

**SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI**  
**Scheme of Teaching, Learning and Examination Leading to the Degree - Master of Science (Zoology)**  
**(Two Year- Four Semester Degree Programme-CBCS)**

<b>Curriculum Scheme for Second Year M.Sc. II, Sem-III (Zoology)</b>																	
Sr. No.	Subjects	Subject Code	Teaching and Learning Scheme								Examination and Evaluation Scheme						
			Teaching Periods Per Week				Credits			Duration of Exam Hours	Maximum Marks			Minimum Passing			
			L	T	P	Total	Lectures	Practical	Total		Theory		Practical		Total Marks	Marks	Grade
Theory+ MCQ (Ext)	Theory (Int)	Internal	External	Total Marks	Marks	Grade											
1.	DSC-IX	3ZOO1	4	--	--	4	4	--	4	3	75	25	--	--	100	40	P
2.	DSC-X	3ZOO2	4	--	--	4	4	--	4	3	75	25	--	--	100	40	P
3.	DSE-XI	3ZOO3	4	--	--	4	4	--	4	3	75	25	--	--	100	40	P
4.	DSE-XII	3ZOO4	4	--	--	4	4	--	4	3	75	25	--	--	100	40	P
5.	Lab-5	3ZOO5	--	--	8	8	--	4	4	6	--	--	25	75	100	50	P
6.	Lab-6	3ZOO6	--	--	8	8	--	4	4	6	--	--	25	75	100	50	P
	<b>Total</b>		<b>16</b>	<b>--</b>	<b>16</b>	<b>32</b>	<b>16</b>	<b>08</b>	<b>24</b>						<b>600</b>		

L: Lecture, T: Tutorial, P: Practical

For Theory, 1 credit = 01 hour.

For Practical, 1 credit is = 02 hours.

# Students may complete their internship/Field Work/Work Experience in First or Second or Third Semester of M.Sc.(Zoology) according to their convenience; @ denotes Non-Examination Credit.

**Note:** Internship/Apprenticeship/Field Work/Work Experience (During vacations of Semester I to Semester III for duration of minimum 60 hours to maximum 90 hours mandatory to all students, to be completed during vacations of Semester I to III. This will carry 2 Credits for learning of 60 hours or 3 credits for learning of 90 hours. Its credits and grades will be reflected in final semester IV credit grade report.

-OEC (Optional) can be studied during semester I to IV.

Curriculum Scheme for Second Year M.Sc. II, Sem-IV (Zoology)																		
Sr. No.	Subjects	Subject Code	Teaching and Learning Scheme								Examination and Evaluation Scheme							
			Teaching Periods Per Week				Credits			Duration of Exam Hours	Maximum Marks			Minimum Passing				
			L	T	P	Total	Lectures	Practical	Total		Theory		Practical		Total Marks	Marks	Grade	
									Theory+ MCQ (Ext)	Theory (Int)	Internal	External						
1.	DSC-XIII	4ZOO1	4	--	--	4	4	--	4	3	75	25	--	--	100	40	P	
2.	DSC-XIV	4ZOO2	4	--	--	4	4	--	4	3	75	25	--	--	100	40	P	
3.	DSE-XV	4ZOO3	4	--	--	4	4	--	4	3	75	25	--	--	100	40	P	
4.	DSE-XVI	4ZOO4	4	--	--	4	4	--	4	3	75	25	--	--	100	40	P	
5.	Lab-7	4ZOO5	--	--	8	8	--	4	4	6	--	--	25	75	100	50	P	
6.	Project	4ZOO6	--	--	8	8	--	4	4	6	--	--	25	75	100	50	P	
	<b>Total</b>		<b>16</b>	<b>--</b>	<b>16</b>	<b>32</b>	<b>16</b>	<b>08</b>	<b>24</b>						<b>600</b>			

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-OEC (Optional) can be studied during semester I to IV.

**Sant Gadge Baba Amravati University, Amravati**  
**Faculty: Science and Technology**  
**Programme: M.Sc. II SEM-III (Zoology)**

**POs:**

The post graduate course of Zoology will provide theoretical as well as experimental knowledge as per the courses included under the syllabi by which build up creativity in students will lead towards thorough learning and development of ideas of research work and will become ready to face recent challenges. Students can attain the employability skills through the experiences based on their practical knowledge.

**After completion of M.Sc. in Zoology successfully, the students would be able to-**

1. Demonstrate the significance of the topics of syllabi and evaluate its relevance. Think creatively for its gravity and develop ideas.
2. Interpret scientific ideas and can do its analysis. Create experiments independently and draw inferences by sharing it with others.
3. Derive information from various digital sources. Develop skills for scientific writing and present the data and analyse it scientifically.
4. Articulate scientific ideas lay down a hypothesis; design the pathway to develop research ideas.
5. Acquaint skills in handling the instruments and different techniques through practical and developing the scientific temperaments for research.
6. Develop competence through healthy atmosphere and quality intercommunication with different groups.
7. Understand environmental and sustainability issues and its sensitivity in relation to regional relevance.
8. Get the facility of different training and internship programs through job-oriented curriculum.
9. Utilize the sources confidently and independently and develop self-sustenance.

**PSOs:**

**Upon completion of the programme successfully, students would be able to -**

1. Learn to prepare the checklist and inventories through the identification of the fauna in local areas being Melghat Tiger Reserve and Pohra Forest are very nearer to survey.
2. Gain comprehensive knowledge about different animals and develop confidence to handle them during research work.
3. Interpret metabolic pathways, their correlation in concern with prokaryotes and eukaryotes.
4. Compare genetic aspects, genetic traits, diseases and their specific causes.
5. Survey and analyse data of the various kinds of diseases in the locality.
6. Understand various strategies and phenomena related to animal reproduction and their development.
7. Get acquainted with conservation strategies and environmental threats to reduce and save energy through Wildlife Week Celebration.
8. Compare the different developmental events during embryogenesis of different animals.

**Employability Potential of the Programme:**

**Zoology** deals with the structure, embryology, evolution, classification, habits, and distribution of all animals, both living and extinct. If you are interested in making a career in Zoology then you need to deal with both the existing, dead and quite possible the extinct species of the animal kingdom. M.Sc. Zoology Programme scope is very rewarding owing to the relevancy of the course. Employability can be found in both the private and public sectors.

A zoologist might even get to travel because the nature of his/her job. Channels like **National Geographic, Animal Planet, Discovery Channel** are in constant need of Zoologists for research and documentaries based on it. Zoologists are also hired for zoos, wildlife services, conservation organizations, national parks, nature reserves, universities, laboratories, aquariums, animal clinics, fisheries and aquaculture, museums, research, pharmaceutical Companies, veterinary hospitals, etc.

**There are various sectors of employment in the field of Zoology. Here's the list of job profiles:**

Jobs are available with a wide range of organizations in the public, private and not-for-profit sectors. Typical employers include:

- Zoos or wildlife parks and environmental protection agencies
- Government agencies and research institutions (CCMB, CDFD, CSIR, ICMR)
- Medical research establishments and the National Health Services
- Universities
- Environmental consultancies
- **Wildlife Biologist:** In the current scenario of global warming, mankind needs to pay attention to conserve the wildlife. Main concern of wildlife biologist is conservation and propagation of wildlife.
- **Community development organizations:** Ideal places to apply theoretical knowledge in real life settings. Student can also join a number of organizations to pursue career in community development like:
  - Zoo Outreach Organization
  - Dr. Salim Ali School of Ecology
  - Indian Tiger Welfare Society
  - Wildlife Trust of India
  - Bombay Natural History Society (BNHS), NEERI
  - Protection Society of India
  - Ashoka Trust for Research in Ecology and the Environment (ATREE) etc.
  - Central Zoo Authority (CZA)
  - Regional Resource Centers of Ministry of Environment and Forest Wildlife
  - Wildlife Information Liaison Development
  - Centre for Science and Environment (CSE)

• **Indian Forest Services (IFoS):** A candidate can take IFoS exam conducted by Union Public Services Commission (UPSC). The upper age limit is relaxable up to 5 years for the candidates belonging to categories: Scheduled Caste/ Scheduled Tribe (SC /ST).

• **Research work:** If student is keen in research then he/she can apply for IISc, IISER, TIFR, NCBS, JNCASR, etc. for an Integrated MSc-PhD program or pursue advanced degree in wildlife biology or ecological sciences in various institutes.

• **Freelance consultant:** Student may also work as a freelance consultant in various research and development organizations.

This a great career interest for students, who are fascinated with nature and would not mind spending time understanding it. There are several specializations that the students pursuing the field can venture into. Many research agencies recruit expert people for various research projects for environmental research, Animal Biodiversity research, Conservation of Wildlife, environmental management research and monitoring of ecosystems etc.

Zoology Student has ample opportunities as Zoology teacher, Lab Assistant, Conservationist, Wildlife biologist, Marine Biologist, Museum Curator, Taxonomist, Forensic Expert, Eco-toxicologist, Biomedical Scientist, Animal Care taker, Animal and wildlife Educator, Zoo Curator, Environmental Consultant, Zoo Educator, wildlife Rehabilitator, Medical Representative, Sustainability officer.

Some top organizations also employ students such as Wildlife Institute of India (NII), Zoological Survey of India (ZSI), National Institute of Oceanography (NIO), State Forest Department, Centre Marine Fisheries Research Institute (CMFRI), Central Inland Fisheries Research Institute (CIFRI), Ministry of Environment and forest, Medical Laboratories, Agricultural firms Pharmaceutical Companies, etc.

Being Zoology is a basic Science, the demand of Zoology is increasing day by day. It provides a good career option to students. It provides wide horizon of knowledge with preview of employability potential. P.G. in Zoology provides services in various sectors like, Biological Medical, Agriculture as Zoologist, Assistant Professor, Ecologist, Entomologist, Herpetologist, Department of Fishery Zoo Keeper, Zoo Officer, Marine Scientist etc.

The student can also work in forest department by qualifying Indian Forest Service examination. They can work in sample investigator for those derived from animals in different poaching and forest crime cases.

They have opportunities like Wildlife Conservationist, Forest Ranger, Zoologist, Wildlife Educator, Naturalist, Field Officer, Biomedical Scientist, Toxicologist, Marine Scientist, Medical Coder etc.

They can opt to do research-based programs or study for competitive examinations like civil services besides doing a job in a zoology-related field. Other than this they can opt post PG Studies M.Phil or Ph.D or can qualify competitive exam like NET/SET/GATE to join as Assistant Professor or as a Researcher. A Scholar Student can join services at Bhabha Atomic Research Centre (BARC), NCBS/TIFR, NIO/ZSI etc. as a scientist.

### Syllabus Prescribed for Second Year 2023-24

S. N.	PG Programme: M.Sc. Zoology Semester-III	Code of the Course/Subject	Title of the Course/Subject	Total Number of Periods
1.	DSC-IX	3ZOO1	Molecular Cytogenetics-I	60
2.	DSC-X	3ZOO2	Molecular Cytogenetics-II	60
3.	DSE-XI	3ZOO3	Molecular Biology-I/Animal Physiology-I/Fishery- I/ Entomology-I	60
4.	DSE-XII	3ZOO4	Molecular Biology-II/Animal Physiology-II/Fishery- II/ Entomology-II	60
5.	Lab-5	3ZOO5	Lab-V	60
6.	Lab-6	3ZOO6	Lab-VI	60

**Note:** Internal assessment marks for all semesters for theory papers (separately for each paper) shall be granted on the basis of performance of the student in the following activities: (i) Seminar/Assignment, (ii) Unit tests and/or Common tests, and (iii) Study tour/Field Visit/Industrial Visit/Visit to Research Institute/Co-curricular Activity.

### Theory Paper-IX (Molecular Cytogenetics-I) and Paper-X (Molecular Cytogenetics-II) and Related Practical

CO1: Molecular Cytogenetics gives the knowledge of biological mechanisms of variations and heredity.

CO2: It also gives an elementary idea about different hereditary diseases and syndromes and their inheritance.

CO3: It trains the students to perform laboratory exercises in Cytogenetics.

**PG Programme: M.Sc. Zoology Semester-III**  
**DSC – IX, Code of the Course: 3ZOO1**

### M.Sc. II (Zoology) Semester-III DSC-IX (Molecular Cytogenetics-I)

Unit	Contents
<b>Unit-I</b>	<b>Mutation:</b> 1.1 Basic features of mutation. 1.2 Adaptation versus mutation. 1.3 Phenotypic effects of mutation. 1.4 Mutation induced by chemicals and radiation. 1.5 Mutation caused by the DNA replication machinery. 1.6 Hot spots of mutation. 1.7 Detection of mutagens-The Ames Test. 1.8 DNA repair mechanisms. 1.9 Diseases resulting from defects in DNA repair mechanisms.
<b>Unit-II</b>	<b>Somatic Cell Genetics:</b> 2.1 Agents and mechanism of cell fusion. 2.2 Mechanism of cell fusion. 2.3 Selection of hybrids and chromosome segregation.

	<p>2.4 Radiation hybrid panels and gene mapping.</p> <p><b>Epigenetics:</b></p> <p>2.5 Mechanisms of DNA methylation.</p> <p>2.6 Methyl-CpG recognition.</p> <p>2.7 Mechanisms of histone modification.</p> <p>2.8 Prions and epigenetic inheritance.</p> <p>2.9 Polycomb mechanisms and epigenetic control of gene activity.</p>
<b>Unit-III</b>	<p><b>Transposable Genetic Elements:</b></p> <p>3.1 Transposable elements in bacteria.</p> <p>3.2 Transposable elements in <i>Drosophila</i>.</p> <p>3.3 Transposable elements in human.</p> <p>3.4 Effects of transposable genetic elements.</p> <p><b>Genetics of Cancer:</b></p> <p>3.5 Properties of cancer cells.</p> <p>3.6 Metastasis.</p> <p>3.7 Relationship of cell cycle to cancer.</p> <p>3.8 Oncogenes.</p> <p>3.9 Tumor suppressor genes.</p>
<b>Unit-IV</b>	<p><b>Human Genetic Diseases:</b></p> <p>4.1 Human karyotype.</p> <p>4.2 Banding and nomenclature of human chromosomes.</p> <p>4.3 Dosage compensation.</p> <p>4.4 Patau syndrome.</p> <p>4.5 Edwards syndrome.</p> <p>4.6 Down syndrome.</p> <p>4.7 Turner syndrome.</p> <p>4.8 Klinefelter syndrome.</p> <p>4.9 Cri-du-chat syndrome.</p> <p>4.10 Prader-Willi syndrome.</p>
<b>Unit-V</b>	<p><b>Human Genetic Diseases:</b></p> <p>5.1 Phenylketonuria.</p> <p>5.2 Lesch-Nyhan syndrome.</p> <p>5.3 Tay-Sachs disease.</p> <p>5.4 Albinism.</p> <p>5.5 Emphysema.</p> <p>5.6 Sickle cell anemia.</p> <p>5.7 Hemophilia.</p> <p>5.8 Thalassemia.</p> <p>5.9 Mitochondrial DNA and human diseases.</p> <p>5.10 <b>Genetic Counseling:</b> Carrier detection, Fetal analysis by amniocentesis and chorionic villus sampling, Pedigree analysis.</p>

**PG Programme: M.Sc. Zoology Semester-III**  
**DSC – X, Code of the Course: 3ZOO2**

**M.Sc. II (Zoology) Semester-III**  
**DSC-X (Molecular Cytogenetics-II)**

<b>Unit</b>	<b>Contents</b>
<b>Unit-I</b>	<p><b>Bacterial Genetics:</b></p> <p>1.1 Bacterial chromosome.</p> <p>1.2 Bacterial transformation and conjugation.</p> <p>1.3 Bacterial transduction.</p> <p><b>Bacteriophages:</b></p> <p>1.4 Types of bacteriophages.</p> <p>1.5 Structure of T4 phage and its morphogenesis.</p> <p><b>Extra-chromosomal Inheritance:</b></p>

	1.6 Maternal inheritance of <i>kappa</i> particles in <i>Paramecium</i> . 1.7 Shell coiling in <i>Lymnaea</i> .
<b>Unit-II</b>	<b><i>Drosophila</i> Genetics:</b> 2.1 Advantages of <i>Drosophila</i> as a model organism for genetic studies. 2.2 <b>Polytene chromosomes:</b> Polytenization process, significance of polytenization, bands and interbands, puffs, regulation of puffing activity. 2.3 <b>Behavioral traits:</b> Mutants, tools and methodologies for genetic analysis. 2.4 Genetic and molecular basis of behavioural traits in <i>Drosophila</i> .
<b>Unit-III</b>	<b>Molecular Cytogenetic Techniques:</b> 3.1 DNA fingerprinting: Principle, procedure and applications. 3.2 Chromosome separation by flow cytometry. 3.3 Chromosome painting. <b>DNA Sequencing:</b> 3.4 Sanger's dideoxy method, Maxam and Gilbert's chemical degradation method. 3.5 Polymerase chain reaction (PCR): Procedure and applications. 3.6 Fluorescence <i>in situ</i> hybridization (FISH).
<b>Unit-IV</b>	<b>Population Genetics:</b> 4.1 Genetic variation in natural populations: Phenotypic variation, Polymorphism of chromosome structure, Variation at molecular level. 4.2 Hardy-Weinberg principle of genetic equilibrium and its applications. 4.3 Gene pool. 4.4 Genetic drift. 4.5 Ecological significance of molecular variations. <b>Genetics of quantitative traits in populations:</b> 4.6 Molecular analysis of quantitative traits. 4.7 Genotype-environmental interactions. 4.8 Inbreeding depression and heterosis.
<b>Unit-V</b>	<b>Molecular Phylogenetics:</b> 5.1 Methods of phylogenetic tree reconstruction 5.2 Nucleic acid phylogeny based on DNA-DNA hybridization, Restriction enzyme sites, Nucleotide sequence comparisons and homologies. 5.3 Protein phylogeny. 5.4 Molecular clocks. 5.5 Use of mitochondrial DNA in the study of molecular evolution.

## PRACTICAL

**PG Programme: M.Sc. Zoology Semester-III**  
**LAB-5 Code of the Course: 3ZOO5**

### Practical-5 based on Paper – IX and X (Molecular Cytogenetics-I and II)

- 1) Demonstration of Barr bodies in leucocytes of human female.
- 2) Demonstration of salivary gland chromosomes from *Chironomous/Drosophila* larvae.
- 3) Study of mitosis in cleaving eggs of Frog/any invertebrate.
- 4) Study of meiosis from Grasshopper/Rat testes using smear method
- 5) Histological demonstration of meiosis in Rat testis
- 6) Preparation of human karyotype by using photograph/picture.
- 7) Culture of *Drosophila* and study of life cycle and sexual polymorphism.
- 8) Identification of wing and eye mutants in *Drosophila*.
- 9) Extraction of DNA.
- 10) Estimation of DNA (spectrophotometric/colorimetric).
- 11) Extraction of RNA.

- 12) Estimation of RNA (spectrophotometric/colorimetric).
- 13) Problems on Genetics based on dihybrid crosses, sex-linked inheritance and blood groups.
- 14) Study of various human genetic traits and genetic disorders.
- 15) Study of mDNA disorders through photographic slides.

**Note:** Besides these any other additional experiment relevant to the syllabi depending on resources.

**The examinee shall be required to produce at the practical examination the following:**

1. Practical record book duly signed by teacher in charge and certified by the Head of the Department as a *bona fide* work of the examinees.

**Distribution of Marks:**

The practical shall be of six hours duration & distribution of Marks will be as follows:

**External Marks**

- |                                   |            |
|-----------------------------------|------------|
| 1. Estimation /Experiment         | : 30 marks |
| 2. Cytological Preparation        | : 25 marks |
| 3. Problems on Genetics (any two) | : 20 marks |

**Internal Marks**

- |                 |            |
|-----------------|------------|
| 4. Class Record | : 10 marks |
| 5. Viva Voce    | : 15 marks |

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<b>Total</b>	<b>: 100 marks</b>
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**Suggested Readings (All recent editions):**

1. Atherly, A.G., J. R. Girton and J.F. McDonald. The Science of Genetics. Saunders College Publishing, Harcourt Brace College Publishers, NY.
2. Brooker, R.J. Genetics: Analysis and Principles, Benjamin Cummings, Longman
3. Fairbanks, D. J. and W. R. Anderson. Genetics – The continuity ofLife. Brooks/Cole Publishing Company ITP, NY, Toronto.
4. Gardner, E.J., M.J. Simmons and D.P. Snustad. Principles of Genetics. John Wiley and Sons, Inc. NY.
5. Griffiths, A.J.F., J. H. Miller, D.T. Suzuki, R.C. Lewontin and W. M. Gelbart. An Introduction to genetic analysis. W.H. Freeman and Company, New York.
6. Lewin, B. Genes XII. Oxford University Press, Oxford, New York, Tokyo.
7. Snustad, D.P. and M.J. Simmons. Principles of Genetics. John Wiley& Sons.
8. Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steiz and A.M.Weiner, Molecular Biology of Genes. The Benjamin/Cummings Pub.Co. Inc.Tokyo
9. Mange E. J. and A.P.Mange.Basic Human Genetics 2/Ed. SinauerAssociates
10. Russel P. J. Genetics 5th edn.The Benjamin/Cummings Pub.Co.
11. Vogel, F. and A.G.Motulsky. Human Genetics. Springer-Verlog, NY
12. Hartl, D. L and E.W.Jones: Genetics-Principles and analysis.4th edn.Jones & Bartlett Pub.Boston
13. Weaver, R.F. & P. W. Hedrick: Genetics 3rd edn. Wm. C.BrownPub.London
14. Tollefsbol, T. Handbook of Epigenetics: The New Molecular and Medical Genetics. Academic Press.



## Theory Paper-XI (Molecular Biology-I) and Paper-XII (Molecular Biology-II) and Related Practical

CO1: Molecular Biology gives the knowledge of biological processes through the investigation of molecular mechanisms.

CO2: It enables to understand the chemical and molecular processes that occur in and between cells.

CO3: Trains the students to perform laboratory exercises in Molecular Biology that is applicable to medicine, forensics and pharmaceutical industry.

**PG Programme: M.Sc. Zoology Semester-III**

**DSE – XI Code of the Course: 3ZOO3**

### M.Sc. II. (Zoology) Semester-III DSE – XI (Molecular Biology-I)

Unit	Contents
<b>Unit-I</b>	<p><b>DNA replication:</b></p> <p>1.1 General features of DNA replication. 1.2 Enzymes of DNA replication. 1.3 Prokaryotic DNA replication. 1.4 Eukaryotic DNA replication.</p> <p><b>Transcription:</b></p> <p>1.5 Structure and function of RNA polymerases. 1.6 General and specific transcription factors. 1.7 Regulatory elements. 1.8 Mechanism of prokaryotic transcription. 1.9 Mechanism of eukaryotic transcription.</p>
<b>Unit-II</b>	<p><b>Regulation of Transcription:</b></p> <p>2.1 Transcription regulation in eukaryotes. 2.2 Transcription regulation in prokaryotes: Trp, Gal and Ara operons. 2.3 Transcriptional and post-transcriptional gene silencing.</p> <p><b>Co -and Post-transcriptional modifications in mRNA:</b></p> <p>2.4 5'-cap formation. 2.5 Transcription termination. 2.6 3'-end processing and polyadenylation. 2.7 Splicing. 2.8 Editing. 2.9 Nuclear export of mRNA. 2.10 mRNA stability.</p>
<b>Unit-III</b>	<p><b>Translation (Protein synthesis):</b></p> <p>3.1 Genetic code. 3.2 Protein synthesis in prokaryotes. 3.3 Protein synthesis in eukaryotes. 3.4 Polyribosome formation. 3.5 Regulation of translation. 3.6 Co- and post-translational modifications of proteins.</p>
<b>Unit-IV</b>	<p><b>Antisense and ribozyme technology:</b></p> <p>4.1 Molecular mechanisms of antisense molecules. 4.2 Inhibition of splicing, polyadenylation and translation. 4.2 Disruption of RNA structure and capping. 4.4 <b>Biochemistry of ribozymes:</b> hammerhead, hairpin and other ribozymes. 4.5 Strategies for designing ribozymes. 4.6 Applications of antisense and ribozyme technologies.</p>

<b>Unit-V</b>	<b>Fluorescent proteins:</b> 5.1 General properties of fluorescent proteins 5.2 Properties and modifications of <i>Aequorea victoria</i> green fluorescent protein. 5.3 Yellow fluorescent proteins, Blue and Cyan fluorescent proteins, and Red fluorescent proteins. 5.4 Fluorescent protein vectors and gene transfer. 5.5 Mutations that improve fluorescent proteins as imaging probes. 5.6 Applications of fluorescent proteins.
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**PG Programme: M.Sc. Zoology Semester-III**  
**DSE – XII Code of the Course: 3ZOO4**

**M.Sc. II. (Zoology) Semester-III**  
**DSE – XII (Molecular Biology-II)**

<b>Unit</b>	<b>Contents</b>
<b>Unit-I</b>	<b>Molecular Mapping of Genome:</b> 1.1 Physical mapping: Restriction mapping, Mapping by FISH, Sequence tagged site mapping. 1.2 Genetic mapping: Linkage analysis, DNA markers-based mapping. 1.3 Choice of mapping population, simple sequence repeat loci. 1.4 Chromosome microdissection and microcloning.
<b>Unit-II</b>	<b>DNA Markers:</b> 2.1 Restriction fragment length polymorphism (RFLP). 2.2 Random amplified polymorphic DNA (RAPD). 2.3 Amplified fragment length polymorphism (AFLP). 2.4 Single-nucleotide polymorphism (SNP). 2.5 Simple tandem repeat polymorphism (STRP). 2.6 Applications of RFLP in forensics, disease prognosis, genetic counseling and pedigree analysis. 2.7 Application of molecular markers in solving animal trafficking cases.
<b>Unit-III</b>	<b>Hybridization Techniques and PCR:</b> 3.1 Preparation of radioactive and nonradioactive probes. 3.2 <b>Hybridization Techniques:</b> Southern blotting, Northern blotting, Western blotting, Dot blot, Fluorescence <i>in situ</i> hybridization (FISH), and DNA microarray. 3.3 <b>Polymerase Chain Reaction (PCR):</b> Principle, methodology, modifications, applications, advantages and limitations.
<b>Unit-IV</b>	<b>Recombinant DNA Technology (RDT):</b> 4.1 Enzymes used in RDT. 4.2 <b>Vectors used in RDT:</b> Plasmids, Bacteriophages, Phagemids, Cosmids, BACs, PACs, YACs, Transcribable vectors, and expression vectors. 4.3 Procedure of RDT. 4.4 Applications of RDT in agriculture, pharmacy, gene therapy and environmental pollution. 4.5 Construction and screening of genomic and cDNA library.
<b>Unit-V</b>	<b>DNA Sequencing Techniques:</b> 5.1 Sanger's dideoxy method, Automated DNA sequencing, Targeted sequencing. 5.2 Next Generation Sequencing: Illumina sequencing, Ion torrent sequencing. 5.3 <b>Third-Generation Sequencing:</b> Nanopore sequencing, single-molecule real-time (SMRT) sequencing. <b>Other Techniques:</b> 5.4 Protein sequencing by Sanger's method. 5.5 DNA Fingerprinting: Principle, procedure and applications. 5.6 CRISPR-Cas9 System: Mechanism and applications. 5.7 RNA Interference (RNAi): Mechanism and applications.

## PRACTICAL

PG Programme: M.Sc. Zoology Semester-III

LAB- 6 Code of the Course: 3ZOO6

### Practical -6 Based on DSE -XI and DSE -XII (Molecular Biology – I & II)

1. DNA fingerprinting.
2. Extraction of DNA from bacteria.
3. Extraction of DNA from yeast.
4. Extraction of DNA from animal tissue.
5. Extraction of DNA from whole blood.
6. Determination of molecular size of DNA.
7. Restriction digestion.
8. Preparation and demonstration of plasmid by gel electrophoresis.
9. Isolation and cleaning of DNA fragment of interest from the agarose gel.
10. Electrophoretic separation and determination of molecular weight of protein by SDS-PAGE.
11. Estimation of total protein from serum.

**Note:** Besides these any other additional experiment relevant to the syllabi depending on resources.

**The examinee shall be required to produce at the practical examination the following:**

Practical record book duly signed by teacher in charge and certified by Head of the Department as a *bona fide* work of the examinees.

### Distribution of Marks:

The practical shall be of two days each of six hours duration & distribution of marks will be as follows.

#### External Marks

- |   |            |
|---|------------|
| 1. DNA electrophoresis based experiment | : 25 marks |
| 2. DNA extraction based experiment      | : 25 marks |
| 3. Estimation                           | : 25 marks |

#### Internal Marks

- |                                    |            |
|------------------------------------|------------|
| 4. Certified practical record book | : 10 marks |
| 5. <i>Viva voce</i>                | : 15 marks |

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<b>Total</b>	<b>: 100 marks</b>
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### Suggested Reading Material: (All recent editions)

1. Kourilsky, P. "Genetics - the thread of life". Wiley Eastern Ltd. New Delhi
2. Newton, C. R. & A. Graham. PCR 2/ed. Bios Scientific Publishers
3. Fanning, E., R. Knippers & E. L. Winnacker. "DNA Replication and The Cell Cycle". Springer – Verlag, New York
4. Resnekov, O. & A.V. Gabain (Editors) "Post – Transcriptional Control of Gene Expression" Springer – Verlag, New York
5. Singer, M. & P. Berg (editors) "Exploring Genetic Mechanisms". University Science Books, California
6. Williamson, R. (editor). "Genetic Engineering - 2", Academic Press, Inc. London.
7. Lodish *et al.* Molecular Cell Biology, 8/Ed.
8. Powar C.B. Genetics Vol.I & Vol. II, Himalaya Publication
9. Benjamin Lewin. Genes XII, Oxford Press
10. McWright & Yamamoto. Transcriptional regulation, ColdSpring Harbor Pub.
11. Molecular Biology of the Gene. James D. Watson, Michael Levine, Richard Losick, Bell, Baker Latest edition. Publisher: Benjamin Cummings.

12. Molecular Biotechnology: Principles and Applications of Recombinant DNA. Bernard R. R. Glick, Jack J. Pasternak. Publisher: ASM Press.
13. DNA Microarrays: A Molecular Cloning Manual. David Bowtell (Editor), Joseph Sambrook (Editor). Latest edition /Publisher: Cold Spring Harbor Laboratory Press.

**Theory Paper- DSE -XI (Animal Physiology-I) and DSE -XII (Animal Physiology-II) and Related Practicals**

CO1: Animal physiology gives the knowledge of biological processes through the investigation of physiological processes.

CO2: It enables to understand the chemical and molecular processes that occur in and between cells.

CO3: It also provides knowledge about the theoretical processes related to hormonal action.

CO4: Trains the students to perform laboratory exercises in Animal physiology that is applicable to Pathology laboratory, medicine, forensics and pharmaceutical industry.

**PG Programme: M.Sc. Zoology Semester-III  
DSE – XI Code of the Course: 3ZOO3**

**M.Sc. II (Zoology) Semester-III  
DSE – XI (Animal Physiology-I)**

Unit	Contents
<b>Unit-I</b>	<b>Muscle Physiology:</b> 1.1 Ultra structure of skeletal muscle and Sarcotubular system. 1.2 Ion distribution. 1.3 Types of muscle contraction. 1.4 Muscle proteins. 1.5 Physical and Chemical Properties skeletal muscles. 1.6 Sliding filament theory of muscle contraction. 1.7 Role of Ca <sup>++</sup> , Calcium receptors, Calmodulin and calcium pump.
<b>Unit-II</b>	<b>Muscle Physiology:</b> 2.1 Ultra Structure of neuromuscular junction. 2.2 Presynaptic Events during muscle contraction. 2.3 Action of acetylcholine on the end plate membrane. 2.4 Myasthenia gravis. 2.5 Neuromuscular transmission influenced by toxins, drugs. 2.6 Muscular disorders: Hypo tonicity, Hypertonicity. 2.7 Red and White fibers and muscle function.
<b>Unit-III</b>	<b>Nerve Physiology:</b> 3.1 Ultra structure of neuron. 3.2 Electrical properties of nerve. 3.3 Ionic concentration in the cytoplasm (Donnan equilibrium system). 3.4 Action potential, Resting potential. 3.5 Depolarization and Repolarization. 3.6 Local circuit theory and Saltatory conduction. 3.7 Ionic theory and nerve conduction.
<b>Unit-IV</b>	<b>Nerve Physiology:</b> 4.1 Ultrastructure of synapse. 4.2 Biosynthesis, storage and release of acetylcholine. 4.3 Electrical events in postsynaptic neurons. 4.4 Synaptic delay. 4.5 Acetylcholine receptor and role of acetylcholine esterase. 4.6 Role of calcium, sodium and potassium channels. 4.7 Types of neurotransmitters.

<b>Unit-V</b>	<b>Neuromuscular Coordination:</b> 5.1 Neurotrophins and Growth factor. 5.2 Factors affecting neuronal growth. 5.3 Physiology of imprinting. 5.4 Physiology of Emotions. 5.5 Parkinson's disease. 5.6 Duchenne's muscular dystrophy.
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**PG Programme: M.Sc. Zoology Semester-III**  
**DSE – XII Code of the Course: 3ZOO4**

**M.Sc. II (Zoology) Semester-III**  
**DSE – XII (Animal Physiology-II)**

<b>Unit</b>	<b>Contents</b>
<b>Unit-I</b>	<b>Senses and Receptors:</b> 1.1 Mechanoreceptors. 1.2 Photo receptors. 1.3 Thermoreceptors. 1.4 Chemoreceptors. 1.5 Electroreceptors. 1.6 Magnetoreceptors.
<b>Unit-II</b>	<b>High Altitude and Exercise Physiology:</b> 2.1 Effects of acute exposure to high altitude. 2.2 Hypoxia. 2.3 Exercise at high altitude. 2.4 Physiology of Exercise: Cardiovascular response to exercise. 2.5 Respiratory response during exercise. 2.6 Fatigue-biochemical and Physiological changes.
<b>Unit-III</b>	<b>Physiology of Excretion:</b> 3.1 Urine formation, Ultra filtration, Reabsorption, and Secretion. 3.2 Significance of Henley's loop in production of hyper osmotic urine. 3.3 Function of aldosterone, antidiuretic hormone. 3.4 Rennin-Angiotensin system in renal physiology. 3.5 Role of kidney in pH regulation and water salt regulation.
<b>Unit-IV</b>	<b>Hormonal Physiology:</b> 4.1 Structure and mechanism of action of Hypothermic hormones (TRH, GnRH) 4.2 Control of Pituitary hormones by hypothalamus. 4.3 Hormonal function of male. 4.4 Hormonal function of female. 4.5 Fetal Physiology. 4.6 Neonatal Physiology.
<b>Unit-V</b>	<b>Socio-physiology:</b> 5.1 Introduction to Socio-physiology. 5.2 Honey and lac productions in insect. 5.3 Pheromones in insects and mammals. 5.4 Physiology underlying fear and anxiety in animals. 5.5 Physiology underlying parental care in Primates.

**PG Programme: M.Sc. Zoology Semester-III**  
**LAB- 6 Code of the Course: 3ZOO6**

**Practical-6 based on DSE -XI and DSE -XII (Animal Physiology-I and II)**

1. Simple muscle curve Effects of temperature and calcium.
2. Estimation of serum creatinine.
3. Estimation of serum urea.
4. Qualitative analysis of urea.
5. Estimation of calcium, phosphorus, sodium and potassium.
6. Separation and identification of amino acids by paper and thin layer chromatography.
7. Separation of proteins by paper or SDS-PAGE electrophoresis.
8. Determination of Erythrocyte sedimentation rate (E.S.R.).
9. Determination of pack cell volume (P.C.V).
10. Determination of mean corpuscular volume (M.V.C.)
11. Detection of blood by haemin crystals test.
12. Estimation of protein in blood.
13. Estimation of glucose in given sample.
14. Estimation of cholesterol in blood.

**Note:** Besides these any other additional experiment relevant to the syllabi depending on resources.

**Distribution of Marks:**

The practical shall be of 6 hours duration and distribution of marks will be as follows:

**External Marks:**

- |                                    |          |
|------------------------------------|----------|
| 1 Major physiology experiment..... | 30 Marks |
| 2 Minor physiology experiment..... | 20 Marks |
| 3 Experiment on blood.....         | 25 Marks |

**Internal Marks:**

- |                          |          |
|--------------------------|----------|
| 4 Class record.....      | 10 Marks |
| 5 <i>Viva voce</i> ..... | 15 Marks |

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<b>Total</b>	<b>: 100 Marks</b>
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**Suggested Reading Material (All latest editions)**

1. Baileys: Textbook of Histology
2. Bell Davidson: Text book of physiology and Biochemistry
3. Bolander F.F.: Molecular endocrinology
4. Clerk E.E.C. Isolation and identification of Drugs in pharmaceutical of body fluid and post martical Vol. I &II.
5. Cole S. W.: The practical physiological chemistry.
6. Cooper: Poisoning by drugs and chemicals.
7. Eckert, Marsall: Animal physiology mechanism and Adaptations
8. Eckert & Ranadal: Animal physiology (CBS) 2nd ED (1978)
9. Garden M.S.: Animal physiology principal and Adaptations.
10. Hara & Oserburg; An introduction to crimminalistie.
11. Hill R.W.: Comparative physiology of animals
12. Hoar W.S.: General and comparative physiology.
13. Houssa: Human physiology (McGraw Hill Books Company)
14. Hunter & Bornford: Hutchisons Clinical methods
15. Hynes: The Biology of polluted water.
16. Jacobs M. B.: The analytic toxicology of inorganic poison
17. Keil J. B., Samson Wrightsa, : Applied Physiology
18. Heil E. Joets N.: Physiology (Oxford Uni press ) (1982)
19. Klein L: River pollution, causes& effects
20. Madhu Raj: Environmental Management of toxic and hazardous chemicals
21. Mill peter J.: Comparative neurobiology EdHrbord London

22. Modi N.J.: Text Book of toxicology
23. Mitchell P.H.: Text Book of General physiology.
24. Norman A.W.: Hormones.
25. Odum: Fundamental of ecology.
26. Osterbong: The crime laboratory
27. Philips G.: Environmental physiology.
28. Prosser C.L.: Comparative animal physiology.
29. Ramkumar: Environmental Biodegradation.
30. Ramkumar: Environmental Chemical hazards

**Theory Paper- DSE - XI (Fisheries-I) and DSE - XII (Fisheries-II) and Related Practical**

CO1: Fisheries gives the knowledge of diversity of fishes.

CO2: It helps students to know the commercial importance of different fishes.

CO3: It also provides knowledge about the processes like physiology and ecology of fishes.

CO4: Trains the students to perform laboratory exercises in fisheries that is applicable to agriculture, aquaculture and commercial fisheries.

**PG Programme: M.Sc. Zoology Semester-III**

**DSE– XI Code of the Course: 3ZO03**

**M.Sc. II (Zoology) Semester-III  
DSE - XI [Fisheries-I (Fish Nutrition, Capture and Culture Fishery)]**

Unit	Contents
<b>Unit-I</b>	<b>Fisheries and Management:</b> 1.1 Riverine fisheries: Riverine fisheries resources. 1.2 Improvement of fish stock 1.3 Effects of river pollution on riverine fisheries. 1.4 Dams and their effect on fish migration and remedial measures. 1.5 Fisheries management and Development in cold water. 1.6 Lacustrine fisheries resources 1.7 Estuarine fisheries and marine fisheries.
<b>Unit-II</b>	<b>Fish Nutrition:</b> 2.1 Chemical composition and nutritional value of fish. 2.2 Food and feeding habits of freshwater fishes, prawn, mussel and oysters. 2.3 Nutrient requirement (proteins, lipids, carbohydrates, minerals and vitamins) for various growth stages of freshwater carp, prawn and mussel. 2.4 Conventional and non conventional feed sources. 2.5 Presence of anti nutritional factors and their removal procedures. 2.6 Supplementary feed: Kind, Composition and nutrient source. 2.7 Live feed culture.
<b>Unit-III</b>	<b>Fish Culture:</b> 3.1 Fish culture systems: Ponds 3.2 Fish farm: Construction and lay out of different types of ponds 3.3 Pond management: Nursery pond, Rearing Pond and Stocking pond. 3.4 Composite fish farming: Exotic fishes and their role in fish farming. 3.5 Predatory and weed fishes and their eradication. 3.6 Aquatic vegetation and its control.
<b>Unit-IV</b>	<b>Fisheries Equipments:</b> 4.1 Cage, Rafts, Pens, Raceways. 4.2 Recirculating water system. 4.3 Sewage-fed fisheries. 4.4 Fish culture in paddy fields.

	4.5 Culture of Larvicidal fishes- Guppy. 4.6 Types of hatcheries and their operation and management. 4.7 Types of neurotransmitters.
<b>Unit-V</b>	<b>Non-fin fisheries:</b> 5.1 Prawn fishery. 5.2 Crab fishery. 5.3 Lobster fishery. 5.4 Oyster fishery. 5.5 Maintenance of Aquarium. 5.6 Ornamental fishes.

**PG Programme: M.Sc. Zoology Semester-III**  
**DSE – XII Code of the Course: 3ZOO4**

**M.Sc. II (Zoology) Semester-III**  
**DSE - XII [Fisheries-II (Fish Physiology)]**

<b>Unit</b>	<b>Contents</b>
<b>Unit-I</b>	<b>Physiology of Respiration:</b> 1.1 Epidermis: Mucogenic and Keratinized epidermis 1.2 Dermis: General organization, Scales and Chromatophores 1.3 Aquatic respiration: Organs of respiration, mechanism of respiration 1.4 Air-breathing: Accessory respiratory organs and respiratory epithelium 1.5 Physiological adaptation in air-breathing fishes. 1.6 Transport of respiratory gases
<b>Unit-II</b>	<b>Physiology of Digestion:</b> 2.1 Digestion: Alimentary canal and its modifications. 2.2 Digestive fluids and enzymes. 2.3 Digestion and absorption of lipid, protein and carbohydrate 2.4 Gastrointestinal motility control 2.5 General organization, structure and Functions of swim bladder.
<b>Unit-III</b>	<b>Physiology of Circulation:</b> 3.1 Structure of heart. 3.2 Regulation of cardiac activity 3.3 Hemodynamics. 3.4 Cardiac output. 3.5 Fish haemoglobins and polymorphism.
<b>Unit-IV</b>	<b>Receptor and Neurophysiology:</b> 4.1 Nervous system of fish: Brain and Cranial nerves 4.2 Structure of eye of fish. 4.3 Photoreceptive functions, Functional adaptations. 4.4 Acoustico-lateralis system 4.5 Chemoreceptors, Gustatory receptors, Olfactory receptors 4.6 Electroreceptors.
<b>Unit-V</b>	<b>Physiology of Excretion:</b> 5.1 Excretion and osmoregulation in fishes: Glomerular and aglomerular kidneys. 5.2 Excretion of nitrogenous wastes, water and ion balance. 5.3 Urea cycle. 5.4 Stenohaline teleosts, Euryhaline teleosts. 5.5 Migratory teleosts.

**PG Programme: M.Sc. Zoology Semester-III**  
**LAB-6 Code of the Course: 3ZOO6**



**Practical based on DSE - Paper- XI [Fisheries-I (Fish Nutrition, Capture and Culture Fishery, Fisheries)] and DSE - Paper- XII [Fisheries-II (Fish Physiology)]**

1. Experiments on Water Analysis: Estimation Dissolved Oxygen, Free Carbon dioxide, Estimation of Dissolved Solids, Chlorides, Carbonate, Bicarbonate, Total Alkalinity, Total hardness, Nitrites, Nitrates, Ammonia, Phosphates, Estimation of Biological Oxygen Demand, Estimation of Chemical Oxygen Demand, Estimation of Primary productivity of any local pond, river, lake or reservoir.
2. Plankton Analysis Collection, preservation and estimation of planktons, Quantitative analysis- Enumeration of Zooplanktons by i) drop count method ii) Sedgwick Rafter Cell method/ Preparation of Diversity indices, Population density, Determination of dominance of the species.
3. Collection, identification and classification of locally available fishes, prawns, lobsters and mollusks of economic importance.
4. Collection and Identification of common aquatic insects/ aquatic weeds
5. Permanent micro preparation of different kinds of scales in fishes.
6. Dissection of locally available fishes: Accessory respiratory organs in *Clarias* and *Heteropneustes*, Digestive, Reproductive Nervous system Brain, Cranial nerves Pituitary, in carps, Nervous system in Prawn, Lobster, Crab.
7. Formulation and processing of feeds.
8. Collection and Identification of carp spawn and fry.
9. Construction and Maintenance of Aquarium.
10. Preparation of models and designing of cages and pens Visit to Fish farm.
11. Fish pathology- Study of fish parasites and diseases, pathological experiments.
12. Fish physiology experiments- Digestive enzymes, biochemical composition

**Note:** Besides these any other additional experiment relevant to the syllabi depending on resources.

Candidates shall be required to produce at the practical examination the Following:

1. Practical Record Book duly signed by the teacher in-charge and certified by the Head of the Department as the bona fide work of the candidate.
2. Permanent stained micro- preparations prepared by the examinee.
3. Collection of the specimens
4. Study tour diary.

**Distribution of Marks for practical**

**External marks**

- |   |  |          |
|---|--|----------|
| 1. Dissection:  |  |          |
| i. Major.....   |  | 15 marks |
| ii. Minor.....  |  | 10 marks |
| 2. Experiment based on, water analysis/Fish pathology .....   |  | 10 marks |
| 3. Identification and comments on spots (05)<br>(Fishes, Crustaceans, Aquatic Insects, Aquatic weeds, Zooplanktons) ... |  | 20 marks |
| 4. Permanent micro preparation .....  |  | 10 marks |
| 5. Submission of permanent slides and specimens.....  |  | 10 marks |

**Internal Marks**

- |   |  |          |
|---|--|----------|
| 6. Practical record .....               |  | 10 marks |
| 7. Submission of study tour report..... |  | 05 marks |
| 8. <i>Viva voce</i> .....               |  | 10 marks |

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**Total** **: 100 marks**

**Books Recommended:**

1. Bentley, P. J., Comparative Vertebrate Endocrinology, Cambridge University Press, 2000.
2. Bond, C.E., Biology of Fishes, Saunders College Publishing Philadelphia, 1979.
3. Brown, M.E., The Physiology of Fishes Vol. I, II. Academic Press, 1953 & 1957

4. C.I.F.R.I., Prawn Fisheries Bulletin No. 10, 1977.
5. Chakroff, M., Freshwater Fish Pond Culture and Management, Scientific Publishers, 1987.
6. Datta-Munshi, J.S. & Hughes G. M., Air-breathing fishes of India, Oxford and IBH Publ. Co. New Delhi, 1992.
7. Davis. H. S., Culture and Diseases of Game Fishes, University of California Press, 1956
8. Duijn, C. V., Diseases of Fishes: London Iliffe Books Ltd, 1967.
9. Evans, D.H., The Physiology of Fishes, CRC Press, 1998
10. Gopakumar, K., Singh, B.N. and Chitranshi, V.R. Fifty Years of Fisheries Research in India, Fisheries Division Indian Council of Agricultural Research, New Delhi, 2000.
11. Gorbman et al: Comparative Endocrinology, John Wiley & Sons, New York, Chichester, Brisbane 12. Hadley, M. E., Endocrinology, Prentice Hall, International Editions, 2000.
12. Hall, C. B., Ponds and Fish Culture, Agro Botanical Publishers, 1994
13. Hoar W.S. & Randall, D. J., Fish Physiology, Series Vol. I - XIV, Academic Press
14. Hora, S. L. and Pillay, T.V. R., Handbook on Fish Culture in the IndoPacific Region, Fisheries Division, Biology Branch, FAO, 1962.
15. Howard & Churchill, Canning technology. London
16. Huet, M., Textbook of Fish Culture, Breeding and Cultivation of Fish, Fishing News (Books) Ltd., 1989.
17. Hughes, G. M. Comparative Physiology of Vertebrate Respiration, Heinemann Educational Books Ltd., 1967
18. Jhingran, V.G. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi. 1985.
19. Khanna S. S. and H. R. Singh. A textbook of Fish Biology and Fisheries, Narendra Publishing House, 2003
20. Kreuzer, R., Fishery products, FAO, Fishing News (Books) Ltd., England. 1974

**PG Programme: M.Sc. Zoology Semester-III**  
**DSE – XI Code of the Course: 3ZOO3**

**M.Sc. II (Zoology) Semester-III Paper-XI**  
**DSE –XI [Entomology –I (Insect Classification and Morphology)]**

Unit	Contents
<b>Unit-I</b>	<b>Classification of Class-Insecta:</b> 1.1 Major Classification of Class Insecta 1.2 Distinguishing Characters of insects. 1.3 Apterygota 1.4 Pterygota 1.5 Division Palaeoptera 1.6 Division: Neoptera 1.7 Subdivision: Orthopteroid. 1.8 Hemipteroid Orders
<b>Unit-II</b>	<b>Characteristics of Different Insect Orders:</b> 2.1 Distinguishing characters of different insects order. 2.2 General biology of different insects order. 2.3 Habits and habitats of different insects order. 2.4 Subdivision Endopterygota. 2.5 Characteristics of order Neuroptera 2.6 Coleopteroid Orders 2.7 Panorpoid Orders 2.8 Hymenopteroid Orders.
<b>Unit-III</b>	<b>Structure of Insects:</b> 3.1 Structure of insect body wall

	<p>3.2 Cuticular outgrowths.</p> <p>3.3 Coloration and special integumentary structures in insects.</p> <p>3.4 Body tagmata.</p> <p>3.5 Sclerites and segmentation.</p> <p>3.6 Head- Origin, structure and modification.</p> <p>3.7 Types of mouthparts and antennae.</p>
<b>Unit-IV</b>	<p><b>Structure of Thorax, Wings and Legs:</b></p> <p>4.1 Thorax- Areas and sutures of tergum.</p> <p>4.2 Sternum and pleuron.</p> <p>4.3 Wings: structure and modifications.</p> <p>4.4 Wing venation.</p> <p>4.5 Wing coupling apparatus.</p> <p>4.6 Mechanism of flight in insect.</p> <p>4.7 Legs: structure and modifications</p>
<b>Unit-V</b>	<p><b>Segmentation and Receptors:</b></p> <p>5.1 Abdomen- Segmentation and appendages</p> <p>5.2 Genitalia and their modifications</p> <p>5.3 Types of metamorphosis</p> <p>5.4 Insect sense organs –mechanoreceptors</p> <p>5.5 Photoreceptors</p> <p>5.5 Chemoreceptors.</p>

**PG Programme: M.Sc. Zoology Semester-III**  
**DSE – XII Code of the Course: 3ZOO4**

**M.Sc. II (Zoology) Semester-III Paper – XII**  
**DSE – XII [Entomology-II (Insect Anatomy and Physiology)]**

<b>Unit</b>	<b>Contents</b>
<b>Unit-I</b>	<p><b>Digestive and Circulatory System of Insects:</b></p> <p>1.1 Structure of Digestive system of insects.</p> <p>1.2 Modifications of digestive system.</p> <p>1.3 Physiology of digestive system.</p> <p>1.4 Structure of Circulatory system of insects</p> <p>1.5 Modifications of Circulatory system.</p> <p>1.6 Physiology of Circulatory system.</p>
<b>Unit-II</b>	<p><b>Respiratory and Excretory System of Insects:</b></p> <p>2.1 Structure of respiratory system of insects.</p> <p>2.2 Modifications of respiratory system.</p> <p>2.3 Physiology of respiratory system.</p> <p>2.4 Structure of excretory system of insects.</p> <p>2.5 Modifications of excretory system.</p> <p>2.6 Physiology of excretory system.</p>
<b>Unit-III</b>	<p><b>Nervous System of Insects:</b></p> <p>3.1 Structure of nervous system of insects.</p> <p>3.2 Modifications of nervous system.</p> <p>3.3 Physiology of nervous system.</p> <p>3.4 Structure of sensory systems.</p> <p>3.5 Physiology of sensory systems.</p>
<b>Unit-IV</b>	<p><b>Reproductive System, Exocrine and Endocrine Glands of Insects:</b></p> <p>4.1 Structure of reproductive system of insects.</p> <p>4.2 Modifications of reproductive system.</p> <p>4.3 Physiology of reproductive system.</p>

	4.4 Structure of endocrine glands of insects. 4.5 Structure of exocrine glands of insects. 4.6 Physiology of exocrine and endocrine glands of insects.
<b>Unit-V</b>	<b>Physiology of Metamorphosis:</b> 5.1 Physiology of insect growth. 5.2 Physiology of metamorphosis in insects. 5.3 Polyphenism and diapause. 5.4 Biochemistry of insect cuticle. 5.5 Physiology of moulting process.

**PG Programme: M.Sc. Zoology**  
**LAB- 6**

**Semester-III**  
**Code of the Course: 3ZOO6**

**Practical based on DSE-XI and DSE-XII (Entomology):**

1. Study of Orders of insects and their identification using taxonomic keys.
2. Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera.
3. Field visits to collect insects of different orders.
4. Study of insect segmentation, various tagmata and their appendages.
5. Preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia.
6. Dissection of different insects to study comparative anatomical details of different system.
7. Preparation of permanent mounts of internal systems.
8. Chromatographic analysis of free amino acids of haemolymph.
9. Determination of chitin in insect cuticle.
10. Examination and counting of insect haemocytes.
11. Determination of respiratory quotient.
12. Preparation and evaluation of various diets.
13. Qualitative survey of digestive enzymes in salivary glands.
14. Estimation of total proteins/carbohydrates/lipids in haemolymph/tissues.
15. Detection of uric acid as end product of excretion in terrestrial insects.
16. Separation of haemolymph proteins by electrophoresis.
17. Estimation of Na<sup>+</sup> & K<sup>+</sup> in haemolymph by flame photometer.
18. Estimation of DNA and RNA in Haemocytes/tissues.

**Note:** Student should collect local insects and submit at the time of examination, 10 morphological and 10 histological slide preparations should also be submitted.

**Distribution of Marks for practical**

The practical shall be of six hours duration & distribution of marks will be as follows. Distribution of Marks

**External marks:**

1. Dissection
  - a. Major..... 15 Marks
  - b. Minor..... 10 Marks
2. Physiological experiment..... 20 Marks
3. Permanent stained preparation..... 10 Marks
4. Identification of Morphological & Histological spots (ten).....20 Marks

**Internal marks:**

5. Practical Record and Insect Collection .....10 Marks
6. Viva Voce .....15 Marks

**Total: 100 Marks**

**Suggested Reading Materials: (All recent editions):**

1. Chapman RF. 1998. The Insects: Structure and Function. Cambridge Univ. Press, Cambridge.
2. David BV & Ananthkrishnan TN. 2004. General and Applied Entomology. Tata-McGraw Hill, New Delhi.
3. Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi.
4. Evans JW. 2004. Outlines of Agricultural Entomology. Asiatic Publ., New Delhi.
5. Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman & Hall, London.
6. Saxena RC & Srivastava RC. 2007. Entomology: At a Glance. Agrotech Publ. Academy, Jodhpur.
7. Snodgrass RE. 1993. Principles of Insect Morphology. Cornell Univ. Press, Ithaca.
8. Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi.
9. Kerkut GA & Gilbert LI. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. I-XIII. Pergamon Press, New York.
10. Patnaik BD. 2002. Physiology of Insects. Dominant, New Delhi.
11. Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Vol. 1. Structure, Physiology and Development. Chapman & Hall, New York.
12. Saxena RC & Srivastava RC. 2007. Entomology at a Glance. Agrotech Publ. Academy, Jodhpur.
13. Wigglesworth VB. 1984. Insect Physiology. 8th Ed. Chapman & Hall, New York.
14. Kerkut GA & Gilbert LI. 1985. Insect Physiology, Biochemistry and Pharmacology. Vols. I-XIII. Pergamon Press, Oxford, New York.
15. Muraleedharan K. 1997. Recent Advances in Insect Endocrinology. Assoc. for Advancement of Entomology, Trivandrum, Kerala.
16. CSIRO 1990. The Insects of Australia: A Text Book for Students and Researchers. 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.
17. Freeman S & Herron JC. 1998. Evolutionary Analysis. Prentice Hall, New Delhi.
18. Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman & Hall, London. 41-42
19. Ross HH. 1974. Biological Systematics. Addison Wesley Publ. Co.
20. Triplehorn CA & Johnson NF. 1998. Borror and DeLong's Introduction to the Study of Insects. 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.

**Sant Gadge Baba Amravati University, Amravati**  
**Faculty: Science and Technology**  
**Programme: M.Sc. II SEM-IV (Zoology)**

**Program Outcome:**

PO1. Knowledge of various branches of Zoology and in particular Molecular Biology for Postgraduate studies is made possible.

PO2. This higher studies make the student for widening the horizon of knowledge for the sustenance of the stakeholders.

PO3. Awareness and relative action to reduce the hurdles of the lives of people through the steps for reduction of pollution and global warming.

PO4. Students acquainted to the skills in handling the instruments and different techniques through the practical and developing the scientific temperaments for research.

**Program specific Outcomes:**

PSO1. Preparation of the checklist and inventories are possible through the identification of the fauna in local areas.

PSO2. Knowledge of the various vital reactions at molecular level which are going in the organisms

PSO3. Survey and data analysis of the various kinds of disease in the locality through project work of the students.

PSO4. Understand the various strategies and phenomena related to animal reproduction.

PSO5. Conservation strategies and awareness about environmental threats to reduce and save energy through Wildlife Week Celebration.

PSO7. Analysis of corporation water samples for the investigation of parasitic presence.

PSO8. Investigation of bones for identification of the samples from different animals found at the poaching sites in forest.

**Syllabus Prescribed for Second Year 2023-24**

S. N.	PG Programme: M.Sc. Zoology Semester-IV	Code of the Course/ Subject	Title of the Course/Subject	Total Number of Periods
1.	DSC-XIII	4ZOO1	Biochemistry	60
2.	DSC-XIV	4ZOO2	Enzymology and Biostatistics	60
3.	DSE-XV	4ZOO3	Molecular Biology-III/Animal Physiology-III/Fishery- III/ Entomology-III	60
4.	DSE-XVI	4ZOO4	Molecular Biology-IV/Animal Physiology-IV/Fishery- IV/ Entomology-IV	60
5.	Lab-7	4ZOO5	Lab-VII	60
6.	Project	4ZOO6	Lab-VIII (Project Work)	60

**Theory Paper- DSC-XIII (Biochemistry) and Related Practicals**

CO1: Biochemistry gives the knowledge of biomolecules and the biochemical processes occurring inside the cell and the body as a whole.

CO2: It trains the students to carry out laboratory exercises in biochemistry and biochemical investigations.

**PG Programme: MSc Zoology Semester IV**  
**DSC – XIII Code of the Course: 4ZOO1**

**M.Sc. II (Zoology) Semester-IV  
DSC– XIII (Biochemistry)**

Unit	Contents
Unit-I	<p><b>Chemical Foundations of Biochemistry:</b></p> <p>1.1 pH, pK, acids, bases, buffers, free energy and isomerization.</p> <p>1.2 Physicochemical properties of water.</p> <p>1.3 Bonds and forces stabilizing biomolecules: Van-der-Waals electrostatics, hydrogen bonding and hydrophobic interactions.</p> <p>1.4 Biologically important monosaccharides, disaccharides and polysaccharides.</p>
Unit-II	<p><b>Amino Acids and Proteins:</b></p> <p>2.1 Structure and chemistry of standard amino acids.</p> <p>2.2 Essential and non-essential amino acids.</p> <p>2.3 Biosynthesis of nutritionally non-essential amino acids.</p> <p>2.4 Transamination and deamination.</p> <p>2.5 Ornithine cycle.</p> <p>2.6 Protein structure &amp; folding, Ramchandran plot.</p> <p>2.7 Conjugated proteins: structure and function.</p> <p>2.8 Protein-protein interactions.</p>
Unit-III	<p><b>Nucleic Acids:</b></p> <p>3.1 Structure of DNA.</p> <p>3.2 Triplex and quadruplex DNA.</p> <p>3.3 Structural polymorphism of DNA.</p> <p>3.4 Circular DNA.</p> <p>3.5 Structure, types and functions of RNAs.</p> <p>3.6 Nucleic acid-protein interactions.</p> <p>3.7 <i>De novo</i> and salvage pathways of nucleotide biosynthesis.</p> <p>3.8 Degradation of nucleotides.</p>
Unit-IV	<p><b>Carbohydrate metabolism:</b></p> <p>4.1 Glycolysis, its regulation and energetics.</p> <p>4.2 TCA cycle &amp; its regulation.</p> <p>4.3 Gluconeogenesis and its regulation.</p> <p>4.4 Glycogenesis.</p> <p>4.5 Glycogenolysis.</p> <p>4.6 Coordinated regulation of glycogenesis and glycogenolysis.</p> <p>4.7 Pentose phosphate pathway and its significance.</p> <p>4.8 Electron transport complexes, electron transport, oxidative phosphorylation, energetics of electron transfer.</p>
Unit-V	<p><b>Lipid Metabolism:</b></p> <p>5.1 Biosynthesis of fatty acids, triglycerides, phospholipids and cholesterol.</p> <p>5.2 <math>\beta</math>-oxidation of saturated fatty acids.</p> <p>5.3 Oxidation of monounsaturated fatty acids.</p> <p>5.4 Oxidation of polyunsaturated fatty acids.</p> <p>5.5 <math>\alpha</math> - and <math>\omega</math>-oxidation of fatty acids.</p> <p>5.6 Coordinated regulation of fatty acid synthesis and breakdown.</p> <p>5.7 Obesity and the regulation of body mass.</p> <p>5.8 Biosynthesis and utilization of ketone bodies.</p>

**Theory Paper- DSC-XIV (Enzymology and Biostatistics) and Related Practicals**

CO1: Enzymology enables to understand the role and activities of various enzymes functioning in the body.

CO2: It also gives some idea about clinical and pharmaceutical applications of enzymes.

CO3: It trains the students to carry out laboratory exercises related to enzyme activity and estimations of enzymes.

CO4: Biostatistics trains the students in handling and analyzing the biological clinical data.

**PG Programme: M.Sc. Zoology Semester-IV**  
**DSC – XIV Code of the Course: 4ZOO2**

**M.Sc. II (Zoology) Semester-IV**  
**DSC– XIV (Enzymology and Biostatistics)**

Unit	Contents
<b>Unit-I</b>	<b>Enzymes-Structure, Classification and Kinetics:</b> 1.1 Origin of enzymes. 1.2 Classification of enzymes. 1.3 Features of enzyme's active site. 1.4 Mechanism of enzyme action (Chymotrypsin). 1.5 Kinetics of single substrate and bisubstrate enzyme catalyzed reactions. 1.6 Allosteric enzymes. 1.7 Cooperativity in enzyme catalysis. 1.8 Mechanism of coenzyme action (NAD, FAD)
<b>Unit-II</b>	<b>Enzymes-Categories &amp; Functions:</b> 2.1 Activators of enzymes. 2.2 Inhibitors of enzymes. 2.3 Isozymes, ribozymes and abzymes. 2.4 Zymogen activation. 2.5 Covalent modification
<b>Unit-III</b>	<b>Enzymes-Functional Diversity &amp; Applications:</b> 3.1 Enzymes involved in free radical removal. 3.2. Enzymes involved in cell signalling. 3.3 Enzymes involved in nucleic acid metabolism (DNA replication, DNA repair and transcription). 3.4 Enzymes involved in energy production (Glycolysis and TCA cycle). 3.5 Immobilized enzymes and their applications. 3.6 Enzymes and modern medicine.
<b>Unit-IV</b>	<b>Biostatistics:</b> 4.1 Diagrammatic representation of data (Line graph, Bar diagram, Pie diagram). 4.2 Graphic representation of data (histogram, frequency polygon, frequency curve, cumulative frequency). 4.3 Confidence Intervals (CI). 4.4 Standard deviation. 4.5 Standard error. 4.6 Significance test (Student's t - test)- paired and unpaired.
<b>Unit-V</b>	<b>Biostatistics:</b> 5.1 Chi square test as a test for goodness of fit. 5.2 Analysis of variance (ANOVA). 5.3 Correlation analysis: Correlation types and methods to study correlation, significance test of correlation coefficient. 5.4 Regression analysis: Kinds of regression analysis (regression line, regression equations). 5.5 Examples on Hardy-Weinberg equilibrium.

**PG Programme: M.Sc. Zoology Semester-IV**  
**LAB-7 Code of the Course: 4ZOO5**

**Practical -7 Based on DSC-XIII and DSC-XIV and DSE-XV and DSE-XVI (mentioned in the concerned syllabi)**

- 1) Determination of isoelectric pH of protein and amino acids.
- 2) Isolation of casein from milk.



- 3) Study effect of pH and temperature on enzyme activity. Ex. Salivary amylase.
- 4) To study the effect of inhibitors on enzyme activity.
- 5) Determination of acid value of fat.
- 6) Determination of saponification value of fat.
- 7) Colorimetric estimation of some respiratory enzymes.
- 8) Estimation of plasma / serum glucose.
- 9) Estimation of glycogen from tissue.
- 10) Estimation of serum cholesterol.
- 11) Estimation of phospholipids.
- 12) Estimation of lactate dehydrogenase.
- 13) Estimation of plasma proteins.
- 14) Estimation of Na ions.
- 15) Estimation of K ions.
- 16) Estimation of calcium.
- 17) Estimation of ATPase.
- 18) Estimation of SGOT / SGPT.
- 19) Estimation of Acetylcholinesterase.
- 20) Estimation of acid alkaline phosphatase.
- 21) Estimation of catalase.
- 22) Examples from Biostatistics as per theory.
- 23) Drawing Pie, Bar (column) and Line diagrams on computer.

**Note:** Besides these any other additional experiment relevant to the syllabii depending on resources

Candidates shall be required to produce at the practical examination, the following-

Practical Record Book duly signed by the teacher in-charge and certified by the Head of the Department as the *bona fide* work of the candidate.

The practical shall be of two days each of six hours duration & distribution of marks will be as follows.

**Distribution of Marks:**

**External marks**

- |  |            |
|--|------------|
| 1) Estimation/experiment                             | : 30 Marks |
| 2) From elective paper<br>(Estimation/experiment)    | : 20 Marks |
| 3) Example/experiment/slide/computer based practical | : 25 Marks |

**Internal marks**

- |   |            |
|---|------------|
| 4) Class Record, collection, slides (as per syllabus) | : 10 Marks |
| 5) <i>Viva-Voce</i>                                   | : 15 Marks |

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**Total : 100 Marks**

**Suggested Reading Material (All latest editions)**

1. Animal Cell Culture – A practical approach, Ed. JohnR.W. Masters.IRL Press.
2. Introduction to instrumental analysis, Robert Braun. McGraw Hill International Editions.
3. A Biologists Guide to Principles and Techniques of Practical Biochemistry. K. Wilson & K.H. Goulding, ELBS Edn.
4. Samuel Delvin,Enzymes,Sarup& Sons,N.Delhi
5. Practical biochemistry edited by Walker
6. Foundation in microbiology: Talaro
7. Microbiology: Pelczar
8. Biology of microorganisms: Madigan, Martinko and Parker.
9. Biophysical chemistry- Principles and technique: Upadhyay, Nath

10. Statistical techniques in Bioassay Z.Govindarajulu (2000): Pub.S.Kargar
11. Statistical method in Bioassay Pub D.J.Finney (1971): Griffin
12. Laboratory manual for Biochemistry and Molecular biology, Shivnery Publishers R. N. Vankhede & S. N. Niwane
13. Probit analysis D.J. Finney (1971): 3rd edition Pub. Griffin

**Theory Paper DSE-XV (Molecular Immunology-I) and DSE- XVI (Molecular Immunology-II) and Related Practicals**

CO1: Molecular Immunology gives the knowledge of biological defence processes through the investigation of molecular mechanisms.

CO2: It enables to understand the physiological and molecular mechanisms that occur in the body during host defence to parasitic infections.

CO3: It gives an idea about various aspects of vaccines and their development.

CO4: Trains the students to perform laboratory exercises in Molecular Immunology that is applicable to medicine and pharmaceutical industry.

**PG Programme: M.Sc. Zoology Semester-IV**

**DSE – XV Code of the Course: 4ZOO3**

**M.Sc. II (Zoology) Semester-IV  
DSE- XV [Molecular Biology-III (Molecular Immunology-I)]**

Unit	Contents
<b>Unit-I</b>	<p><b>The immune system:</b></p> <p>1.1 Innate and Acquired immunity.            1.2 Organization and structure of lymphoid organs.            1.3 Cells of the immune system and their functions.            1.4 Lymphocyte traffic.</p> <p><b>Nature of antigens and immunogens:</b></p> <p>1.5 Antigenicity and immunogenicity.            1.6 Requirements for Immunogenicity.            1.7 Epitopes.            1.8 Haptens.            1.9 Adjuvants.            1.10 Superantigens.</p>
<b>Unit-II</b>	<p><b>Structure and Functions of antibodies:</b></p> <p>2.1 Structural features of immunoglobulins (IgG, IgA, IgM, IgD, IgE): Structure of light and heavy chains, domains, hinge region, variable region.            2.2 Biologic properties of immunoglobulins (IgG, IgA, IgM, IgD, IgE).            2.3 <b>Immunoglobulin variants:</b> Isotypes, allotypes and idiotypes.            2.4 Antibody mediated effector functions.</p> <p><b>Complement system:</b></p> <p>2.5 Alternative, Classical and Lectin pathways of complement activation.            2.6 Late steps of complement activation.            2.7 Structure and functions of MAC.            2.8 Receptors for complement proteins.            2.9 Regulation of complement activation.            2.10 Functions of complement system.</p>
<b>Unit-III</b>	<p><b>Biology of T-lymphocytes:</b></p> <p>3.1 Isolation and molecular components of T-lymphocytes.            3.2 T-cell generation, maturation, activation, proliferation and differentiation.            3.3 T-cell receptor complex.            3.4 T-cell coreceptors.            3.5 Generation of T-cell receptor diversity.            3.6 T-Cell death and T-cell population.            3.7 T-Cell mediated effector functions.            3.8 Mechanism of action of CTL and NK cells.</p>

	3.9 <b>Signal Transduction by TCR Complex:</b> Early membrane events during T-cell signaling, MAP kinase signaling pathways in T-lymphocytes, Calcium and PKC-mediated signalling pathways in T-lymphocytes, Activation of transcription factors that regulate T-cell gene expression.
<b>Unit-IV</b>	<b>Biology of B-lymphocytes:</b> 4.1 B-cell generation, maturation, activation, proliferation and differentiation. 4.2 B-cell receptors. 4.3 Selection of immature self-reactive B-cells. 4.4 T-B cell interactions. 4.5 Humoral immune response. 4.6 Signal Transduction by BCR Complex. 4.7 Role of complement in B-cell activation. 4.8 Immunological memory.
<b>Unit-V</b>	<b>Cytokines:</b> 5.1 General properties of cytokines. 5.2 Cytokines that mediate and regulate innate immunity. 5.3 Cytokines that mediate and regulate adaptive immunity. 5.4 Cytokines that stimulate hematopoiesis. 5.5 Cytokine receptors. 5.6 Cytokine receptor-mediated signal transduction. 5.7 Role of cytokines and cytokine receptors in diseases. <b>Major Histocompatibility Complex in mouse and HLA system in human:</b> 5.8 MHC haplotypes. 5.9 Structure of Class I and Class II MHC molecules 5.10 Peptide binding to MHC molecules. 5.11 Genomic organization of the MHC. 5.12 Expression of MHC. 5.13 Diversity of MHC. 5.14 Disease susceptibility and MHC/HLA.

**PG Programme: M.Sc. Zoology Semester-IV**  
**DSE – XVI Code of the Course:4ZOO4**

**M.Sc. II (Zoology) Semester-IV**  
**DSE– XVI [Molecular Biology-IV (Molecular Immunology –II)]**

Unit	Contents
<b>Unit-I</b>	<b><i>In vitro</i> Antigen-Antibody interactions:</b> 1.1 Characteristics of antigen-antibody reactions. 1.2 Precipitation reactions in fluid. 1.3 Precipitation reactions in gel. 1.4 Agglutination reactions. 1.5 Enzyme Linked Immunosorbent Assay (ELISA) and its variants. 1.6 Radioimmunoassay (RIA). 1.7 Production of monoclonal antibodies by Hybridoma technology. 1.8 Applications of monoclonal antibodies.
<b>Unit-II</b>	<b>Principles of Immunization:</b> 2.1 <b>Basic Mechanisms of Protection:</b> Significance of primary and secondary responses, Age and timings of immunizations. 2.2 <b>Vaccine Precautions:</b> Site of administration of antigen, Hazards. 2.3 <b>Approaches to Vaccine Production:</b> Vaccines produced by recombinant DNA technology, Conjugated polysaccharide vaccines, Synthetic peptide vaccines, Virus-carrier vaccine, Bacterium-carrier vaccine, DNA Vaccines, Toxoids as vaccines. 2.4 <b>Passive Immunization:</b> Passive immunization through placental antibody transfer, Passive immunization via colostrum, Passive antibody therapy and serum therapy, Preparation and properties of human immune serum globulin.

<b>Unit-III</b>	<p><b>Hypersensitivity Reactions:</b></p> <p><b>IgE-mediated (Type-I) Hypersensitivity:</b></p> <p>3.1 General characteristics of allergic Reactions.</p> <p>3.2 Sensitization phase.</p> <p>3.3 Activation phase.</p> <p>3.4 <b>Effector Phase:</b> Preformed mediators, Newly synthesized mediators, Late phase reaction.</p> <p>3.5 Clinical aspects of allergic reactions.</p> <p>3.6 Protective role of IgE.</p> <p><b>Antibody Mediated (Type-II) Cytotoxic Hypersensitivity:</b></p> <p>3.7 Complement-mediated reactions.</p> <p>3.8 Antibody-dependent cell-mediated cytotoxicity.</p> <p>3.9 Antibody-mediated cellular dysfunction.</p> <p>3.10 Examples of (Type-II) hypersensitivity reactions: Transfusion reactions, Drug-induced reactions, Rhesus-incompatibility reactions.</p>
<b>Unit-IV</b>	<p><b>Hypersensitivity Reactions:</b></p> <p><b>Immune complex-mediated (Type III) Hypersensitivity:</b></p> <p>4.1 Systemic immune complex diseases.</p> <p>4.2 Localized immune complex diseases.</p> <p><b>Cell-Mediated (Type- IV) Delayed-Type Hypersensitivity(DTH):</b></p> <p>4.5 Mechanisms of DTH.</p> <p>4.6 Examples of DTH: Contact sensitivity, Granulomatous hypersensitivity, Tuberculin-type hypersensitivity.</p> <p><b>Transplantation Immunology:</b></p> <p>4.7 <b>Immune Responses to Allografts:</b> Recognition of alloantigens, Activation of alloreactive lymphocytes.</p> <p>4.8 <b>Mechanisms of Allograft Rejection:</b> Hyperacute rejection, Acute Rejection, Graft vasculopathy and Chronic rejection.</p> <p>4.9 Prevention of allograft rejection.</p> <p>4.10 Xenogeneic transplantation.</p>
<b>Unit-V</b>	<p><b>Immunologic Tolerance:</b></p> <p>5.1 T-lymphocyte tolerance</p> <p>5.2 B lymphocyte tolerance</p> <p>5.3 Tolerance induced by foreign protein antigens.</p> <p>5.4 Autoimmunity: Pathogenesis of autoimmunity.</p> <p>5.5 <b>Autoimmune Diseases:</b> Organ-specific autoimmune diseases, Systemic Autoimmune diseases.</p> <p>5.6 <b>Acquired Immunodeficiency Syndrome (AIDS):</b> Origin of AIDS virus, Structure of HIV, Mechanism of HIV infection, HIV-I genome, T<sub>H</sub> cell specificity for HIV infection, Mechanism of destruction of T cells, Functional abnormalities of different cell types in AIDS patient, Development of AIDS vaccine.</p>

**Practical to be carried out in practical No. 7 Based on Molecular Immunology-I and II**

1. Identification of blood groups - A, B, AB, O and Rh.
2. Screening of antigen and antibody (screening test in antibody production-Ouchterlony Double Diffusion).
3. Estimation of antigen and antibody content in the samples by Radial Immunodiffusion.
4. Counter -current immunoelectrophoresis.
5. Dot-ELISA.
6. Estimation of antigen and antibody content in the samples by quantitative precipitation assay.

**Suggested reading material (All latest editions):**

1. Cellular and Molecular Immunology, 5-10/Ed. Abul K. Abbas *et al.*
2. Kuby Immunology, 6-8/Ed. Jenni Punt *et al.*
3. Immunology-A Short Course, 7/Ed. Richard Coico *et al.*
4. Immunology–An Introduction, 4/Ed. Ian R. Tizard
5. Textbook of Basic and Clinical Immunology, Sudha Gangal *et al.*
6. Immunology, 8/Ed. David Male *et al.*
7. Roitt's Essential Immunology, 13/Ed. Peter J. Delves *et al.*
8. Clinical Immunology- Principles and Practice, 5/Ed. Robert R, Rich *et al.*
9. Fundamental Immunology, 7/Ed. William E Paul (Editor)

**PG Programme: M.Sc. Zoology Semester-IV**  
**DSE – XV Code of the Course: 4ZOO3**

**M.Sc. II (Zoology) Semester-IV**  
**DSE – XV (Animal Physiology-III)**

<b>Unit</b>	<b>Contents</b>
<b>Unit-I</b>	<b>Physiology of Nervous System:</b> 1.1 Physiology Nervous System: a) Fore brain, b) Mid brain, c) Hind brain 1.2 Reflex arc and types of reflexes. 1.3 Physiology and pharmacology of ANS. 1.4 Physiology of sleep. 1.5 Neurotransmitters involve in sleep.
<b>Unit-II</b>	<b>Mimicry and Bioluminescence:</b> 2.1 Mimicry: Cryptic mimicry Concealing mimicry Depressive mimicry 2.2 Audio signals, Echo-location: Organs and physiology. 2.3 Bioluminescence: Mechanism of Bioluminescence. 2.4 Significance of Bioluminescence. 2.5 Bioelectricity.
<b>Unit-III</b>	<b>Homeostasis Physiology:</b> 3.1 Homeostasis Physiology: Water contents and distribution 3.2 Composition of ECF (Extra cellular fluid) and ICF (Intracellular fluid) 3.3 Abnormal water and electrolyte metabolism and water intoxication. 3.4 Maintenance of pH. 3.5 Components of Homeostatic Control system. 3.6 Reflexes, Local Homeostatic Responses.
<b>Unit-IV</b>	<b>Thermoregulation and Osmoregulation:</b> 4.1 Adaptation and Acclimatization. Biological Rhythms 4.2 Balance in the Homeostasis of chemicals 4.3 Homeostatic control systems - feed back. 4.4 Basic thermoregulatory mechanism in poikilotherms and endotherms. 4.5 Ectothermic adaptations to extreme temperatures. 4.6 Osmoregulatory mechanism in stenohaline and euryhaline species. 4.7 Osmoregulatory mechanism in Fresh water, Marine water and Terrestrial environment.
<b>Unit-V</b>	<b>Control of Homeostasis:</b> 5.1 Nitrogen excretion among different animal Groups. 5.2 Mechanism of calcium and phosphate Homeostasis. 5.3 Homeostasis of iron maintenance. 5.4 Homeostasis mechanism of fever.

	5.5 Homeostatic mechanism of minerals.
	5.6 Homeostasis and antidiuretic hormone

**PG Programme: M.Sc. Zoology Semester- IV**  
**DSE – XVI Code of the Course: 4ZOO4**

**M.Sc. II (Zoology) Semester-IV**  
**DSE– XVI (Animal Physiology-IV)**

Unit	Contents
<b>Unit-I</b>	<b>Physiology of Digestion:</b> 1.1 Digestion, Absorption, Utilization of Protein 1.2 Digestion, Absorption, Utilization of carbohydrates. 1.3 Digestion, Absorption, Utilization of lipid. 1.4 Histophysiologies of gastric gland. 1.5 Gastrointestinal Function—Motility, Nervous Control 1.6 Gastrointestinal peptides 1.7 Gastrointestinal disorders (Achalasia, gastritis, pancreatitis and colitis).
<b>Unit-II</b>	<b>Physiology of Respiration:</b> 2.1 Physiology of Respiration: Anatomical and physiological organization of respiratory system. 2.2 Mechanism of respiration. 2.3 Transport of gases by blood. 2.4 Oxygen dissociation curve, Co <sub>2</sub> dissociation curve. 2.5 Respiratory center and Neuro Hormonal and Chemical regulation of respiration. 2.6 Infectious respiratory diseases (SARS, Avian Flu and Swine flu).
<b>Unit-III</b>	<b>Physiology of Circulation:</b> 3.1 Composition of Blood. 3.2 Regulation of heart beat and blood pressure. 3.3 Origin and conduction of cardiac impulse. 3.4 Oxygen dissociation curves and their physiological significances. 3.5 Myocardial infarction and cardiomyopathy.
<b>Unit-IV</b>	<b>Physiology of Heart:</b> 4.1 Anatomy and histology of mammalian heart 4.2 Structure & function of Myogenic and neurogenic heart. 4.3 Cardiac cycle, Cardiac sound. 4.4 Pulmonary circulation. 4.5 Hormonal control on circulation. 4.6 Cardiac arrest. 4.7 Electrocardiograph and its interpretation.
<b>Unit-V</b>	<b>Lymphatic System:</b> 5.1 Lymph-Composition and Formation 5.2 Functions of lymph. 5.3 Structure and functions of lymph nodes. 5.4 Lymphedema.

**Practical to be carried in practical No. 7: Based on Animal Physiology- DSE-XV and DSE-XVI**

1. Properties of saliva. Isolation and identification of rumen microorganisms.
2. Estimation of rumen ammonia and blood urea under various physiological conditions.
3. Normal and abnormal constituents of urine.
4. Microscopic examination of urine.
5. Preparation and examination of blood smear to study blood cells.
6. Differential leucocytes count.

7. Histochemical demonstration of Carbohydrates, Proteins, Lipids, Nucleic acids, Acid and alkaline phosphatases.
8. Separation of proteins by paper and gel electrophoresis.
9. Qualitative analysis of urea, ketone bodies and salts.

**Suggested Reading Material (All latest editions)**

1. Baileys: Text book of Histology
2. Bell Davidson: Text book of physiology and Biochemistry
3. Bolander F.F.: Molecular endocrinology
4. Clerk E.E .C. Isolation and identification of Drugs in pharmaceutical of body fluid and post
5. Cole S. W.: The practical physiological chemistry.
6. Cooper: Poisoning by drugs and chemicals.
7. Eckert, Marsall: Animal physiology mechanism and Adaptations.
8. Garden M.S.: Animal physiology principal and Adaptations.
9. Hill R.W.: Comparative physiology of animals
10. Hoar W.S.: General and comparative physiology.
11. Houssa: Human physiology (McGraw Hill Books Compny)
12. Hunter & Bornford: Hutchisons Clinical methods
13. Hynes: The Biology of polluted water.
14. Jacobs M. B.: The analytic toxicology of inorganic poison
15. Keil J.B., Samson Wright: Applied Physiology
16. Heil E. Joets N.: Physiology (Oxford Uni press ) (1982)
17. Klein L: River pollution, causes& effects
18. Madhu Raj: Environmental Management of toxic and hazardous chemicals
19. Mill peter J.: Comparative neurobiology (EdHrbord London
20. Modi N.J.: Text Book of toxicology
21. Mitchell P.H.: Text Book of General physiology.
22. Norman A.W.: Hormones.
23. Odum: Fundamental of ecology.
24. Osterbong: The crime laboratory
25. Philips G.: Environmental physiology.
26. Prosser C.L.: Comparative animal physiology.
27. Ramkumar: Environmental Biodegradation.
28. Ramkumar: Environmental Chemical hazards

**PG Programme: M.Sc. Zoology Semester-IV**  
**DSE – XV Code of the Course: 4ZOO3**

**M.Sc. II (Zoology) Semester-IV**  
**DSE – XV [Fisheries-III (Fish Harvest and Post Harvest Technology)]**

Unit	Contents
<b>Unit-I</b>	<b>Fishing Methods:</b> 1.1 Inland fishing gears and fishing methods 1.2 Biological factors in fishing 1.3 Natural and synthetic fibers and preparation of fishing nets 1.4 Maintenance of nets. 1.5 Fishing crafts- Mechanised and non-mechanised boats. 1.6 Unconventional fishing methods- Electrofishing, light fishing, Echosounder and sonar
<b>Unit-II</b>	<b>Fish Composition:</b> 2.1 Biochemical composition and nutritional value of fish. 2.2 Fish decomposition- Post mortem changes and rigormortis, Causes of spoilage. 2.3 Methods of fish preservation: freezing, Drying, Salting, Smoking, Pickling, pasting and spicing.

	2.4 Fermentation. 2.5 Canning.
<b>Unit-III</b>	<b>Fish Products:</b> 3.1 Production and utilization of liver oils. 3.2 Production and utilization of Fish flour. 3.3 Production and utilization of Fish silage. 3.4 Production and utilization of Fish protein. 3.5 Production and utilization of Fish glue. 3.6 Production and utilization of Fish skin.
<b>Unit-IV</b>	<b>Fish Marketing:</b> 4.1 Scope and functions of fish marketing. 4.2 Fish Markets and Fish market structure 4.3 Types of market: wholesale, terminal, retail, and fairs. 4.4 Functions: Selling, transportation, storage, gradation, money transaction. 4.5 Marketing system: Use flows, physical flows and channel flows. 4.6 Strategy for fish market development. 4.7 Price determination.
<b>Unit-V</b>	<b>Fisheries Management:</b> 5.1 Fisheries managements and extension. 5.2 Government and Fishermen's Co-operative Societies, integration, marketing efficiency. 5.3 Marketing cost and price spread, marketing planning, 5.4 Survey of Fishery Resources. 5.5 Fish Farmers Developmental Agencies. 5.6 Institutional Support to fisheries, Crop Insurance.

**PG Programme: M.Sc. Zoology Semester- IV**  
**DSE – XVI Code of the Course: 4ZOO4**

**M.Sc. II (Zoology) Semester-IV**  
**DSE – XVI [Fisheries-IV (Fish Reproductive Physiology and Pathology)]**

<b>Unit</b>	<b>Contents</b>
<b>Unit-I</b>	<b>Fish Reproductive Physiology:</b> 1.1 Gametogenesis in fishes. 1.2 Reproductive behaviour and pheromones. 1.3 Types and mode of reproduction. 1.4 Secondary sexual characters. 1.5 Sexuality, Intersex, Bisexuality, Hermaphroditism. 1.6 Parental care.
<b>Unit-II</b>	<b>Fish Breeding:</b> 2.1 Cryopreservation of gametes and embryo (gene banking). 2.2 Fecundity, Survival and Mortality in fishes. 2.3 Induced breeding. 2.4 Factors affecting spawning 2.5 Hypophysation. 2.6 Use of different synthetic and natural hormones, their formulation and mechanism of action.
<b>Unit-III</b>	<b>Fish Fertilization:</b> 3.1 <i>In vitro</i> fertilization and incubation. 3.2 Fish seed collection from natural resources. 3.3 Fundamentals of fish genetics. 3.4 Gynogenesis, Androgenesis, Polyploidy, Production of monosex population, Hybridization. 3.5 Transgenic fishes.
<b>Unit-IV</b>	<b>Endocrine System of Fishes:</b>



	4.1 Hypothalamo-hypophyseal system 4.2 Functional morphology of pituitary gland. 4.3 Hypothalamic control of pituitary. 4.4 Structure and functions of the Thyroid gland. 4.5 Structure and functions of the Pancreas. 4.6 Structure and functions of the Corpuscles of Stannius, Urophysis
<b>Unit-V</b>	<b>Fish Pathology:</b> 5.1 Protozoan diseases of fish. 5.2 Helminth diseases of fish. 5.3 Crustacean parasites of fish. 5.4 Fungal diseases of fish. 5.5 Bacterial and viral diseases of fish.

**Practical to be carried out along with practical -7, Based on – DSE-- XV [Fisheries-III (Fish Harvest and Post Harvest Technology)] and DSE--XVI [Fisheries-IV (Fish Reproductive Physiology and Pathology)]**

1. Study of gonadal development in carps and other cultivable finfishes.
2. Induced breeding of fishes through various inducing agents.
3. Evaluation of carp milt and egg.
4. Collection and Identification of carp spawn and fry
5. Determination of age of fish by scale reading.
6. Study of length weight relationship in fish.
7. Morphometric study of given fish.
8. Exercises on Hardy-Weinberg equation.
9. Isolation of DNA from fish blood.
10. 10 Collection, identification and isolation of live food organisms using various techniques.
11. Preparation of various culture media
12. Mass culture of cladocerans, copepods and rotifers.

**Books Recommended (All latest editions):**

1. Bentley, P. J., Comparative Vertebrate Endocrinology, Cambridge University Press, 2000.
2. Bond, C.E., Biology of Fishes, Saunders College Publishing Philadelphia, 1979.
3. Brown, M.E., The Physiology of Fishes Vol. I, II. Academic Press, 1953 & 1957
4. C.I.F.R.I., Prawn Fisheries Bulletin No. 10, 1977.
5. Chakroff, M., Freshwater Fish Pond Culture and Management, Scientific Publishers, 1987.
6. Datta-Munshi, J.S. & Hughes G. M., Air-breathing fishes of India, Oxford and IBH Publ. Co. New Delhi, 1992.
7. Davis.H. S., Culture and Diseases of Game Fishes, University of California Press, 1956
8. Duijn, C. V., Diseases of Fishes, LondonIiffe Books Ltd, 1967.
9. Evans,D.H., The Physiology of Fishes, CRC Press, 1998
10. Gopakumar, K., Singh, B.N. and Chitranshi, V.R. Fifty Years of Fisheries Research in India, Fisheries Division Indian Council of Agricultural Research, New Delhi, 2000.
11. Gorbman et al: Comparative Endocrinology, John Wiley & Sons, New York, Chicheester, Brisbane 12. Hadley, M. E., Endocrinology, Prentice Hall, International Editions, 2000.
12. Hall, C. B., Ponds and Fish Culture, Agro Botanical Publishers, 1994
13. Hoar W.S. & Randall, D. J., Fish Physiology, Series Vol. I - XIV, Academic Press
14. Hora, S. L. and Pillay, T.V. R., Handbook on Fish Culture in the IndoPacific Region, Fisheries Division, Biology Branch, FAO, 1962.
15. Howard & Churchill, Canning technology. London
16. Huet, M., Textbook of Fish Culture, Breeding and Cultivation of Fish, Fishing News (Books) Ltd.,
17. Hughes, G. M. Comparative Physiology of Vertebrate Respiration, Heinemann Educational Books Ltd., 1967

18. Jhingran, V.G. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi. 1985.
19. Khanna S. S. and H. R. Singh. A textbook of Fish Biology and Fisheries, Narendra Publishing House, 2003
20. Kreuzer, R., Fishery products, FAO, Fishing News (Books) Ltd., England. 1974

**PG Programme: M.Sc. Zoology Semester -IV**  
**DSE – XV Code of the Course: 4ZOO3**

**M.Sc. II (Zoology) Semester-IV**  
**DSE – XV [ Entomology-III (Developmental and Commercial Entomology)]**

Unit	Contents
<b>Unit-I</b>	<b>Insect Development:</b> 1.1 Types of immature stages in insect orders. 1.2 Morphology of insect egg. 1.3 Nymph/larva And pupa. 1.4 Life history strategies in hemimetabola and holometabola. 1.5 Significance of immature stages for pest management.
<b>Unit-II</b>	<b>Apiculture:</b> 2.1 Bee keeping in different seasons. 2.2 Managing colonies for honey production and pollination. 2.3 Artificial queen rearing. 2.4 Pests and diseases of honey bees. 2.5 Bee poisoning. 2.6 Production and marketing of quality honey and value added honey products.
<b>Unit-III</b>	<b>Sericulture:</b> 3.1 Cultivation of food plants for Mulberry sericulture. 3.2 Bioecology of mulberry silkworms. 3.3 Rearing of silkworms. 3.4 Harvesting and processing of cocoons. 3.5 Reeling appliances. 3.6 Diseases of Bombyx mori.
<b>Unit-IV</b>	<b>Sericulture:</b> 4.1 Tasar sericulture: Cultivation of food plants. 4.2 Bioecology and rearing of tasar silkworms. 4.3 Stifling and reeling of cocoons. 4.4 Muga sericulture: Cultivation of food plants. 4.5 Grainage technology. 4.6 Eri sericulture.
<b>Unit-V</b>	<b>Lac Culture:</b> 5.1 Lac insect and its life history. 5.2 Host plant management for lac culture. 5.3 Strains of lac insects. 5.4 Propagation of lac insects. 5.5 Lac crop management. 5.6 Natural enemies of lac insects and their management. 5.7 Lac extraction.

**PG Programme: M.Sc. Zoology Semester-IV**  
**DSE – XVI Code of the Course: 4ZOO4**

**M.Sc. II (Zoology) Semester-IV**  
**DSE – XVI [Entomology –IV (Insect Pests and Pest Control)]**

Unit	Contents
<b>Unit-I</b>	<b>Insect Pests:</b> 1.1 Insect pests of cereals and millets. 1.2 Major Insect pests of pulses

	<p>1.3 Major Insect pests of tobacco.  1.4 Major Insect pests of oilseeds.  1.5 Major Insect pests of fibre crops.  1.6 Major Insect pests of forages.  1.7 Major Insect pests of sugarcane.</p>
<b>Unit-II</b>	<p><b>Insect Pests:</b>  2.1 Major Insect pests of mango.  2.2 Major Insect pests of guava..  2.3 Major Insect pests of banana.  2.4 Major Insect pests of citrus.  2.5 Major Insect pests of tomato, brinjal.  2.6 Major Insect pests of stored grain.</p>
<b>Unit-III</b>	<p><b>Biology, Damage and Control of Insect Pests:</b>  3.1 Biology, damage and control of mosquitoes.  3.2 Biology, damage and control of houseflies head and body lice.  3.3 Biology, damage and control of moths, crickets.  3.4 Biology, damage and control of wasps, house dust mites.  3.5 Insect pests of cattle, poultry, pet animals and their management.  3.6 Biological control of insect pest.</p>
<b>Unit-IV</b>	<p><b>Modern Trends in Pest Control:</b>  4.1 Modern trends in pest control: use of chemosterilants, radiation.  4.2 Modern trends in pest control: use of hormones and pheromones.  4.3 Principle of Integrated pest management.  4.4 Application of Integrated pest management.  4.5 Implications of IPM  4.6 Pest risk analysis and pesticide risk analysis.</p>
<b>Unit-V</b>	<p><b>Classification of Insecticides:</b>  5.1 Physical tools of insect pest management.  5.2 Mechanical methods of insect pest management.  5.3 Classification of insecticide's based on mode of entry.  5.4 Classification of insecticide's based on mode of action.  5.5 Chemical nature of insecticides.  5.6 Insect growth regulators.</p>

**List of Practical: To be carried for practical-7**

1. Types of immature stages; their collection, rearing and preservation.
2. Identification of immature insects to orders and families, in endopterygote orders viz., Diptera, Lepidoptera, Hymenoptera and Coleoptera using key.
3. Identification of honey bee species, bee castes and special adaptations.
4. Identification and handling of bee-keeping equipments.
5. Dissections of honey bees/silk worm
6. Visit to bee nursery and commercial apiaries.
7. Silkworm rearing and management. 8. Dissections of larval and adult silk moths.
8. Lac host and crop management technology and processing of lac. Products and by-products of lac.
9. Collection and identification of important pests and their natural Enemies; detection and estimation of infestation and losses in different crops; study of life history of important insect pests.
10. Assessing pest status in dwellings (labs, canteen or hostel), implementation of pest control against flies, mosquitoes, bed bugs, cockroaches.
11. control of silverfishes in the library.
12. Visit to poultry units and assessing pest status in poultries.
13. Laboratory and field evaluation of bioefficacy of insecticides; Bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action.
14. Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers.

15. Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds.
16. Field collection of parasitoids and predators.
17. Hands-on training in culturing, identification of common insect pathogens.

**Suggested reading material (All latest editions):**

1. Atwal AS. 2006. The World of the Honey Bee. Kalyani Publ., New Delhi.
2. Ganga G. 2003. Comprehensive Sericulture. Vol. II. Silkworm Rearing and Silk Reeling. Oxford & IBH, New Delhi.
3. Partiban S & David BV. 2007. Management of Household Pests and Public Health Pests. Namratha Publ., Chennai.
4. Singh S. 1975. Beekeeping in India. ICAR, New Delhi.
5. Aruga H. 1994. Principles of Sericulture. Oxford & IBH, New Delhi.
6. Dhaliwal GS & Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publ., New Delhi.
7. Dhaliwal GS, Singh R & Chhillar BS. 2006. Essentials of Agricultural Entomology. Kalyani Publ., New Delhi.
8. Flint MC & Bosch RV. 1981. Introduction to Integrated Pest Management. 1st Ed., Springer, New York.
9. Partiban S & David BV. 2007. Management of Household Pests and Public Health Pests. Namratha Publ., Chennai.
10. Atwal AS, & Dhaliwal GS. Elements of Economic Entomology. Popular Book Dpt, Chennai.
11. Dunston AP. 2007. The Insects: Beneficial and Harmful Aspects. Kalyani Publ., New Delhi
12. Evans JW. 2005. Insect Pests and their Control. Asiatic Publ., New Delhi.
13. Nair MRGK. 1986. Insect and Mites of Crops in India. ICAR, New Delhi.
14. Prakash I & Mathur RP. 1987. Management of Rodent Pests. ICAR, New Delhi.
15. Saxena RC & Srivastava RC. 2007. Entomology at a Glance. Agrotech Publ. Academy, Jodhpur

**PG Programme: M.Sc. Zoology Semester-IV**  
**PROJECT Code of the Course: 4ZOO6**

**M. Sc. II ZOOLOGY SEMESTER-IV**

**Project Work**

The subject of the project will be given to a student independently on any topic belonging to Life sciences. The examinee shall be required to produce three typed copies of project signed by teacher in-charge and certified by the department as bona fide work of him/her. Oral presentation is necessary to explain details there of the project. Therefore, he/she is required to prepare PowerPoint program for LCD/DLP projector. The *viva voce* on the project shall be the part of interaction among the examiner and the student presenting his/her project. Valuation and marks will be submitted to the university.

**Distribution of marks:**

1. Project Submission.....75 Marks
2. *Viva voce*.....25 Marks

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Total: **100 Marks**

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