WD, Jr. 2002. *Commercial Chicken Meat and Egg Production*, 5th ed. Kluwer Academic Publishers.
- ICAR. 2013. *Nutrient Requirements of Poultry*. ICAR Publication.
- Leeson S and Summers JD. 2001. *Scott's Nutrition of the Chicken*. University Books.
- Leeson S and Summers JD. 2008. *Commercial Poultry Nutrition*, 3rd ed. University Books. Nutrient
- Singh RA and Panda B. 1992. *Poultry Production*. Kalyani Publishers.
- *Selected articles from journals.*

I. Course Title : Recent Trends in Commercial Poultry Production

II. Course Code : PSC 702

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge on different systems of poultry rearing, care and management of commercial layers/ broilers for optimal egg and meat production.

V. Theory**Unit I (7 Lectures)**

Global trends in poultry production - Advances in broiler production in India – concepts in egg production – Latest concepts in breeder management – advances in hatchery operations for higher hatchability and chick quality – Use of artificial intelligence in poultry production.

Unit II (8 Lectures)

Optimal microclimatic condition in poultry houses and cages for higher production – Management of poultry in environmentally controlled houses – Management of poultry under adverse climatic conditions – advances in the management of other species of poultry - Behavioural patterns of poultry in different growing systems.

Unit III (7 Lectures)

Advanced management techniques for egg and meat production - advances in lighting management, feeding management, litter management and manure management.

Unit IV (5 Lectures)

Factors influencing egg production in different species of poultry – Factors influencing growth rate and egg production - Automation in poultry production.

Unit V (7 Lectures)

Regulations for cage-free egg production and organic chicken production – Functional feeds for functional foods – Production of HACCP and GMP certified table eggs, meat, chicks, hatching eggs and other value-added products for export. Advances in Biosecurity, welfare and waste management - Role of integration in poultry production.

VI. Practical (17 Classes)

Performance study in the commercial layer, broiler, Japanese quail, duck, turkey and other species of poultry farms by Interpretation of the farm records - Management

routines of different species of poultry - calculating the cost of production – Estimation of microclimatic conditions and comparing the productive traits– Modern poultry house and cage design for optimal efficiency and cost reduction.

VII. Teaching methods

- Classroom teaching with farm visits
- Use of Audio-visual capsules

VIII. Learning outcome

Gaining knowledge of advanced commercial poultry production practices

IX. Suggested Reading

- Bell DD and Weaver WD, Jr. 2002. *Commercial Chicken Meat and Egg Production*, 5th ed. Kluwer Academic Publishers.
- Sreenivasaiah PV. 2006. *Scientific Poultry Production: A Unique Encyclopaedia*. International Book Distributing Co.
- Online sources of equipment manufacturers
- *Selected articles from journals.*

I. Course Title : Developments in Poultry Processing and Products Technology

II. Course Code : PSC 703

III. Credit Hours : 2+1

IV. Aim of the course

Composition and nutritive value of eggs and chicken meat, grading, packaging and preservation methods of eggs and meat, functional and value-added poultry products, marketing of eggs and poultry meat.

V. Theory

Unit I (9 Lectures)

Global trends in egg and poultry processing -Indian scenario of poultry processing industry - Nutrients and Non-nutrient components in regular and value-added poultry products – various measures of egg and meat quality control – advances in value addition to poultry products.

Unit II (12 Lectures)

Concepts in poultry meat and egg preservation – Newer concepts in meat tenderization, canning, dehydration, curing, irradiation, etc. - Modified atmosphere packaging and other packaging techniques – Other processed products - Room temperature preservation of poultry fast foods by multi hurdle technology – Further processing to produce ready to eat products.

Unit III (5 Lectures)

Egg powder production - Egg desugarization - pasteurization – Functional properties of eggs – Industrial uses of eggs – Marketing trends in poultry meat and eggs.

Unit IV (8 Lectures)

Improving the product quality to meet Codex and European standards – Standards for the egg, meat and their products -Production of immunoglobulins, lecithin, lysozyme, sialic acid and other pharmaceutical products from eggs – Sanitary and phytosanitary measures for food safety.



VII. Practical (17 Classes)

Preparation of value-added products suitable for preservation at room temperature– Further processing – Barbecuing and Tandoori preparation – preparation of local specific poultry meat and egg products – Meatballs, meat patties, etc. - Quality estimation of egg, meat and their products - Preservation of meat and eggs - Measuring the microbial quality of poultry foods.

VIII. Teaching methods

- Classroom teaching with laboratory analysis
- Preparation of value-added meat and egg products
- Use of Audio-visual capsules

IX. Learning outcome

Gaining knowledge of advanced poultry products and processing technology.

X. Suggested Reading

- Biswas A and Kondaiah N. 2014. *Meat Science and Technology*. Jaya Publishing House.
- Mead G. 2004. *Poultry Meat Processing and Quality*. Elsevier.
- Mountney GJ and Parkhairst CR. 1995. *Poultry Products Technology*, 3rd ed. AVI Publ.
- Owens CM. 2010. *Poultry Meat Processing*. CRC Press.
- Stadelman WJ and Cotteril OJ. 1995. *Egg Science and Technology*, 4th ed. CRC Press.
- *Selected articles from journals.*

I. Course Title : Emerging and Reemerging Diseases of Poultry and Health Management

II. Course Code : PSC 704

III. Credit Hours : 2+1

IV. Aim of the course

To study about common diseases and disorders of poultry, their diagnosis, vaccination, prevention and treatment, emphasis on control of emerging poultry diseases of zoonotic importance, disease diagnostic techniques.

V. Theory

Unit I (6 Lectures)

Concepts of disease prevention in poultry – Emerging and re-emerging avian diseases -Factors influencing immunosuppression/ immunity – Enhancing immunity in poultry.

Unit II (10 Lectures)

Water sanitation, hatchery sanitation procedures - Control of vertically transmissible diseases, hatchery borne diseases – non-infectious, metabolic and parasitic diseases in poultry and their control –Mycotoxins and their control.

Unit III (12 Lectures)

Stress alleviation – prevention and control of bacterial and viral diseases in poultry – Biosecurity measures – Control measures of problematic re-emerging diseases of poultry like Ranikhet, Avian influenza, Marek's disease, Infectious bursal disease, Infectious Bronchitis, Infectious laryngotracheitis, etc.

Unit IV (6 Lectures)

Flock management for Specific pathogen-free egg production – Maintaining the



HACCP standards in poultry farms – developments in the EXIM policies for flock health – Concept of compartmentalization and zoning as per terrestrial code., geographical information system in disease control.

VI. Practical (17 Classes)

Studying the Immune status of birds – Egg inoculation techniques in laboratory diagnosis – differential diagnosis of various poultry diseases by post-mortem, and laboratory techniques – Molecular diagnosis of diseases - Antibiotic sensitivity test – Designing Vaccination schedule for different poultry species – Disinfection and sanitation - Ectoparasite control, medication procedures.

VII. Teaching methods

- Classroom teaching with laboratory techniques
- Post-mortem examination and sample collection
- Use of Audio-visual capsules

VIII. Learning outcome

Gaining knowledge of the emerging disease of poultry and health management.

IX. Suggested Reading

- Davison F, Kaspers B and Schat KA. 2008. *Avian Immunology*. Elsevier
- Pattison M, McMullin P, Bradbury JM and Alexander D. 2008. *Poultry Diseases*, 6th ed. Elsevier.
- Thyagarajan D. 2011. *Diseases of Poultry*. Satish Serial Publishing House.
- Vegad JL. 2015. *Poultry Diseases Farmers. A Guide for Farmers and Poultry Professionals*. International Book Distributing Co.
- *Selected articles from journals.*

I. Course Title : Applied Poultry Breeding

II. Course Code : PSC 705

III. Credit Hours : 1+1

IV. Aim of the course

To impart knowledge about different systems of breeding, selection methods and implementation of the breeding programme in developing egg and meat type hybrids. Modern tools in poultry breeding.

V. Theory

Unit I (7 Lectures)

Gene and genotypic frequency - Sex-linked, limited and influenced traits-Auto sexing- Qualitative and quantitative traits and its inheritance in poultry- methods of selection – family selection – selection for multi characteristics and construction of selection indices –Reciprocal recurrent selection – Recurrent selection, Marker assisted selection – Random bred control populations - Selection limit - Osborne's index – construction of selection index for multiple traits - Use of molecular genetics in poultry breeding.

Unit II (5 Lectures)

Exploitation of additive and non-additive gene action for commercial poultry production - Heterosis – Exploitation of hybrid vigour for commercial production of layers and broilers - Formation of synthetic lines – Development of strains in poultry - Comparative efficiency of different selection methods in poultry.



Unit III (5 Lectures)

Modern methods in commercial layer and broiler breeding, performance testing – Pure line-breeding – Inbreeding and hybridization - Diallele mating. Pedigree hatching. Genotype × Environment interaction.

VI. Practical (17 Classes)

Construction of selection index – Analysis of breeding data collected from breeding records – Estimation of qualitative and quantitative inheritance - Estimation of variance, heritability and standard error of heritability by different methods – Repeatability - analysis of heritability for different traits – Estimation of inbreeding coefficient – Artificial insemination in poultry.

VII. Teaching methods

- Classroom teaching with breeding farm visits
- Utilizing computer for quantitative genetic analysis
- Use of Audio-visual capsules

VIII. Learning outcome

Gaining knowledge on applied poultry breeding methods

IX. Suggested Reading

- Crawford RD. 1990. *Poultry Breeding and Genetics*. Elsevier.
- Muir WM and Aggrey SE. 2003. *Poultry Genetics, Breeding and Biotechnology*. CAB International.
- Singh R and Kumar J. 1994. *Biometrical Methods in Poultry Breeding*. Kalyani Publishers.
- *Selected articles from journals*.

I. Course Title : Poultry Economics, Marketing and Integration

II. Course Code : PSC 706

III. Credit Hours : 2+1

IV. Aim of the course

To study about measures of performance efficiency in poultry farms and its allied sectors, hatcheries and developing poultry projects.

V. Theory

Unit I (11 Lectures)

Present practices and future trends in the production of egg and meat – Present trends in consumption – Demand and supply - Seasonal variations in production and consumption. Marketing channels- procedures of marketing for eggs and meat - Market intelligence -Advertising and branding of poultry products.

Unit II (14 Lectures)

Various poultry enterprises – choice of production size of business – input and output analysis – calculating cost of various inputs – calculating cost of production – Break-even point analysis - Price determination – Role of NECC, BroMark and other marketing agencies - Least demand and supply indices of performance – Performance targets and achievements - marketing and business management - market managerial skills and human resource development - cost and financial management.

Unit III (9 Lectures)

Future trends in broiler and egg production – Factors influencing the profit margin

in poultry enterprises – Role of integration in Poultry business – Different types of integration.

VI. Practical (17 Classes)

Study of marketing channels of egg and meat, calculating the cost of production of eggs, meat, day-old chick and feed – Calculating marketing costs - Preparing other related poultry projects. Use of social media in popularizing poultry and poultry products – Study of successful business models in the poultry sector.

VII. Teaching methods

- Classroom teaching and interaction with the poultry industry
- Use of Audio-visual capsules

VIII. Learning outcome

Gaining knowledge of market intelligence and marketing techniques

IX. Suggested Reading

- Narahari D and Asha Rajini R. 2005. *Poultry Economics and Projects*. PIXIE Publications India (P) Ltd.
- Vashisht K. 2006. *Practical Approach to Marketing Management*. Atlantic.
- Online sources of NABARD website4. *Selected articles from journals*.

I. Course Title : Diversified Poultry Production

II. Course Code : PSC 707

III. Credit Hours : 2+1

IV. Aim of the course

To provide knowledge on care and management of different breeds, varieties of poultry other than chicken, methods of rearing and common diseases affecting them and their control measures.

V. Theory

Unit I (9 Lectures)

Commercial hybrid strains of ducks for egg and meat production – Feeding and management – Housing – Specific diseases of ducks, prevention and their control – Slaughter and processing of ducks – Economics of production of ducks, indigenous duck production system including polythene duck pond.

Unit II (8 Lectures)

Varieties of Japanese quail for meat and egg production – Cage and deep litter system of rearing of quails – Feeding and management – Housing – Emerging diseases affecting Japanese quail – Nutritive value of Japanese quail meat and egg - Economics of production of Japanese quail.

Unit III (9 Lectures)

Varieties/ breeds of Turkey, Guinea fowl, Geese, Emu and Ostriches – System of rearing – Feeding and management – Housing – Emerging diseases and their prevention – Nutritive value of Turkey, Geese and Guinea fowl – By-products of Geese, Emu and Ostriches.

Unit IV (8 Lectures)

Scope and constraints in the marketing of diversified poultry products – Rearing



and management of common pet birds and other birds of regional importance – Common diseases affecting pet birds and their prevention and treatment - Economics of production of different pet birds.

Learning outcome

Gaining advanced knowledge of diversified poultry production

VI. Practical (17 Classes)

Layout and design of housing for other species of poultry. Visit commercial Japanese quail, turkey and duck farms. Incubation and care of hatching eggs and young ones – Rearing practices followed for duck, quails and turkey farmers under field conditions – Designing of aviaries for pet birds - Different types of feed prepared for pet birds – Vaccination and medication for diversified poultry species - Preparing project reports for different species and calculating the cost of production.

VII. Teaching methods

- Classroom teaching and visit to other avian species farms
- Use of Audio-visual capsules

VIII. Suggested Reading

- Cherry P and Morris T. 2011. *Domestic Duck Production: Science and Practice*. CAB International.
- CPDO. *Duck – Management Guide*. Central Poultry Development Organization Publication (online resource)
- CPDO. *Turkey – Management Guide*. Central Poultry Development Organization Publication (online resource)
- Pathak N. 2013. *Poultry and Ratite Nutrition*. Narendra Publishing House.
- Thiyagarajan D. 2012. *Scientific Turkey Farming*. SSPH, New Delhi.

ANNEXURE I

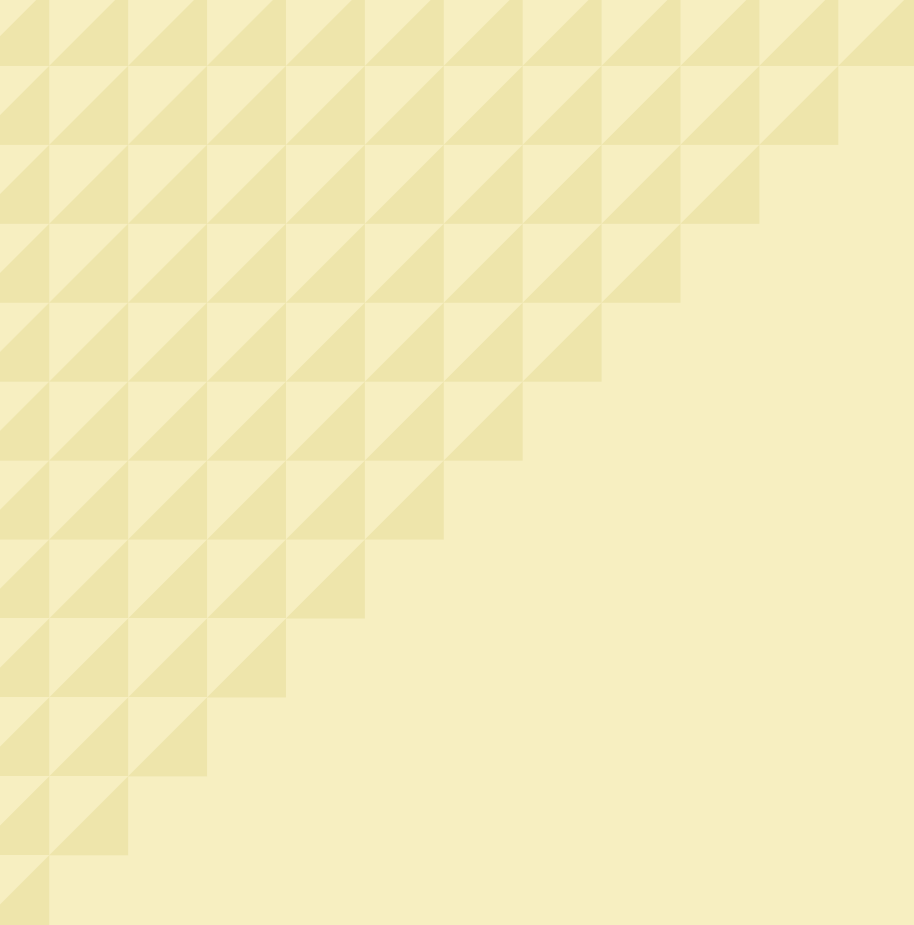
List of BSMA Committee Members for Animal Production Sciences

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2. Dr A.K. Pattanaik Principal Scientist Division of Animal Nutrition ICAR-Indian Veterinary Research Institute Izatnagar-243 122	Convener	Animal Nutrition
3. Dr A.K. Ghosh Professor Department of Animal Genetics and Breeding GB Pant University of Agriculture and Technology Pantnagar-263 145	Member	Animal Genetics and Breeding
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6. Dr (Mrs) Sanjita Sharma Head Department of Livestock Production and Management, and Dean, Post Graduate Institute of Veterinary Education and Research (RAJUVAS) Jaipur-302 031	Member	Livestock Production and Management
7. Dr K. Kondal Reddy Registrar (Retd.) PV Narsimha Rao Telangana Veterinary University Hyderabad-500 030	Member	Livestock Products Technology

Annexure



Name, designation and address	Position	Specialization
8. Dr S.K. Mendiratta Head Division of Livestock Products Technology ICAR-Indian Veterinary Research Institute Izatnagar-243 122	Member	Livestock Products Technology
9. Dr A.S. Yadav Principal Scientist Division of Post-Harvest Technology ICAR-Central Avian Research Institute Izatnagar-243 122	Member	Poultry Science
10. Dr P.K. Shukla Registrar PDDU Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go Anusandhan Sansthan (DUVASU) Mathura-281 001	Member	Poultry Science



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