

# Pt. Ravishankar Shukla University, Raipur (C.G.)



## CURRICULUM & SYLLABI

(Based on CBCS & LOCF)

### M. Sc. Zoology Program Code: ZOO402

Semester System

Session: 2024-26

Approved by:	Board of Studies	Academic Council
Date:	Chairman: Dr. Sheela Dubey External Expert: Dr. Neeru Agrawal Dr. Shubhada Rahalkar Special Invite(NGO): Mr. M. Suraj Members: Dr. Rajesh Mishra Dr. Sangeeta Banjare Dr. Shweta Agniwanshi Dr. Richa Tikariha	<i>NA</i> 14-5-24 <i>Dr. Sangeeta Banjare</i> <i>Dr. Richa Tikariha</i>

M. Sc. Zoology

2024 - 2026

## Program Objectives:

The Master of Science in Zoology program is a two-year, four-semester program, designed to cater to the needs of students aspiring for higher education in Zoology.

Zoology is an important part of biological sciences and inculcates the study of life and living organisms, their life cycles, physiological processes, adaptations, and environment. It covers a fascinating range of branches like Molecular cytogenetics, Biochemistry, Developmental Biology, Environmental and Evolutionary Biology, Immunology, Molecular Biology, Physiology, Biostatistics, Animal behavior, Parasitology, Chronobiology, etc. giving the modern biologist an insight into animal life. The program's main goal is to provide students with an excellent education in zoology as a basic science and its applied branches.

The Program comprises of the following objectives-

1. **Knowledge:** Learn about the biological diversity and varying degrees of complexity of different animal forms through comparative structural investigations and systematic classification.
2. **Skill development:** Develop technical skills in biotechnology, bioinformatics, biostatistics, tools and techniques in biology, animal culture techniques viz. Aquaculture, Sericulture etc.
3. **Interdisciplinary Interaction:** Integrate zoological concepts and techniques into interdisciplinary contexts, collaborating effectively with professionals from other fields to address complex problems.
4. **Problem solving:** Development of an aptitude to synthesize a range of biological concepts and ideas.

All of these will be beneficial for laying a solid foundation for further biological science study as well as for becoming ready for an effective and lucrative career in both teaching and research. Following the awarding of this degree, a student has the option of entering the workforce or continuing their education at a higher level. Following graduation, one can pursue careers in academia, industry, public health, etc. As a result, the postgraduate will have the chance to make a meaningful contribution to the advancement of societal welfare.

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### Program Outcomes:

Upon successful completion of the Master of Science in Zoology program, students will be able to:

PO-1	<b>Knowledge:</b> This program offers advanced theoretical as well as practical knowledge to students in their chosen specialization. The MSc specialization opted by students is usually the one studied by them during graduation and enhance their knowledge in selected subject.
PO-2	<b>Critical Thinking and Reasoning:</b> The course is designed to provide the in-depth knowledge of the Specialized Subject. It further enhances the vocabulary, skill sets, reasoning and IQ level. Demonstrate critical thinking and reasoning skills.
PO-3	<b>Skill development:</b> A zoology degree will provide students with abilities that will help them succeed academically and make them stand out in an increasingly competitive work environment. It will foster an interest in research as well as aid in the development of the capacity to understand the nature of living things and biological processes. The student would acquire the ability to synthesize a variety of biological concepts and ideas in addition to receiving training in the technical and analytical abilities required in contemporary biological research.
PO-4	<b>Effective Communication:</b> Effectively convey difficult biological concepts and findings to audiences with and without technical background through written reports, presentations, and instruction. They will also be able to integrate the results of biological research into the corpus of biological knowledge already in existence and effectively communicate the results of biological research.
PO-5	<b>Social/ Interdisciplinary Interaction:</b> Integrate biological concepts and techniques into interdisciplinary contexts, collaborate effectively with professionals from other fields to address complex problems.
PO-6	<b>Self-directed and Life-long Learning:</b> Understand the value of lifelong learning and professional growth in the quickly changing area of biology, and demonstrate the capacity to acquire new things on your own or in formal educational settings.
PO-7	<b>Effective Citizenship, Leadership, and Innovation:</b> Take the lead and invent in a variety of biological contexts, advancing the discipline and using

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	mathematical knowledge to solve new problems. Additionally, they would be aware of the place of science and the moral obligations placed on it by society, which would enable them to share their knowledge for the benefit of all people.
PO-8	<b>Ethics:</b> Follow professional standards and best practices while doing ethical and responsible biological research, teaching, and teamwork.
PO-9	<b>Further Education or Employment:</b> This program is a prerequisite to enter into careers like lecturer in schools, Asst. Professor in colleges, and also open portal to appear in examinations like NET, SET, GATE etc. Get employment in academia, research institutions, industry, government, and other sectors.
PO-10	<b>Global Perspective:</b> Recognize the global nature of biological research and its impact, appreciating diverse cultural perspectives.

### PROGRAMME SPECIFIC OUTCOMES (PSOs)

At the end of the program, the student will be able to:

PSO1	<ul style="list-style-type: none"> <li>Gain an understanding of the natural world, the environment, animal classification and behavior, human genetics, cytology, and evolution. Recognize the differences in animal evolution, structure, function, and behavior.</li> </ul>
PSO2	<ul style="list-style-type: none"> <li>Carry out, evaluate, and put into practice practical methods and procedures to address biological issues as well as assess and quantify data gathered for any project. Recognise how biological approaches are applied in different sectors of biology.</li> </ul>
PSO3	<ul style="list-style-type: none"> <li>Pursue research in challenging areas of Zoology.</li> </ul>
PSO4	<ul style="list-style-type: none"> <li>Understand the applications of Biological techniques to various fields of biology</li> </ul>
PSO5	<ul style="list-style-type: none"> <li>Qualify national level tests like NET/GATE etc.</li> </ul>

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M.Sc. Zoology

Specification of Course	Semester	No. of Courses	Credits
Core [Theory]	I-IV	14	70
Core [Practical]		07	17
Elective [Theory]	IV	02	10
Elective [Practical]		01	03
<b>Total</b>		<b>24</b>	<b>100</b>

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## M.Sc. Zoology Programme Structure

Semester	Course Nature	Course Code	Course Title	Course Type(T/P)	Hrs/Week	Credits	Marks		
							CIA	ESE	Total
Semester I	Core	ZOO110	Biosystematics, Taxonomy and Biodiversity	T	6	5	30	70	100
	Core	ZOO120	Structure and Function of Invertebrates	T	6	5	30	70	100
	Core	ZOO130	Population Genetics and Evolution Biology	T	6	5	30	70	100
	Core	ZOO140	Tools & Techniques in Biology	T	6	5	30	70	100
	Core	ZOO150	Lab Course I (Based on paper I & II)	P	4	2	30	70	100
	Core	ZOO160	Lab Course II (Based on paper III & IV)	P	4	2	30	70	100
Semester II	Core	ZOO210	Molecular Cell Biology and Biotechnology	T	6	5	30	70	100
	Core	ZOO220	General physiology and Endocrinology	T	6	5	30	70	100
	Core	ZOO230	Human Reproductive Physiology	T	6	5	30	70	100
	Core	ZOO240	Quantitative Biology and Computer Application	T	6	5	30	70	100
	Core	ZOO250	Lab Course I (Based on paper I & II)	P	5	3	30	70	100
	Core	ZOO260	Lab Course II (Based on paper III & IV)	P	5	3	30	70	100
Semester III	Core	ZOO310	Comparative Anatomy of vertebrate	T	6	5	30	70	100

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	Core	ZOO320	Animal Behavior	T	6	5	30	70	100
	Core	ZOO330	Immunology	T	6	5	30	70	100
	Core	ZOO340	Environment Physiology and Population Ecology	T	6	5	30	70	100
	Core	ZOO350	Lab Course I (Based on paper I & II)	P	4	2	30	70	100
	Core	ZOO360	Lab Course II (Based on paper III & IV)	P	4	2	30	70	100
Semester IV	Core	ZOO410	Biochemistry. Metabolic Regulation and Cell function	T	6	5	30	70	100
	Core	ZOO420	Neurophysiology	T	6	5	30	70	100
	Elective 1-a	ZOO431	Fish (Ichthyology) structure and function	T	6	5	30	70	100
	Elective 1-b	ZOO432	Cell biology	T	6	5	30	70	100
	Elective 1-c	ZOO433	Entomology	T	6	5	30	70	100
	Elective 1-d	ZOO434	Wild life conservation	T	6	5	30	70	100
	Elective 1-e	ZOO435	Biology of Vertebrates immune system	T	6	5	30	70	100
	Elective 1-f	ZOO436	Ornithology (Avian Biology)	T	6	5	30	70	100
	Elective 2-a	ZOO441	Pisciculture and Economic importance of fishes (Ichthyology)	T	6	5	30	70	100
	Elective 2-b	ZOO442	Cellular and Molecular organization	T	6	5	30	70	100
	Elective 2-c	ZOO443	Applied Entomology	T	6	5	30	70	100
	Elective 2-d	ZOO444	Environment and Biodiversity conservation	T	6	5	30	70	100
	Elective 2-e	ZOO445	Molecular endocrinology and reproductive technology	T	6	5	30	70	100

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	Elective 2-f	ZOO446	Avian Biology and Ecological Importance	T	6	5	30	70	100
	Core	ZOO450	Lab Course I (Based on paper I & II)	P	5	3	30	70	100
	Elective	ZOO460	Lab Course II (Based on paper III & IV) Or Dissertation (Based on Paper I, II, III and IV)	P	5	3	30	70	100

- Student has choice to opt for one paper each from Elective I & Elective II in fourth Semester.
- The respective teachers on each paper will ensure the internal evaluation by a class test and a seminar/ poster presentation of 10 marks each and submit the foil and counter foil to the HOD by the end the activity.
- Students can choose in Lab Course II of the fourth semester either practical based on Paper III and IV or Dissertation based on Paper I, II, III and IV.
- Each theory paper will have questions divided in three sections A, B, and C. Section A will have 10 MCQs/Fill in the blanks/One Word answers of total 15 marks each from the whole syllabus. Section B will have 4 short answer questions (100 words) of 05 marks each, one from each unit. Section C will have 4 questions one from each unit with internal choice of 10 marks each. The questions will have to be answered in about 350 words each.

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**M. Sc. ZOOLOGY FIRST SEMESTER  
(July- December 2024)**

**PAPER - I**

**BIOSYSTEMATICS, TAXONOMY AND BIODIVERSITY**

**Course Code ZOO110**

**Course Objective**

This paper is aimed to introducing the students for the salient features of Taxonomy and Evolution.

**UNIT-I**

- Definition and Basic concept of Biosystematics.
- Zoological nomenclature.
- History and theories of biological classification and uses.
- Different types of taxonomic characters.
- Taxonomic procedure, collection, preservation, and Identification.

**UNIT-II-**

- Newer trends in biosystematics-
- Morphological
- Embryological
- Behavioral
- Cytological
- Molecular
- Hierarchy of Categories.
- Types of taxonomic key their merits and demerits

**UNIT-III**

- Dimension of Speciation.
- Mechanism of speciation in Panmictic and Apomictic species.
- Species concept-Sub, eco, ceno, and super species.
- Different type of species categories-Biological, Evolutionary, Typological, Nomenalistic, and Polytyping.

**UNIT-IV**

- Conservation of biodiversity
- Types of Biodiversity.
- Hot Spots of Biodiversity.
- Threats to biodiversity.
- Evaluation of biodiversity indices
- Shannon-Weiner Index

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## Learning Outcomes

After successfully completing this course, the students will be able to

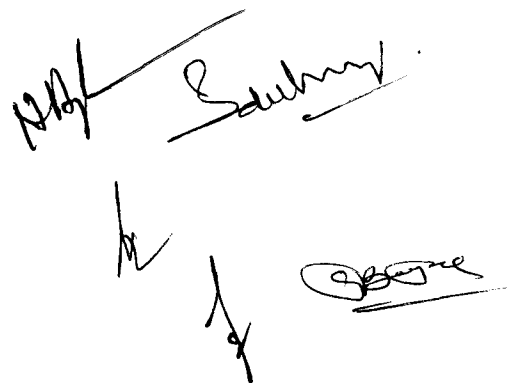
- Classify animals on the basis of their relation to other animals by body structure, external characters.
- Apply the International rules of Nomenclature to give a scientific name to animals which are found during research.
- Understand the gradual development and evolutionary history of different kinds of living organisms from earlier forms over several generations.
- Understand and demonstrate the internal anatomy of various animals, biodiversity and related indices
- To identify diversity of fauna on earth and implement conservation measures to save diversity

## Skill Development/Employability

- To understand importance of wildlife and conservation measures, National parks and Sanctuaries.
- Analyze biological data mathematically and statistically

## SUGGESTED READING MATERIALS - (ALL LATEST EDITION)

- Biosystematics & Taxonomy,
- Dr.R.C.Tripathi, University Book House JAIPUR.
- Theory & Practice of Animal Taxonomy
- V.C. Kapoor, 5th Edition Oxford & IBH Publishing Co.
- Principle of Animal Taxonomy
- G.G. Simpson, Oxford & IBH Publishing Co.
- Elements of Taxonomy
- Earnst Mayer
- Biodiversity
- E.O. Wilson, Academic Press Washington
- The Biology of Biodiversity
- M. Kato, Springer
- Molecular Markers - Natural History & Evolution
- J.C. Avise



**M. Sc. ZOOLOGY FIRST SEMESTER  
(July- December, 2024)**

**PAPER- II**

**Structure and Function of Invertebrates**

**Course Code ZOO120**

**Course Objective**

This paper is aimed to introducing the students for structure & function of Invertebrate.

**UNIT-I**

- Organization of coelom
- Acoelomates and Pseudocoelomates
- Coelomates: Protostomia and Deuterostomia.
- Locomotion
- Flagellar and ciliary movement in Protozoa.
- Hydrostatic movement in Coelenterata, Annelida and Echinodermata

**UNIT-II**

- Nutrition and Digestion
- Patterns of feeding and digestion in Protozoa
- Filter feeding in polychaeta.
- Respiration
- Organs of respiration Gills, lungs and trachea. Respiratory pigments

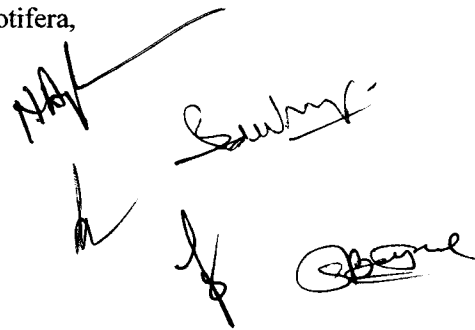
**UNIT-III**

**Excretion**

- Organs of excretion.
- Excretion and osmoregulation
- Primitive nervous system: Coelenterata and Echinodermata.
- Advanced Nervous system: Annelida, Arthropoda (Crustacea and insecta) and Mollusca, Cephalopoda)

**UNIT-IV**

- Invertebrate larvae
- Larval forms of free-living and parasitic invertebrates
- Minor Phyla -Organization and general characters of (Ctenophore, Rotifera, Ectoprocta, Endoprocta)



## Learning Outcomes

After successfully completing this course, the students will be able to

- Understand the structure and organization of invertebrate animals.
- Explain modifications in various functions of animals during transition from invertebrates to vertebrates.

## Skill Development/Employability

- Identify invertebrates and homology, analogy, and modifications of mouthparts in relation to feeding habits, Respiration, Excretion, Locomotion.

## SUGGESTED READING MATERIALS (ALL LATEST EDITION)

- Invertebrate Structure and function:-  
E.J W. Barrigton English language Book society UK.
- Invertebrate Zoology:  
Robert Barnes IVth Edition Holt Saunders International Edition  
Japan.
- The Cambridge Natural History Vol 1  
- 9. S F Harmer, A.E. Shipley.  
Todays & Tomorrows Book agency, N Delhi India.
- A Text book of Zoology Invertebrate:  
  
Parker Haswell, Marshall & Williams. A ITBS  
Publishing & Distributers, Delhi
- The Invertebrates Vol. 1 - 9  
Libbie Henrietta Hyman, McGraw Hill Book Company

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**M. Sc. ZOOLOGY FIRST SEMESTER  
(July- December 2024)**

**PAPER-III**

**Population Genetics and Evolution Biology**

**Course Code ZOO130**

**Course objective**

This paper is aimed to introducing the students for the salient features of Evolution and Speciation.

**UNIT-I**

- Origin of Life
- Concepts of evolution and theories of organic evolution: Lamarckism, Darwinism and Synthetic theory of Evolution .
- Evidences of evolution: anatomical, embryological, paleontological, physiological and Bio-chemical

**UNIT-II**

- Detailed account of destabilizing forces.
- Natural selection
- Mutation
- Variation
- Genetic Drift
- Hardy-Weinberg law of genetic equilibrium

**UNIT-III**

- Patterns and mechanisms of reproductive isolation
- Phylogenetic and biological concepts of species
- Gene Evolution, Evolution of gene families
- Factors affecting human disease frequency

**UNIT-IV**

- Origin of higher categories
- Micro-and Macro-evolution
- Evolution of horse, elephant, camel, man

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## Learning Outcomes

After successfully completing this course, the students will be able to:

- Enable the students to understand the evolution of universe and life.
- Understanding on the process and theories in evolutionary biology.

### Skill Development/Employability

- Develop an interest in the debates and discussion taking place in the field of evolutionary biology.

## SUGGESTED READING MATERIALS - (ALL LATEST EDITION)

- Gene & Evolution, Jha A.P. John Publication, New Delhi
- Evolution & Genetics Merrel D.J. Holt rinchert & Wiston INC.
- The Genetics & Origin of species Dobzhansky, Columbia University Press.
- Evolution Dobzhansky, Ayala F.J., Stebbins G.L. & Valentine J.M. Surjeet Publication New Delhi.
- Species Evolution - The Role of Chromosomal Change King M. Cambridge University Press. Cambridge
- A Primer of Population Genetics Hartl D.L. Suinaer Associates INC, Massachusetts
- Evolutionary Genetics Smith J.M. Oxford University Press, New York
- Evolutionary Biology Futuyama D.J. Suinaer Associates INC publishers, Dunderland
- Evolution Strikberger M.W. Johns & Bartett Publishes, Boston London

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**M. Sc. ZOOLOGY FIRST SEMESTER  
(July - December 2024)**

**Paper IV**

**TOOLS & TECHNIQUES IN BIOLOGY**

**Course Code ZOO140**

**Course objective**

The course objective is to provide students with a basic understanding of:  
Various techniques used in biological sciences.

**UNIT-I**

- Principles and application of-
- Ultracentrifugation
- Electrophoresis
- Chromatography (various types)
- Lambert-Beers Law and colorimetry and spectrophotometry
- Flow cytometry.

**UNIT-II**

- Principles and Application of Light Microscopy and micrometry
- Phase Contrast microscopy
- Interference microscopy
- Fluorescence microscopy
- Transmission Electron microscopy
- Scanning Electron microscopy

**UNIT-III**

- Chemical assays
- Biological assays-in vivo and in vitro
- Principles of cytological and cytochemical techniques
- Fixation: chemical basis of fixation by formaldehyde, gluteraldehyde, chromium salts, mercury salts, osmium salts, alcohol and acetone  
Chemical basis of staining of carbohydrate, protein lipids and nucleic acids

**UNIT-IV**

- Principle and techniques of-
- Nucleic acid hybridization and cot curve
- Sequencing of proteins and nucleic acids
- Freeze techniques
- Media preparation and sterilization
- Inoculation and growth monitoring

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### **Learning outcomes**

- After successfully completing this course, the students will be able to
- Explain Microscopy, Colorimetry, Chromatography
- Principle, process, applications and working of related instruments.
- Demonstrate Microbiological, Cytological, Histological, Molecular biological techniques.

### **Skill Development/Employability**

- Apply and demonstrate Immunological Surgical Immuno detection and Cell culture techniques.

### **SUGGESTED READING MATERIALS - (ALL LATEST EDITION)**

- **Introduction to Instrumental Analysis**
- **Robert Braun, McGraw Hill International Edition**

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**M. Sc. ZOOLOGY FIRST SEMESTER (July-December 2024)**

**LAB COUSE-I**

**Course Code ZOO150**

**(PRACTICAL BASED ON PAPER I & II)**

• **Biosystematics and Taxonomy**

- Study of biodiversity among various invertebrates and vertebrates (Listing of all the animals found in and around your house and also try to find out their Zoological names).
- Collection of various insect species.
- Visits to a local animal park or zoo to identify and study the captive fauna and preparation of report.
- Study of adaptive characteristics of various invertebrates and vertebrates in different climate.
- Taxonomic key formation and conversion.
- Study of biodiversity in grassland and pond water by using Shannon -Weiner index
- Other exercise related to theory paper

• **Structure and function of invertebrates**

- Identification, classification, and study of distinguishing features of important representatives from various groups (Protozoa to Hemichordata).
- Study of permanent prepared slides (from Protozoa to Hemichordata).
- Dissection; Reproductive, Excretory, nervous and haemocoelomic systems of leech.
- Dissection Reproductive system of cockroach; general anatomy, nervous and reproductive systems of grasshopper; nervous system of crab; nervous and reproductive systems of scorpion.
- Nervous system of Mytilus, Sepia and Aplysia, general anatomy of Aplysia.
- Study of sections of the arm of a starfish; general anatomy of a Holothurian; Aristotle's lantern of a sea urchin complete as well as disarticulated parts of the Aristotle's lantern.
- Permanent preparations of different materials to be provided for study.
- Wonder invertebrates
- Other exercise related to theory paper.

**Examination Scheme**

Based on Paper I	30 Marks
Based on Paper II	30 Marks
Viva	10 Marks
Sessional(Internal)	30 Marks
<b>Total</b>	<b>100 Marks</b>

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**M. Sc. ZOOLOGY FIRST SEMESTER (July-December 2024)**

**LAB COUSE-II**

**Course Code ZOO160**

**(PRACTICAL BASED ON PAPER III & IV)**

**Population Genetics and Evolution Biology**

Comparative anatomy of Vertebrates

- Identification, classification and study of distinguishing features of important representatives, museum specimens and slides (Protochordates and Chordates)
- Comparative studies of integumentary, skeleton and reproductive system of major vertebrate classes.
- Alternative Method-Dissections: fowl/snake cranial nerves  
Wonder vertebrates
- Other exercise related to theory paper

**TOOLS & TECHNIQUES IN BIOLOGY**

- Parts study, principles, and use of following instruments for different techniques:
- pH meter: Determination of pH of different soil and water samples.
- Spectrophotometer: Preparation of absorption spectrum.
- Chromatography: Paper and thin layer chromatography.
- Centrifuge: Extraction proteins and carbohydrates from tissues.
- Electrophoresis: Paper and gel electrophoresis.
- Microscope: Parts study and principles of various microscopes.
- Demonstration of cryostat.
- Other exercise related to theory paper

**Examination Scheme**

Based on Paper III	30 Marks
Based on Paper IV	30 Marks
Viva	10 Marks
Sessional(Internal)	30 Marks
<b>Total</b>	<b>100 Marks</b>

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**M. Sc. ZOOLOGY SECOND SEMESTER (January-June, 2025)**

**PAPER- I**

**MOLECULAR CELL BIOLOGY AND BIOTECHNOLOGY**

**Course Code ZOO210**

**Course Objective**

The course provides an insight into the life processes at the cellular and molecular levels. Other important aspects include DNA and molecular genetics including gene cloning, sequencing and gene mapping in addition to the powerful techniques that revolutionized the pharmaceutical, health and agricultural industries

**UNIT-I**

Bio membrane –

- Molecular composition and arrangement
- Transport across membrane
- Structure and function of-
- Mitochondria
- Golgi complex
- Lysosome
- Ribosome

**UNIT-II**

- DNA replication
- Transcription
- Translation
- Genetic code
- Mechanisms of initiation, elongation and termination
- Regulation of translation

**UNIT-III**

- Genome organization
- Chromosomal organization: morphological and structural types.
- Non-coding DNA
- Molecular mapping of genome
- Genetic and physical maps
- Polymerase Chain Reaction (PCR) and blotting techniques
- Molecular markers in genome analysis.

**UNIT-IV**

- Transgenic animals and knock-outs
- Production and applications
- Embryonic stem cells
- Application of genetic engineering-
- Medicine
- Agriculture

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### Learning outcomes

Develop an understanding of concepts, mechanisms and evolutionary significance and relevance of molecular biology in the current scenario

This course teaches RDNA technology techniques and their application in the field of genetic engineering.

Get well versed in recombinant DNA technology which holds application in biomedical & genomic science, agriculture, environment management, etc. Therefore, a fundamental understanding of Molecular Biology will help in career building in all these fields.

### Skill Development/Employability

Apply their knowledge in problem solving and future course of their career development in higher education and research.

### SUGGESTED READING MATERIALS - (ALL LATEST EDITION)

**MOLECULAR CELLBIOLOGY** Lodish, W.H. Freeman & Co. NewYork **Lehninger**

**PRiNCIPLES OF BIOCHEMISTRY,**

Fourth Edition - David L [1]. Nelson, Michael M. Cox

**MOLECULAR CELL BIOLOGY**

Lodish M. Baltimore, Scientific American books

**ESSENTIALS OF CELL & MOLECULAR BIOLOGY**

Roberties & Roberties, Halt Saunders International Edition.

**CELL & MOLECULAR CELL BIOLOGY**

Gerald Karp, Willey & Sons Co.

**MEDICAL CELL BIOLOGY**

Flickinger E.J. Brown J.C. Halt Saunders International Edition.

**CELL BIOLOGY**

Powar C.B. Himalaya Publishing House

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**M. Sc. ZOOLOGY SECOND SEMESTER (January- June, 2025)**

**PAPER- II**

**General Physiology and Endocrinology**

**Course Code ZOO220**

**Course Objective**

The course deals with various physiological functions in mammals, Endocrine function and Hormone synthesis. It also gives an account of the metabolic/ biochemical pathways.

**UNIT-I**

- Digestion and Metabolism-
- Mechanism of digestion
- Mechanism of absorption
- Respiration-
- Respiratory pigments
- Role of Hemoglobin
- Mechanism and regulation of breathing.
- Transport of Gases
- Internal Respiration
- Regulation of body pH

**UNIT-II**

- Anatomy of muscle
- Muscle Function and Movement
- Mechanism of muscle contraction
- Regulation of muscle contraction
- Nervous System
- Neurons and membrane excitation
- Action potentials
- Synapses and neurotransmitters
- Cardiac Cycle and Its regulation

**UNIT-III**

**Sensory Transduction-**

- Auditory receptors
- Chemoreceptor: taste and smell
- Vision and Photoreception
- Thermoregulation and Cold Tolerance
- Heat balance and exchange
- Endotherms Vs Ectotherms
- Torpor, hibernation and aestivation
- Endocrinology

**UNIT-IV**

- Structure and functions of endocrine glands (Pituitary, pineal, pancreas, adrenal, thyroid etc.)
- Biosynthesis of hormones (thyroid, Adrenal and gonadal)
- Hormones and Reproduction

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## Learning Outcomes

At the end of the course students should:

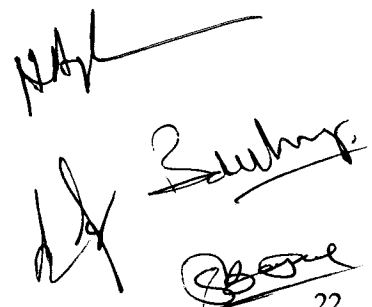
- Have an enhanced knowledge and appreciation of mammalian physiology;
- Understand the functions of important physiological systems including the cardio-respiratory, renal, reproductive and metabolic systems;
- Understand how these separate systems interact to yield integrated physiological responses to challenges such as exercise, fasting and ascent to high altitude, and how they can sometimes fail;

## Skill Development/Employability

- Be able to perform, analyze and report on experiments and observations in physiology;
- Be able to recognize and identify principal tissue structures.

## SUGGESTED READING MATERIALS - (ALL LATEST EDITION)

- Tortora, G.J. and Derrickson, B.H. (2009) Principles of Anatomy and Physiology (12th edition) John Wiley and Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology (9th edition) McGraw Hill.
- Guyton, A.C. and Hall, J.E. (2011) Textbook of Medical Physiology (12th edition) Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
- Marieb, E. (1998) Human Anatomy and Physiology (4th edition) Addison-Wesley.  
Kesar, S. and Vashisht, N. (2007) Experimental Physiology, Heritage Publishers.
- Turner, C. D. (1971) General Endocrinology, Pub- Saunders Toppan.
- Nussey, S.S.; and Whitehead, S.A. (2001) Endocrinology: An Integrated Approach, Oxford: BIOS Scientific Publishers.
- Hadley, M.E. and Levine J.E. (2007) Endocrinology (6th edition) Pearson Prentice-Hall, New Jersey.
- David, O.N. (2013) Vertebrate Endocrinology.



**M. Sc. ZOOLOGY SECOND SEMESTER (January-June, 2025)**

**PAPER- III**

**Human Reproductive Physiology**

**Course Code ZOO230**

**Course Objective**

The major objective of this course is to provide students with a sound coverage of human reproductive biology within the framework of Human Biology. It also envisages the detailed structure and function of the male and female reproductive tracts, gametogenesis, fertilization, early embryogenesis, foetal development and preparation for birth, and maternal adaptations to pregnancy.

**UNIT-I**

- Structure and function of female reproduction.
- Sexual differentiation
- Puberty and Ovarian cycle
- Formation of ova.
- Physiology of ovulation,
- menstrual cycle

**UNIT-II**

- Structure and function of male reproduction.
- Formation of sperm and fertility of individual.
- Biochemistry of semen, Phallus erection, Ejaculation, Y-specific probes
- Male-Endocrine control of testicular function.

**UNIT-III**

- Process of fertilization-Pre and Post fertilization event
- Biochemistry of fertilization
- Implantation and formation of the foetus and placenta;
- Pregnancy,
- foetal development; Labour and birth
- lactation and neonatal life
- Role of hormone in Parturition and Lactation
- Reproductive Ageing; Menopause

**UNIT-IV**

- Sexually transmitted diseases
- Cancers of the reproductive system
- Adenomyosis
- Birth Control
- chronic infection of uterus,

- congenital uterine anomalies;
- Ovarian cysts,
- pelvic varicosities.

### **Learning outcomes**

Upon successful completion of this course, students should be able to:

- Distinguish between the main stages of embryonic, fetal and neonatal development and causes of fetal disorders.
- Understand the origin and characteristics of common congenital malformations;
- Know how sexually transmitted diseases may contribute to altered neonatal or reproductive function.

### **Skill Development/Employability**

- Explain and contrast the processes of spermatogenesis, oogenesis.
- Demonstrate an understanding of the hormonal control of reproduction in males and how this is regulated;

### **Suggested reading material-**

- Developmental Biology, 2<sup>d</sup> edition. Leon, W.B Saunders College publishing
- Current topics in Developmental Biology eds. R.A. Pederson and G.P. Schatten
- Principles of animal development biology: S.C. Goel, Himalaya Publishing house
- Developmental biology, S.F Gilbert, 4<sup>th</sup> edition, Sinauer Assoc. Inc. Publishers
- An introduction to Developmental biology : D.A. Ede
- Principles of Developmental Biology: Paul Weiss edited by Hafner Publishing Co., NY altimore.
- Gary C.S.; Steven B.B.; Philip R.B. and Philippa H.F. (2014) Larsen's Human Embryology (5th edition) Elsevier.
- Gilbert, S.F. (2016) Developmental Biology (11th edition) Sina Cells into organs: 2<sup>n</sup> edition the forces that shape the embryo John Phillip Trinkaus. Tom Aloisi
- Principles of development: Lewis Wolpert et al 1998. Oxford Univ. Press
- Foundations of embryology ; B.M Pattern & B.M. Carlson, Tata Mc Ciraw Hill Publications, New Delhi
- An introduction to embryology: Balinsky 1981 5<sup>th</sup> ed. (CBS College publishing)
- Embryonic and foetal development Cambridge Univ press. By Austin and Short 1982, 1992 2<sup>nd</sup> Ed.
- Marshall physiology of reproduction: Longmont Green and Co. London Voll and 2, lamming 1984, 2000
- Developmental biology; Gudrick
- Endocrinology: Hadley
- Endocrinology: Negi

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**M. Sc. ZOOLOGY SECOND SEMESTER (January- June, 2025)**

**PAPER-IV**

**Quantitative Biology and Computer Application**

**Course Code ZOO240**

**Course Objective**

The course is aimed at introducing the application of statistics and basic computer in biology. It provides foundation on statistical methods to enable students to compute and interpret basic statistical parameters. As an interdisciplinary field it integrates biology, computer science, and statistics together sequence analysis structure analysis and functional analysis of biological data.

**UNIT-I**

- Introduction to digital computer and application.
- Basic knowledge of hardware and software
- CPU (Central Processing Unit)
- Input and Output devices
- Auxiliary storage system
- Operating system and Binary numbering system

**UNIT-II**

- Computer application Introduction to MS office, Word, Excel, PowerPoint
- Computer application in Biostatistics
- Simple computation and elemental knowledge of flow chart

**UNIT-III**

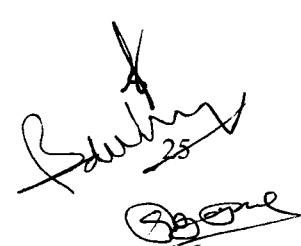
- Types of biological data
- Representation of data
- Sample and sampling
- Measures of central tendency
- Measures of dispersion

**UNIT-IV**

- Chi-square test
- Student's t-test
- Analysis of Variance
- Simple linear regression
- Correlation
- Probability distribution: nominal and binomial

**Learning outcomes**

- After successfully completing this course, the students will be able to:
- Know the theory behind fundamental biostatistics analysis methods.
- Be familiar with widely used databases.



### Skill Development/Employability

- Know basic concepts of probability and statistics.
- Describe statistical methods and probability distributions relevant for molecular biology data. Know the applications and limitations of different bioinformatics and statistical methods.

### SUGGESTED READING MATERIALS

Bataschielet. E. Introduction to inatlielnatics for site scientist springer-verlag, berl ing  
-Lenderen D. Modelling in behavioral ecology. Chapman & Hall Lolidoii U.K.

• Snedecor, G.W. and W.G. cochran, statical methods, Affi1 ited East,  
West Press New Delhi (Indian ed.)

• Muray , J.D. Methamatical B iology, Springer Verlag Berlin

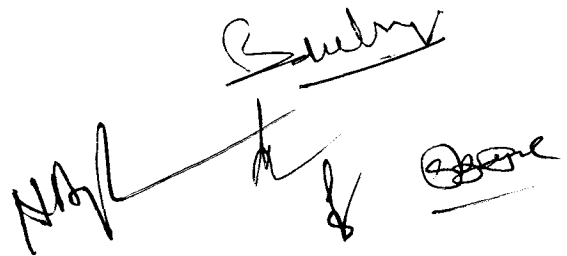
• Pelon, E.C. The interpretation of ecological data : A promer on c  
lassificatioti and ordination.

A. lewis . B iostatics

• B.K. Mahajan Methods in B iostatics

• J. D. M urrey Mathematical Biology

• Georgs & Wilians Startical method



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**M. Sc. ZOOLOGY SEMESTER- II**  
**LAB COURSE – I (PRACTICAL BASED ON PAPER I & II)**  
**Course Code ZOO250**

**I. Molecular biology and Biotechnology**

- Isolation of DNA/RNA
- Study of mitochondria from buccal epithelium by staining with supravital stains.
- Culture of amoeba, paramecium, euglena.
- Study of cell division mitosis/meiosis by squash and smear preparation of root tip and cockroach/grasshopper testis.
- Study of giant chromosome in the salivary gland of Chironomous larvae or Drosophila. .
- Study of Barr body and human chromosome.
- Culture and study of drosophila.
- Preparation of culture media and culture of bacteria.
- Other exercise related to theory paper.

**II. General physiology and endocrinology**

- Estimation of RBC, hemoglobin, hematocrit/PVC, blood group and Rh factor blood clotting time.
- Determine the blood pressure of man.
- Determination of urea, glucose and ketone bodies in urine.
- Demonstration of osmosis.
- Dissection and exposure of major endocrine glands in an experimental animal.
- Study of histology of endocrine glands in different animal types through permanent slides and microtomy.
- Other exercise related to theory paper.

**Examination Scheme**

Based on Paper I	30 Marks
Based on Paper II	30 Marks
Viva	10 Marks
Sessional(Internal)	30 Marks
<b>Total</b>	<b>100 Marks</b>



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**M. Sc. ZOOLOGY SEMESTER – II**  
**LAB COURSE-II (PRACTICAL BASED ON PAPER III & IV)**  
**Course Code ZOO260**

**III. Human Reproductive Physiology**

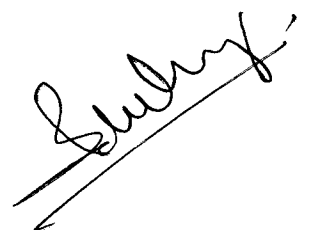
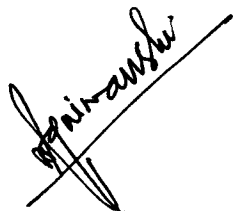
- Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems;
- Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
- Sperm count and sperm motility in rat
- Study of modern contraceptive devices
- Other exercises related to theory paper.

**IV. Quantitative biology and computer application**

- Preparation of frequency tables and graphs.
- Calculation of standard deviation, variance and standard error of mean.
- Calculation of probability and significance between means using t-test, Chi-square test, ANOVA
- Calculation of correlation, regression and probability distribution.
- Computer software use for computational tasks, data presentation, design task and communication
- Other exercises related to theory paper.

**Examination Scheme**

Based on Paper III	30 Marks
Based on Paper IV	30 Marks
Viva	10 Marks
Sessional(Internal)	30 Marks
<b>Total</b>	<b>100 Marks</b>



**M. Sc. ZOOLOGY THIRD SEMESTER (July-December, 2025)**

**PAPER — I**

**Comparative Anatomy of Vertebrates**

**Course Code ZOO310**

**Course objective**

The objective of this course is to develop a proper understanding of evolution and structure of the vertebrates.

**Theory**

**UNIT-I**

- Origin of Chordates
- Amphibians, Reptiles, Birds and Mammals.
- Classification of Vertebrates
- Amphibians
- Reptiles
- Birds
- Mammals.

**UNIT-II**

- Vertebrate integument and its derivatives.
- General structure and functions of Integument.
- Structure and functions of glands, scales, horns, claws, nails, hoof, feather and hair.
- Comparative account of (i) Jaw suspensorium, (ii) Limbs and Girdles.

**UNIT-III**

- Respiration in Vertebrates.
- Comparative account of respiratory organs (structure and functions).
- Circulation in Vertebrates.
- Structure and function of blood.
- Evolution of heart.
- Evolution of aortic arches.

**UNIT-IV**

- Evolution And Comparative account of Urinogenital system
- Nervous system-
- Comparative account of the brain in relation to its function
- Comparative anatomy of spinal cord
- comparison of cranial nerves.

### Learning Outcomes

- Students recognize vertebrate structural principles by studying all body systems of vertebrates in an evolutionary perspective.

### Skill Development/Employability

- Compare and contrast the anatomical systems of different vertebrates and identify common traits across species and groups.

### SUGGESTED READING MATERIALS - (ALL LATEST EDITION)

- **Vertebrate life** :— William N. Ferland, F. Harvey pough, Tom J Gode, John B. Heiser
- Collier MacNille International edition
- **Chordate morphology** :—Malcom Jollie
- Reinhold Publishing Corporation NewYork
- **Chordate —Structure & Function** :- Arnold G. Khage, B.E. Fry Johanson
- Mc Millan Publishing Co. INC. NewYork
- **Comparative Animal Physiology** :- Orosser
- Satish Book Enterprises, Agra
- **The Vertebrate Body** :- Alfred Sherwood Romer
- Vakils, Feffer & Simons Publications Ltd.

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**M. Sc. ZOOLOGY Third SEMESTER (July-December, 2025)**

**PAPER — II  
Animal behavior**

**Course Code ZOO320**

**Course outcomes**

To gain a comprehensive understanding of the behavior of animals.

**UNIT- I**

- Historical perspectives- Ethology
- Behavioural patterns
- Innate behaviour
  
- Biological rhythms
- Types of biological rhythm
- Biological clock

**UNIT- II**

- Communications – Auditory, Visual, Chemical
- Learning and Memory -Conditioning, Habituation, Reasoning
- Reproductive behaviour.

**UNIT-III**

- Orientation
- Echolocation in bats
- Bird migration and navigation.
- Fish migration.
- Neural and hormonal control of behaviour

**UNIT-IV**

- Hormonal effect on behavioural patterns.
- Social behaviour
- Social organization in insects and primates
- Schooling in fishes and Flocking in birds
- Homing, territoriality, dispersal
- Altruism
- Host-parasite relation

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## Learning Outcomes

- Understand types of animal behaviour and their importance to the organisms.
- Enhance their observation, analysis, interpretation and documentation skills by taking short projects pertaining to Animal behaviour and chronobiology.
- Relate animal behaviour with other subjects such as Animal biodiversity, Evolutionary biology, Ecology, Conservation biology and Genetic basis of the behaviour.
- Understand various process of chronobiology in their daily life such as jet lag.
- Learn about the biological rhythm and their application in pharmacology and modern medicine.

## Skill Development/Employability

- Realize, appreciate, and develop passion to biodiversity; and will respect the nature and environment.

## SUGGESTED READING MATERIALS - (ALL LATEST EDITION)

- **ANIMAL BEHAVIOR – Mc Farland** (English Language Book Society)
- **ANIMAL BEHAVIOR – Arora M.P.** (Himalaya Publishing House, Mumbai)
- **ANIMAL BEHAVIOR - Reena Mathur** (Rastogi Publications, Meerut)

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**M. Sc. ZOOLOGY THIRD SEMESTER (July-December, 2025)**

**PAPER — III**

**Immunology**

**Course Code ZOO330**

**Course Objective**

This course aims to provide students with an understanding of the immune system and its components, the defense mechanisms that can establish a state of immunity against infection, and Immune-related diseases.

**UNIT-I**

- Cells of immune system -  
B-Lymphocytes, T-lymphocytes, Null Cells , Mononuclear cells  
Granulocytic cells ,(Neutrophils, Eosinophils and Basophils) ,Mast cells  
Dendritic cells
- Organs of immune system  
Primary lymphoid organs -(Thymus, bone marrow) .  
Secondary lymphoid organs- (Lymph nodes, spleen, mucosal  
associated lymphoid tissue, cutaneous associated lymphoid tissue)

**UNIT-II**

- Immunoglobulin structure and function
- Molecular structure of Immunoglobulin
- Types of Immunoglobulin-IgM,IgG,IgD,IgE
- Monoclonal antibodies

**UNIT-III**

- Antigens -
- Immunogenicity
  - Contribution of the immunogens.
  - Contribution of Biological system.  
Antigen - Antibody Interaction -Precipitation Reaction  
Antibody affinity and activity ,Cross reactivity ,Agglutination reactions
  - Vaccine
  - Active and passive immunization
  - Whole organism vaccine
  - Recombinant vector vaccines
  - DNA vaccines

**UNIT-IV**

- Ageing and immune factor
- Immuno tolerance.
- Hypersensitivity and its types.
- Immune system in Health disease
- Immune response to infectious disease
- Immune response in cancer
- AIDS

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## Learning Outcomes

- After going through this unit student shall be able to: .
- The students will be able to identify the cellular and molecular basis of immune responsiveness will be able to describe the roles of the immune system in both maintaining health and contributing to
- Describe surface membrane barriers and their protective functions.
- Explain the importance of phagocytosis and natural killer cells in innate body defense.
- Describe the roles of different types of T cells, B cells and APCs.
- Compare and contrast the origin, maturation process, and general function of B and T lymphocytes.

## Skill Development/Employability

- Trace the history and development of immunology.

## SUGGESTED READING MATERIALS

- **Immunology** Kuby, W.H. Froeman USA
- **Fundamental of Immunology** W. Paul,
- **Essential Immunology** I.M. Roitt, ELBs Edition
- **Immunology** Richard M. Hyde, Robert A. Patnode, A Wiley Medical Publications
- **Reproductive Physiology** Gayton,

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**M. Sc. ZOOLOGY THIRD SEMESTER (July-December, 2025)**

**PAPER — IV**

**Environmental Physiology and Population Ecology**

**Course Code ZOO340**

**Course objective**

Students will be able to: define population and explain the relationship between species and populations, Basic concepts of environmental stress Levels and Mechanisms of adaptation

**UNIT – I**

- Population dynamics-
- Demography, life table, reproductive rates, reproductive values
- Population growth, exponential, non-overlapping .
- Stochastic and time lag models of population growth
- Population density
- Population evolution
- Community dynamics: Characteristics, development, and classification

**UNIT-II**

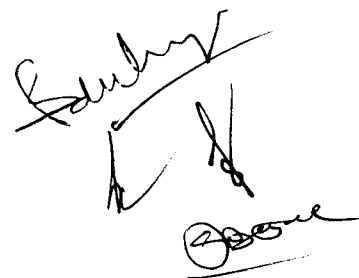
- Adaptations
- Levels of adaptation.
- Mechanisms of adaptation.
- Adaptations to different environments. Marine, shores and estuaries.
- Freshwater. Terrestrial Life

**UNIT-III**

- Stress Physiology
- Basic concepts of environmental stress and strain, Concept of elastic and plastic strain.
- Stress avoidance, stress tolerance and stress resistance.
- Acclimatization, acclimation and adaptation.
- Endothermic and physiological mechanism of regulation of body temperature

**UNIT -IV**

- Stress physiology in different conditions
- Osmoregulation in aqueous and terrestrial habitats.
- Physiological response to oxygen deficient stress.
- Physiological response to body exercise.
- Effect of meditation and yoga

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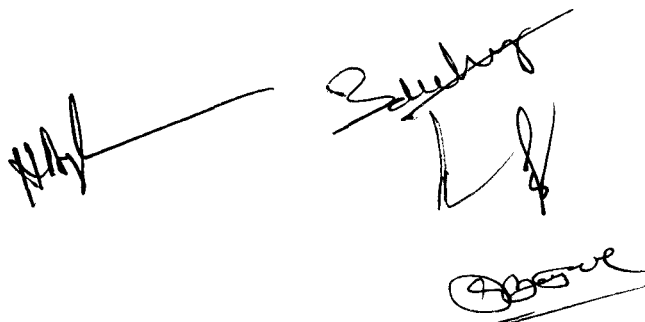
- The goal of this course is to familiarize you with ecological theory and its applications.
- To gain an understanding of the broad biological significance of ecological theory.
- To develop your ability to apply quantitative skills to analyze and interpret ecological data.

### **Skill Development/Employability**

- To gain an understanding of the questions that ecologists study, the methods they use, and the questions that remain unanswered.

### **SUGGESTED READING MATERIALS - (ALL LATEST EDITION)**

- **ECOLOGY** with special reference to animal & man
- **S. Charles, Kendeigh** Prentice hall of India Pvt. Ltd. New Delhi
- **ELEMENTS OF TROPICAL ECOLOGY**
- **Yanney Ewusie** (English language Book Society, Heine mann educational book publication)
- **FUNDAMENTALS OF ECOLOGY**
- **Odum P.**
- **ANIMAL PHYSIOLOGY, MECHANISM AND ADAPTATION -**
- **Eckert, R., W,H, Freeman and Co.**
- **BIOCHEMICAL ADAPTATION -**
- **Hochachka, P.W, and Somero S.N, Princeton, New Jersey**

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M. Sc. ZOOLOGY THIRD SEMESTER (July — December 2025)  
LAB COUSE-I

Course Code ZOO350  
(PRACTICAL BASED ON PAPER I & II)

**Comparative anatomy of Vertebrates**

- Identification, classification, and study of distinguishing features of important representatives, museum specimens and slides (Protochordates and Chordates)
- Comparative studies of integumentary, skeleton, and reproductive system of major vertebrate classes.
- Dissections: fowl/snake cranial nerves
- Wonder vertebrates
- Other exercise related to theory paper.

**II. Animal Behavior**

- To study the phototactic response in earthworm or grain/pulse pest.
- To study the food preference and cleaning behaviour of housefly.
- To study the food preference in tribolium or grain/pulse pests.
- To study the web construction and habituation in spider.
- Estimation of body temperature and pulse rate on daily time scale.
- Estimate the time perception among various individuals at two different time points on daily time scale.
- Determination of effect of time on schooling behaviour in fish
- Other exercise related to theory paper

**Examination Scheme**

Based on Paper I	30 Marks
Based on Paper II	30 Marks
Viva	10 Marks
Sessional(Internal)	30 Marks
<b>Total</b>	<b>100 Marks</b>

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**M. Sc. ZOOLOGY THIRD SEMESTER (July — December 2025)**  
**LAB COUSE-II**  
**Course Code ZOO360**  
**(PRACTICAL BASED ON PAPER III & IV)**

**III. Immunology**


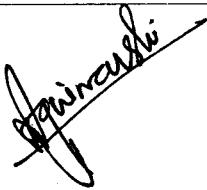
- Dissection of primary and secondary immune organs from fish/fowl- Preparation and study of cell suspension from spleen (spleenocytes) of Fish / fowl.
- Total and differential counting of leucocytes.
- Protein estimation by Lowry's method in normal and infected blood sample.
- Determination of Blood group.
- Study of permanent slides (for spotting); thymus, lymph nodes, spleen, bone marrow, types of cells of various types, adipose tissue, mitotic and meiotic chromosomes, and their different phases cancer cells of various types etc.
  - Study of parasites in fish
  - Study of various parasites through slides and specimen.
  - Other exercises related to theory paper.

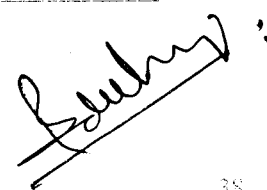
**IV. Environmental Biology and Population ecology**

- Study of biotic community in a pond/grassland ecosystem.
- Study of population growth rate (curve) in protozoan culture.
- Population dynamics of *Tribolium* sp.
- Study of biogeochemical cycles by way of models Visit to some natural habitats and manmade habitats to study the human impact on environment.
- Water analysis for fresh and waste water (Dissolve oxygen and chloride).
- Other exercises related to theory paper.

**Examination Scheme**

Based on Paper III	30 Marks
Based on Paper IV	30 Marks
Viva	10 Marks
Sessional(Internal)	30 Marks
<b>Total</b>	<b>100 Marks</b>



**M. Sc. ZOOLOGY FOURTH SEMESTER — IV (January - June, 2026)**

**PAPER— I  
(Compulsory)**

**Course Code ZOO410**

**BIOCHEMISTRY**

The course introduces the structure of bio molecules with emphasis on the techniques used for structure determination and analysis.

**UNIT-I**

- Properties of Proteins
- Structure and properties of amino acids.
- Classification of proteins.
- Structure of proteins.
- Biological Functions of Proteins.
- Protein Metabolism.

**UNIT-II**

- Carbohydrates
- Classification of carbohydrates.
- Structure and Functions of Carbohydrates.
- Carbohydrate metabolism.
- Lipid
- Lipid structure and functions
- Lipid metabolism.

**UNIT-III**

- Vitamins
- Water and Fat soluble vitamins,
- Chemistry, occurrence and physiological role.
- Enzymes- Classification and nomenclature Regulation of Enzyme, Activity and Function of coenzyme.

**UNIT-IV**

- Nucleic acid
- Chemistry of DNA.
- Chemistry of RNA.
- Biological importance of nucleic acids.
- Nucleoproteins.

Metabolism of nucleic acids

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### Learning Outcomes

- After successfully completing this course, the students will be able to:
- Understand about the importance and scope of biochemistry.
- Understand the structure and biological significance of carbohydrates, amino acids, proteins, lipids and nucleic acids.
- Understand the concept of enzyme, its mechanism of action and regulation.

### Skill Development/Employability

- Understand in detail about amino acid structures, types of amino acids, classifications, structure of proteins and types of proteins.

### Suggested Reading

- **Lehninger Principles of Biochemistry, Fourth Edition**
- David L. Nelson, Michael M. Cox Publisher: W. H. Freeman
- **Biochemistry** Donald Voet, Hardcover: 1616 pages, Publisher: Wiley; 3 edition
- **Principles of Biochemistry With a Human Focus** Reginald H. Garrett, Charles M. Grisham Publisher: Brooks Cole
- **The Molecular Basis of Cell Cycle and Growth Control** Gary S. Stein (Editor), Renato Baserga, Antonio Giordano, David T. Denhardt, Publisher: Wiley-Liss
- **Experiments in Biochemistry: A Hands-On Approach** Shawn O. Farrell, Ryan T. Ran

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**M. Sc. ZOOLOGY SEMESTER — IV (January - June, 2026)**

**PAPER II (Compulsory)**

**NEURO PHYSIOLOGY**

**Course Code ZOO420**

**Course Objective**

To gain an understanding of the principles of neurophysiology by using molecular, synaptic and cellular processes to explain brain function

**UNIT - I**

- Physiological role of neurosecretory cells
- Histological structure of neurons and neuroglial cells
- Physiological properties of neural fibres
- Synapsis and synaptical transmission
- Myoneural junction and neuromuscular transmission
- Degeneration and regeneration of nerve fibre

**UNIT - II**

- Nerve fibre, peripheral nerves, receptors and effector endings, dermatomes and muscle activity
- The spinal cord and the ascending and descending tracts
- The cranial and spinal nerves

**UNIT - III**

- The fore brain, brain stem, the cerebellum
- The meninges and cerebrospinal fluid
- Peripheral nervous system

**UNIT - IV**

- Autonomic nervous system; sympathetic and para-sympathetic nervous system with special comparison to hormonal mechanism of transmission through autonomic nervous system
- Reflex action; varieties, characteristics, unconditional reflex, electrophysiology of spinal reflexes
- Sensation
- Electro encephalography and its physiological basis.

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### **Learning Outcomes**

- After successfully completing this course, the students will be able to:
- Understand the structure of brain and improved methods to study it.
- Understand the structure of different lobes of the brain and their corresponding functions.

### **Skill Development/Employability**

- Understand intricacies of nerve impulse conduction.

### **Suggested Reading**

- The Brain: Our Nervous System by Seymour Simon
- Mass Action in the Nervous System by Walter J. Freeman
- Human Anatomy and Physiology with Interactive Physiology 10-System Suite, 8th Edition by Elaine N. Marieb and Katja N. Hoehn (Jan 10, 2010)
- Neuroanatomy by H.G.Snell
- Clinical Neurophysiology-Guide for Authors - Elsevier
- Foundations of Cellular Neurophysiology (Bradford Books): Daniel Johnston

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**M.Sc. ZOOLOGY SEMESTER – IV (January - June, 2026)**

**Optional papers**

The following optional papers are being suggested as below

**OPTIONAL (SPECIAL PAPER) GROUP 1**

- A. Fish (Ichthyology) structure and function
- B. Cell Biology
- C. Entomology
- D. Wild life conservation
- E. Biology of vertebrate immune system

**OPTIONAL (SPECIAL PAPER) GROUP 2**

- A. Pisci culture and economic importance of fishes (Ichthyology)
- B. Cellular organization and molecular organization
- C. Applied entomology
- D. Environment and Biodiversity conservation
- E. Molecular endocrinology and reproductive technology

**\*\* Student has choice to opt for one paper each (special paper) from group 1 and group 2**

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**M. Sc. Zoology Semester-IV (January - June, 2026)**  
**Paper- III A Optional paper)**  
**Ichthyology (Fish) Structure and Function**

**Course Code ZOO431**

**Course outcomes**

To provide students with an interactive learning environment whereby critical thinking is developed and knowledge is acquired on various aspects of fish anatomy, function, biology and academic writing.

**UNIT-I**

- Origin and evolution of fishes
- Classification of fishes as proposed by Berg
- Fish integument
- Locomotion
- Alimentary canal and digestion

**UNIT-II**

- Accessory respiratory organs
- Air bladder and its functions
- Weberian ossicles their homologies and functions
- Excretion and osmoregulation
- Acoustico-lateral line system

**UNIT-III**

- Luminous organs
- Colouration in fishes
- Sound producing organs
- Deep sea adaptations
- Hill stream adaptations

**UNIT-IV**

- migration in fishes
- Sexual cycle and fecundity
- parental care in fishes
- Early development and hatching
- Poisonous and venomous fishes.

**Learning out comes**

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- Improve your knowledge on the basic physiological, ecological and behavioural adaptations of fishes to life in water,
- Understand the ecological importance of different life history and reproductive strategies

### **Skill Development/Employability**

- Enhance your familiarity with taxonomic diversity of fishes

### **Suggested reading materials**

1. Zingron-Fish and fisheries in India
2. Gavelander-Fish biology
3. KarkLegler-Fresh water fisheries
4. Nikolaski-Fish biology
5. Identification of fishes-Days fauna
6. Khanna-Introduction to fish
7. Parihar-Fish biology
8. Norman-Introduction to fishes
9. Mishra-Identification of fishes in India



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**M. Sc. Zoology Semester-IV (January - June, 2026)**

**Paper III B**

**Cell Biology**

**Course Code ZOO432**

**Course objectives**

Explain the role of compartmentalization and signaling in cellular biology;  
Evaluate and apply knowledge of modern techniques in cellular biology

**UNIT-I**

- Molecular organization of eukaryotic chromosomes: structure of nucleosome particles and higher order composition of mitotic chromosomes, chromatin remodeling
- specialized chromosomes: structural organization and functional significance of polytene chromosomes
- DNA methylation and DNA Aase-1 Hypersensitivity in relation to gene activity and chromatin organization.
- specialized chromosomes II: structural organization and functional significance of lamp brush chromosome.
- Organization and significance of heterochromatin.

**UNIT-II**

- Structural organization of Eukaryotic genes, interrupted genes and overlapping genes and their evolution
- Gene families: organization, evolution, and significance
- Transposable genetic elements of prokaryotes and eukaryotes Gene imitation
- and molecular mechanism of occurrence of mutation repair mechanism
- Organization of eukaryotic transcriptional machinery promoter enhancers transcription factors polymerase activators and repressors.
- DNA binding domains of transcription apparatus zinc finger steroid receptors hemeo domains HILIX-loop, Helix, and Leucine Zipper.

**UNIT-III**

- Eukaryotic transcription of Eukaryotic transcriptional control.
- Environmental modulation of gene activity (stress response) stress genes and stress proteins
- Molecular basis of thalasemias muscular dystrophy cystic fibrosis
- DNA rearrangement
- Amplification during development with special response to
- Ciliates
- Chlorine gene
- 58 RNA genes

**UNIT-IV**

- Drosophila development
- Cleavage
- Gastrulation

Origin of Anterior —Posterior (Maternal effect genes and segmentation genes)

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- Drosophila development II origin of dorsal ventral polarity
- Basic idea of homeotic selector genes and homeotic mutation
- Basic idea of organization of homeoboxes
- Evolutionary significance of homeoboxes

### Learning Outcomes

- Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
- Students will understand how these cellular components are used to generate and utilize energy in cells
- Students will understand the cellular components underlying mitotic cell division.

### Skill Development/Employability

- Students will apply their knowledge of cell biology to selected examples of changes in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

### Suggested Reading Materials:

- Robertis, De and Robertis Cell and molecular biology Lea and Febiger.
- Watson Hopkins Roberts Steitz Weiner. Molecular Biology of the Gene the Benjamin, Cummings Publishing Company, inc.
- Bruce Alberts; Bruce Bray; Jeffery Raff; Robert Watson Molecular Biology of the Cell, Garland Publishing inc.
- Watson Gilman Witkowski Zoller Recombinant DNA Scientific American Books.
- Karp Gerald Cell Biology.
- Lewin B., Genes VII.
- King Cell Biology.
- Kaniel L. Hartl. Elizabeth W. Jones. Genetics Principles and Analysis. Jones and Bartlett Publishers.
- Kuby. Immunology. W.H. Freeman and Company.
- Roitt Male Snustad immunology.

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**M.Sc. Zoology Semester-IV (January - June, 2026)**

**Paper- III C (Optional)**

**Entomology**

**Course Code ZOO433**

**Course objective**

Understanding the history of insect taxonomy and the bases of modern taxonomy.

Compare and assess the concepts and principles behind scientific theories regarding the significance of the specific structure in the insect body.

**UNIT-I**

- Insect head types and modification as per their habit and habitat
- Modification of mouth parts and feeding behaviour
- Structure types and function of antennae
- Hypothetical wing venation
- Structure of cuticle and pigment

**UNIT-II**

- Sclerotisation and tanning of the cuticle
- Structure of alimentary canal and Physiology of digestion
- Malpighian tubules — anatomical organization, Transport mechanism
- Structure of circulatory system
- Cellular elements in the haemolymph

**UNIT-III**

- Cell mediated and humoral immunity
- Structure of compound eye and Physiology of Vision
- Sound Production in insect
- Structure and function of endocrine glands

**UNIT-IV**

- Embryonic development up to the formation of blastoderm
- Metamorphosis
- Insecticide effects on CNS
- Important pest of soybean Modern concept of pest management

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## Learning outcomes

- After completing this course student should be able to:
- Understand the principles of the human – insect relationship.
- Demonstrate the link the basic morphological characteristic of insects including the integument and its components.
- Describe the structure and function of various organs.
- Demonstrate the internal anatomy of insects.

## Skill Development/Employability

- Develop the ability to design and perform a scientific study on insects, and to analyze results.

## Suggested Reading Materials:

- The Insect: Structure and function by R.F. Chapman
- Comparative Insect physiology, Biochemistry and Pharmacology .Vol :1-13. Edited by G.A. Kerkut and L.I. Gilbert.
- Entomophagous Insect by Clausen
- Entomology by Gilbert
- Principles of Insect Physiology by Wigglesworth.
- Fundamentals of Entomology by Elzinga
- Hand book of economic Entomology for South India by Ayyar.
- Insect cytogenetics by R.E.F.Symposium.
- Insects and plants by Sting, Lawton and southwood.
- Insect and hygiene by Busvine.
- Insect Physiology by Wigglesworth.
- Insect morphology by Mat Calf and Flint
- Applied Agricultural Entomology by Dr. Lalit Kumar Jha

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**M. Sc. Zoology Semester-IV (January - June, 2026)**

**Paper- III D (Optional)**

**Wild Life Conservation**

**Course Code ZOO434**

**Course objectives**

It provides understanding and knowledge on modern concepts in wildlife management, also provide an insight into relevant conservation policies and legislation and their enforcement mechanism at Global and Local Level.

**UNIT-I**

- Wild life -Values of wild life - positive and negative.
- Our conservation ethics.
- Importance of conservation.
- Causes of depletion.
- World conservation strategies.
- Habitat analysis, Evaluation and management of wild life.
- Physical parameters - Topography, Geology, Soil and water.
- Biological Parameters - food, cover, forage, browse and cover estimation.
- Standard evaluation procedures - remote sensing and GIS.
- Management of habitats -
- Setting back succession.
- Theories behind Cave Adaptations of Animals
- Cave Organisms identified from Chhattisgarh and their notable troglomorphism
- Energy sources in caves
- Prey-predator relationship in the cave.

**UNIT-II**

- Population estimation.
- Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation.
- Fecal analysis of ungulates and carnivores - Fecal samples, slide preparation, Hair identification, Pug marks and census method.
- National Organization.
- Indian board of wild life.
- Bombay Natural History Society.
- Voluntary organization involved in wild life conservation.
- Wild life Legislation - Wild Protection act - 1972, its amendments and implementation.
  - Management planning of wild life in protected areas.

Cave biology: Define caves and their typical characteristics

- Origin of Biospeleology
- Classification of Cave Animals
- Trglomorphism



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India vol. the report. wild life Institute of India Dehradun.

- Odum E.P: Fundamentals of Ecology
- Saharia V.B: Wild life in India
- Tim ari S.K: Wild life in Central India
- E.P Gee: Wild life of India
- Negi S.S: Wild life conservation (Natraj Publishers
- Arora : Fundamentals of environmental biology
- Anathakrishnan : Bioresources ecology
- Bottain : Environmental studies
- Bouhey : Ecology of populations
- Clark : Elements of ecology
- Dowdoswell : An introduction to animal ecology
- Goldman : Limnology
- Kormondy : Concepts of ecology
- May : Model ecosystems
- Odum : Ecology
- Perkins : Ecology
- Simmons : Ecology of estuaries and costal water
- Pawlosuske : Physico-chemical methods for water
- South Woods : Ecological methods
- Trivedi and Goel : Chemical and biological methods for water  
pollution studies
- Willington : Fresh water biology
- Wetzal : Limnology
- Welch : Limnology Vols. I-II
- Cave Science Insights from the Indian Subcontinent

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**M. Sc. Zoology Semester-IV (January - June, 2026)**  
**Paper- III E(Optional)**  
**Biology of vertebrate immune system**  
**Course Code ZOO435**

**Course Objective**

In this course, the students will be introduced to the basic concepts of immunology as it relates to human and animal health.

**UNIT-I**

- Tissues of Immune system- Primary lymphoid organs, structure and functions (Thymus and Bursa of Fabricius)
- tissues of Immune system- Secondary lymphoid organs, structure and functions (Spleen, lymphnode and Payers patches)
- Antigen processing
- Antigen presentation

**UNIT-II**

- T-cell lineage and receptors
- T-cell activation
- B-cell lineage and receptors
- B-cell activation
- Immunoglobulin structure, Biological and physical properties of immunoglobulin
- Gene model for Immunoglobulin gene structure

**UNIT-III**

- Generation of antibody diversity (Light and heavy chain)
- Immunization
- Immediate type of hypersensitivity reaction of Anaphylectic type-1.
- Antibody dependent cytotoxic type II reaction.
- Complex mediated type III reaction

**UNIT-IV**

- Delayed type cell mediated hypersensitivity type IV reaction.
- Enzyme linked immunosorbent assay (ELISA) technique and its applications.
- Immunofluorescence technique (Direct & Indirect and Sandwich antibody labelling techniques.
- Immunodiffusion techniques ( Mancini and oucheterlony immunodiffusion techniques) Monoclonal antibody technology (Hybridoma technology)

## Learning Outcomes

At the end of the course the student will be able:

- To gain a deep knowledge about the features and mechanisms of innate and adaptive immune response;
- To describes the mechanisms involved in acute and chronic inflammation;
- To apply the acquired knowledge on the immune response to explain defense mechanisms against infectious agents.

## Skill Development/Employability

- To apply the acquired knowledge on the immune response to explain the mechanisms involved in immune system alterations and to comprehend the function of vaccines and immunotherapy;

## Suggested Reading Materials

- **Immunology Kuby, W.H. Froeman USA**
- **Fundamental of Immunology W. Paul,**
- **Essential Immunology I.M. Roitt, ELBs Edition**
- **Immunology Richard M. Hyde, Robert A. Patnode, A Wiley Medical Publications**

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**M.Sc. Zoology Semester-IV (January - June, 2026)**

**Paper- III F (Optional)**

**Ornithology (Avian Biology)**

**Course Code ZOO436**

**Course objectives**

Students will be exposed to the diversity of bird life on Earth and to the myriad ways birds are adapted to fly and survive in all reaches of the planet.

**Unit – I**

Introduction to Ornithology

- Evolution of Birds
- Biogeography; Micro & Macro-ecology;
- Bird taxonomy: Systematic position of bird.
- Avian Diversity and Classification
- Speciation & Affinities of birds

**Unit – II**

Morphology of birds

- Stream lined body,
- Scales and Feathers,
- Coloration in birds,
- Beak types.
- Wings and Bipedal Locomotion

**Unit – III**

Anatomy and modification in Birds

- Alimentary canal and its modifications - Beak, Gizzard, Crop, etc.
- Excretory system,
- Reproductive system,
- Skeleton and muscles,

**Unit – IV**

Physiology

- Respiration in birds
- Excretion and osmoregulation.
- Flight and muscle's function
- Neuroendocrine control of flight,

**Learning Out comes**

- By the end of this course, students will:
- appreciate the diversity of birds of the world and understand how birds are classified;
- learn how birds evolved and are still evolving;
- recognize some of the ways that birds are physically adapted to fly, communicate, find food, and attract mates;

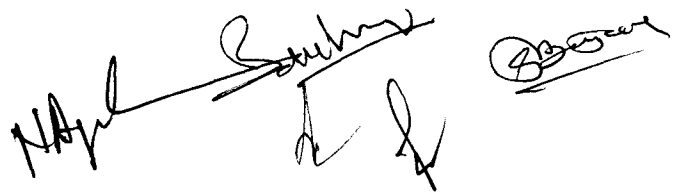
**Skill Development/Employability**

- understand the role of birds in the world and how they interact with humans.

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### Suggested Reading Materials

- **Hellum Field Guide Birds of Indian Subcontinent.** Richard Grimmet, Carol Inskipp, Tim Inskipp, Bloomsbury Publishing London, Bloomsbury Publishing India Pvt Ltd, New Delhi
- **Avian Evolution: The Fossil Record of Birds and Its Paleobiological Significance** – Gerald Mayr
- **The origin and Evolution of Birds** – Alan Feduccia
- **How Birds Evolve: What Science Reveals About Their Origin, Lives, and Diversity** – Douglas J. Futuyma
- **Avian Anatomy 2<sup>ND</sup> Edition Textbook and Color Atlas** – Horst E King and R Diger Korbel and Hans Georg Liebich
- **Bird Behavior** – Bill Oddie
- **Birds: A Complete Guide to Their Biology and Behavior** – Jonathan Elphick

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**M. Sc. Zoology Semester-IV (January - June, 2026)**  
**Paper- IV A Optional**  
**Pisciculture and Economic Importance of Fishes (Ichthyology)**  
**Course Code ZOO441**

**Course objective**

The students will gain knowledge of fish culture and cultivable species, rotational and simultaneous culture. Sewage fed fisheries, culture air breathing fishes. The students will gain knowledge farm Management.

**UNIT-I**

- Collection of fish seed from natural resources and transportation of fish seed.
- Breeding in fish, Bundh breeding and Induced breeding.
- Types of ponds required for fresh water fish culture farms.
- Management of fish farm.
- Physiochemical factors of freshwater for fish farming.

**UNIT-II**

- Composite fish culture
- Prawn culture and pearl industries in India.
- Fisheries resources of C.G
- .REverine fisheries

**UNIT-III**

- Costal fisheries in India
- Offshore and deep sea fishery's in India
- Role of fisheries in rural development
- Sewage fed fisheries

**UNIT-IV**

- Methods of fish preservation
- Marketing of fish in India.
- Economic importance and by product of fishes
- Fish disease.

**Learning outcomes**

- Acquire knowledge on best culture practices
- Demonstrate the different breeding techniques;
- explain growth promoters and live feed significance
- Describe the various culture methods and water quality maintenance in shrimp farming
- Analyze feeding, disease diagnosis in fish culture and Analyze water quality parameters
- Discuss various method of culture of live feed organisms
- Examine and estimate primary productivity



### Skill Development/Employability

- Apply knowledge to enhance production of breeding ponds and hatcheries and methods of treatments
- Apply the knowledge on harvesting, preservation and export through agencies

### Suggested Reading Materials:

Paper III A & IV A

- JR. Norman - The History of fishes.
- Nagaraja Rao - An introduction to fisheries.
- Lagler Ichthyology.
- Herclen Jones Fish migration.
- Marshal The life offishes.
- Thomas - Diseases offish.
- Greenwood - Inter relationship of fishes.
- Gopalji, Srivastava - Freshwater fishes of U.P. and Bihar.
- Brown -Physiology of fishes Vol. I & II.
- Hoar and Randall -Fish physiologyof fishes Vol. I & IX.
- Gunther Sterba C.N.H.-Freshwater fishes of theworld
- W. Lanham -The Fishes.
- G.V. Nikolsky -The ecology offishes,
- Borgstram -Fish as food Vol. I & II.
- Nilsson -Fish physiology -Recent Advances.
- P.B. Myle and J.J. Cech Fishes An Introduction to Ichthyology.
- Carl E. Bond -Biology of fishes.
- M. Jobling -Environmental Biology offishes.
- Santosh Kumar & Manju Ternbhre -Fish and Fisheries.
- S.K. Gupta -Fish and Fisheries
- K.P. Vishwas -Fish and Fishries.
- Jhingaran -Fish and Fishries.

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**M. Sc. Zoology Semester-IV (January - June, 2026)**  
**Paper- IV B (Optional)**  
**Cellular and Molecular Organization**  
**Course Code ZOO442**  
**Course objective**

Students gain knowledge about structure and different forms of DNA in the biological systems and to understand Cell at Molecular level.

**UNIT-I**

- General organization and characterizes of viruses (Examples SV 40 and HIV).
- Yeast: Structure, reproduction and chromosome organization: Basic ideas of its applications as vectors for gene cloning.
- Molecular organization of respiratory chain assemblies, ATP/ ADP Translocase and F<sub>0</sub>F<sub>1</sub> ATPase.
- Cell cycle: Cell cycle control in mammalian cells and xenopus.
- Cyto chemistry of Golgi complex and its role in cell secretion.,

**UNIT-II**

- Peroxisomes and training of paroxysmal proteins.
- Nucleolus: Structure and Biogenesis and functions of lysosomes.
- Intracellular digestion: Ultra structure and function of lysosomes.
- Synthesis and targeting of mitochondrial proteins.
- Secretary pathways and translocation of secretary proteins across the EPR membrane.

**UNIT-III**

- Genome complexity: C- value paradox and cot value.
- DNA sequences of different complexity.
- Difference between normal cells and cancer cells.
- Biochemical changes.
- Cytoskeleton changes.
- Cell surface changes.

**UNIT-IV**

- Chromosomal abnormalities in human cancer.
- General idea of oncogenes and proto-oncogenes.
- Oncogene and cancer.
- Transforming Agents.
- Tumor Suppressor genes.

Receptor — Ligand interaction and signal transduction. Cross — talk among various signaling pathways.

## Learning Out comes

As students proceed through the modules, they will be able to apply this knowledge, skill, and awareness to topics like the following:

- The structure and function of the nucleus
- Genes and chromosomes
- DNA replication
- Transcription
- Translation
- Cytoskeleton and cell motility
- Cellular reproduction
- Cell signalling
- Cancer

## Skill Development/Employability

- Students will develop basic knowledge and skills in cell and molecular biology and become aware of the complexity and harmony of the cell

## Suggested Reading Materials:

- DeRobertis and De Robertis Cell and Molecular Biology. Lea and Febiger.
- We Watson Hopking reberts steits, Weiner molecular biology of the gene, the Benjamin / Cummings Publishin Company Inc.
- Bruce alberts, Bray, Lewis, Raff, Roberts, Watson molecular Biology of the cell garland publishing inc.
- P.K. Gupta. Molecular Cell Biology Rastogi Publication.
- Watson Gilman Witkowski, Zoller Recorndinant D.N.A. scientific American Books.
- Gerald Karp. Cell Biology.
- Lewin B. Genes VII.
  
- King Cell Biology.
- Baniel L. HArtl Elizabeth W. Jones. Genetics Principles and analysis . Jones and Bartlett Publisher.
- Lodish, Berk Zipursky, Matsudaira Baltimore Demell Molecular Cell Biology W.H.Freeman and company.
- !. Travers Immunology current Biology limited.
- Kubey Immunology W.H. Freeman and Company.
- Riott. Male snustad Principles of genetics jolui weley and sons Inc.

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**M. Sc. Zoology Semester-IV (January - June, 2026)**

**Paper- IV C (Optional)**

**Applied Entomology  
Course Code ZOO443**

**Course Objective**

To know about the identification of major insect pests of agricultural and urban sectors, their control methods and pesticide application equipment. To know about the importance of entomological cottage industries and other beneficial aspects of insects.

**UNIT-I**

Classification according to imms

- Classification of apterygota upto families.
- Classification of following insect orders  
(a) orthoptera (b) hemiptera (c) diptera.
- Classification of following insect order  
(a) hymenoptera (b) lepidoptera (c) coleoptera
- Collection and preservation of insects.

**UNIT-II**

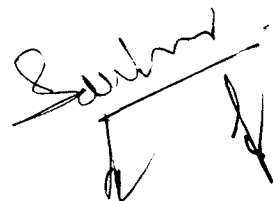
- Insect pest-Management strategies and tools
- Biological control, Genetic control, Chemical control
- Pests of Cotton
- Pests of sugarcane
- Pests of paddy
- Pests of stored food grains
- Pests of citrus fruits and mango
- Pests of pulses
- House hold insect pests

**UNIT-III**

- Insects in relation to forensic science
- Insect migration, population fluctuation and factors
- Insects of medical and veterinary importance
- Ecological factors affecting the population and development of Insects

**UNIT-IV**

- Mulberry and non-mulberry sericulture
- Apiculture
- Lac culture
- Insects as human food for future.



### Learning outcomes

- At the end of the course, the student has learned the basic knowledge of Applied Entomology.
- The student is able to criticize conventional insect pest control and to know integrated pest management.
- Information given to the students it permits to understand how to determine some insect and arthropod species.

### Skill Development/Employability

- A possible sustainable methods and techniques are preferably considered in respect of pest control. This is acquired due to knowledge of general entomology and studies on biological insect cycles, their natural enemies, plus the knowledge of the main insect pest species infesting our agro ecosystems and urban environments.

### Suggested Reading Materials:

- The Insect: Structure and function by R.F. Chapman
- Comparative Insect physiology, Biochemistry and Pharmacology. Vol :1-13.  
Edited by G.A. Kerkut and L.I. Gilbert.
- Entomophagous Insect by Clausen
- Entomology bu Gilbert
- Principles of Insect Physiology by Wigglesworth.
- Fundamentals of Entomology by Elzinga
- Hand book of economic Entomology for South India by Ayyar.
- Insect cytogenetics by R.E.F.Symposium.
- Insects and plants by Sting, Lawton and southwood.
- Insect and hygiene by Busvine.
- Insect Physiology by Wigglesworth.
- Insect morphology by Mat Calf and Flint
- Applied Agricultural Entomology by Dr. Lalit Kumar Jha

N.A.H.

R. S. Chakravarty

Dr. Lalit Kumar Jha

**M. Sc. Zoology Semester-IV (January - June, 2026)**  
**Paper- IV D (Optional)**  
**Environment & Biodiversity Conservation**  
**Course Code ZOO444**

**Course Objective**

- Understanding the basics of science of biodiversity in an ecological context.
- Learning tools and techniques relevant to monitoring of biological diversity.
- Ability to design a field-based project with rationale and appropriate methodology.

**UNIT-I**

- Basic concept of Environmental Biology Scope and Environmental Science
- Biosphere and Biogeochemical cycles.
- Environmental monitoring and impact assessment.
- Environmental and sustainable development.
- Water conservation, rain water harvesting, water shed management.

**UNIT- II**

- Cause, effects and remedial measure of Air pollution, Water pollution.
- Noise, radioactive and thermal pollution.
- Agriculture pollution
- Basic concepts of Bioaccumulation.
- Solid waste management.

**Unit- III**

- Global warming and disaster management
- Cause of global warming
- Impact of global warming — acid rains and ozone depletion, green house effect.
- Control measures of global warming
- Afforestation (b) reduction in the use of CFCS
- Disaster management -floods, earthquake, Cyclones landslides.
- Environmental legislation.

**UNIT-IV**

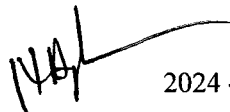
- Natural Resources: - Forest
- Use and over exploitation of forests.
- Timber extraction.
- Land
- Land degradation. Landslides.
- Soil-erosion and desertification. Water
- Use and over utilization of surface and ground water
- Floods. Drought dams- benefits and problems Mineral


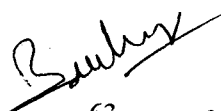
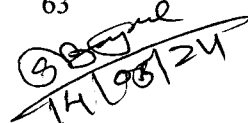
Use and exploitation Environmental effect of extracting and using Mineral resources

Food

World food problem, Effects of modern agriculture and overgrazing Energy

- Conventional and nonconventional energy resources.
- Using of alternate energy sources

  
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- Role of an individual in conservation of natural resources
- Equitable use of resources for sustainable life
  - Biodiversity crisis — habitat degradation poaching of wild life.
  - Socio economic and political causes of loss of biodiversity.
  - In situ and ex situ conservation of biodiversity
  - Value of biodiversity.
  - Cave conservation
  - Major threats to cave biodiversity
  - Conservation measures for cave bats
  - Tourism Versus Conservation

### **Learning Out comes**

- Students will be able to apply knowledge to solve problems related to wildlife conservation and management.
- Students will be able to critically evaluate current events and public information related to wildlife conservation and management as being scientifically-based or opinion-based and contribute to the knowledge base of information.
- Students will be able to work with others to coordinate activities that achieve group/team objectives. Upon successful completion, students will have the knowledge and skills to:
- Articulate why society strives to conserve biodiversity.
- Identify key threats to biodiversity.
- Evaluate which management options are likely to be effective for conserving biodiversity in different settings.

### **Skill Development/Employability**

- Develop appropriate policy options for conserving biodiversity in different settings.
- Communicate informed critique or analysis of biodiversity conservation policy and practice across a range of mediums.

### **Suggested Reading Materials:**

Paper III D & IV D

- Arora : Fundamentals of environmentalbiology
- Anathakrishnan : Bioresourcesecology
- Bottain : Environmental studies
- Bouhey : Ecology of populations
- Clark : Elements ofecology
- Dowdoswell : An introduction to animal ecology
- Goldman : Limnology
- Kormondy : Concepts ofecology
- May : Model ecosystems
- Odum : Ecology
- Perkins : Ecology
- Simmons : Ecology of estuaries and costal water
- Pawlosuske : Physico-chemical methods for water
- South Woods : Ecological methods

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- Trivedi and Goel : Chemical and biological methods for water pollution studies
- Willington : Fresh water biology
- Wetzel : Limnology
- Welch : Limnology Vols. I-II
- Cave Science Insights from the Indian Subcontinent

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**M. Sc. Zoology Semester-IV (January - June, 2026)**  
**Paper- IV E (Optional)**  
**Molecular Endocrinology and Reproductive Technology**  
**Course Code ZOO445**

**Course objectives**

The multidisciplinary the diverse interests of the faculty make possible many approaches to the study of both endocrinology and reproduction.

**UNIT-I**

- Definition and scope of molecular endocrinology.
- Chemical nature of Hormones-
- Protein & polypeptides.
- Amino acid derivative
- Steroids
- Phospholipids derivative
- (tissue hormones)
- Purification and characterization of Hormones.

**UNIT-II**

- Receptors
- Membrane Receptor.
- Nuclear Receptor.
- Orphan Receptor
- G-Protein
- Nuclear Receptor

**UNIT-III**

- Hormone — Transduction
- G-Protein & Cyclic Nucleosides.
- Calcium calmoduline & phospholipids.
- Miscellaneous Second Messengers.
- Phosphorylation & other non transcriptional effect of Hormones.
- Genetic control of formation of Hormone.
- Transcription.
- Post transcription.
- Translation.
- Post translation
- Secretion of Hormone.

**UNIT-IV**

- Multiple ovulation and embryo transfer Technology.
- Study of estrous cycle by vaginal smear technology
- Surgical technique-
- Castration
- Ovariectomy
- Vasectomy
- Tubectomy
- Laprotomy.

## Learning outcomes

- Students will gain detailed theoretical knowledge of reproductive and Endocrine biology while gaining experience of academic and transferable skills, as well as practical skills within a vibrant research environment.

## Skill Development/Employability

- They will focus on the basic sciences and their application to selected clinical aspects of the subject.
- Also, will gain a valuable qualification and sound training for a further career in scientific research or in assisted reproduction. It provided with an in-depth knowledge of molecular and cellular aspects of reproduction.

## Suggested Reading Materials:

- Beiamin Lewim — Genes VI I/ V I I I. oxford University press.
- Lodish etal- Molecular Cell Biology .
- Zarro u , M.X., Yochin J.M. and Machrthy. J.L. — Experimental Endocrinology .
- Chatte•i i C.C.- Human Physiology (Vol- 11).
- Bentley, P.J. — Comparative Vertebrate endocrinology.
- Hadley Mac. E.- Endocrinology.
- Chinoy, N.J. Rao, M.V., Desarai, K.J. and High land, H.N. — Essential techniques in reproductively physiology and Endocrinology.
- Norris, D.O. — Vertebrate Endocrinology.

Handwritten signature: *M. Patel* → *S. Kumar*  
with initials *h* and *f* below, and a circled signature *Sharma* to the right.

**M. Sc. Zoology Semester-IV (January - June, 2026)**  
**Paper- IV F (Optional)**

**Avian Biology and Ecological Importance**  
**Course Code ZOO446**

**Course objectives**

A course on the ecology, evolution, physiology, behavior, and conservation of birds,

**Unit – I: Behavior of birds.**

- Flying pattern
- Nesting.
- Migration
- Parental care
- Flocking and Hunting party,

**Unit – II:**

- Foraging Behavior;
- Mating and Breeding Behavior
- Social Behavior;
- Vocal Behavior,
- Birds of prey.

**Unit – III: Bird population**

- Concepts of Bird Populations and Bird Communities.
- Mixed species flocks;
- Studying Bird Populations and Communities: Techniques
- Tools on bird watching.
- Bird counting methods – Line transect and Point count.

**Unit – IV: Conservation and Economic Importance of birds**

- Threats to bird population
- Rare species of birds
- Birds of Chhattisgarh
- Role of birds in ecosystem and agro-forest habitat
- Birds as an important Bio-indicator
- Avian Disease
- Basics of Research areas on Avifauna.
- Citizen Science in Ornithology eBirds.

**Learning out comes**

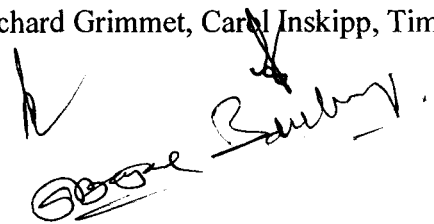
- By the end of this course, students will be able to:
- Describe the general knowledge regarding the evolutionary history, taxonomy, ecology, behavior, and conservation of birds.

**Skill Development/Employability**

- Identify species in the field and in the laboratory using prepared specimens.
- Conduct field inventories of birds and present scientific surveys.

**Suggested Reading Materials**

- **Hellum Field Guide Birds of Indian Subcontinent.** Richard Grimmet, Carol Inskipp, Tim



Inskipp, Bloomsbury Publishing London, Bloomsbury Publishing India Pvt Ltd, New Delhi

- **Avian Evolution: The Fossil Record of Birds and Its Paleobiological Significance** – Gerald Mayr
- **The origin and Evolution of Birds** – Alan Feduccia
- **How Birds Evolve: What Science Reveals About Their Origin, Lives, and Diversity** – Douglas J. Futuyma
- **Avian Anatomy 2<sup>ND</sup> Edition Textbook and Color Atlas** – Horst E King and R Diger Korbel and Hans Georg Liebich
- **Bird Behavior** – Bill Oddie
- **Birds: A Complete Guide to Their Biology and Behavior** – Jonathan Elphick

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*Handwritten signature: R. Diger Korbel*  
*Handwritten signature: Hans Georg Liebich*

M. Sc. ZOOLOGY — IV SEMESTER (January - June, 2026)

Lab course I

Course Code ZOO450

Paper I & II (Compulsory)

**PAPER- I BIOCHEMISTRY**

- Estimation of antioxidant enzymes.
- Estimation of amylase.
- Estimation of protein by Lowry method.
- Estimation of Oil in seeds.
- Estimation of Carbohydrate by anthrone reagent.
- Other exercise related to theory paper.
- Estimation of Protein by the Biuret, Lowry, Bradford and Eosine-a comparison
- Determination of N-terminal Amino acids by the Sangers reagent (FDND)
- Paper chromatographic separation of Amino acids
- Quantitative estimation of Protein, carbohydrate, Mucosaccharide, Lipids and Enzyme (Bromphenol blue, PAS, Alcian blue, aldehyde fucsin, Acetylcholinestrerase technique)
- Identification of hypothalamic nuclei histological, histochemical and immunocytochemical method
- Isolation and characterization of Pituitary cell
- Estimation of MAC, MCH and MCHC
- Total count of WBC and RBC
- Differential count of WBC
- Hemoglobin estimation and PCV estimation or ESR estimation
  - Quantitative estimation of blood serum by Colorimetry (I) Blood Urea (II) Blood glucose
- (III) Blood Calcium (IV) Blood Creatine (V) Blood cholesterol (VI) Blood Cholesterol
- (VI) Blood Protein (VII) Blood Albumin (m)Blood clotting time
- ECG Recording
- Blood Pressure estimation
- EEG

**PAPER- II NEUROPHYSIOLOGY**

- Study of slides of nervous system.
- Neck nerve of squirrel.
- Study of Brain through MODEL.
- Study of Cranial nerve of Bird, Amphibian, Reptile and Mammals.
- Other exercise related to theory paper.

**Examination Scheme**

Based on Paper I	30
Based on Paper II	30
Viva	10
Sessional(Internal)	30
<b>Total</b>	<b>100</b>

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SEMESTER-IV (January - June, 2026)

LAB COURSE-II  
OPTIONAL (SPECIAL PAPER)  
Course Code ZOO460

Paper III and IV

PAPER-III(A) FISH (ICHTHYOLOGY) STRUCTURE AND FUNCTION

- I. Anatomy of various organ systems and mounting of fish materials
- Cranial nerves of teleost fishes: *Wallago*, *Mystus*, *Labeo* and other fishes
- Osteology of fish: *Scoliodon*, carps, catfishes, murrels etc.
- Accessory respiratory organs of air breathing fish
- Study of histological (permanent) slides
- Study of museum specimens of the concerned group
- Other exercise related to theory paper.

PAPER —IV(A) PISCI CULTURE AND ECONOMIC IMPORTANCE OF FISH (ICHTHYOLOGY)

- Systematic identification of freshwater fishes with particular reference to C.G.
- Age determination with the help of scales / otolith
- Pigmentary behaviour in fish
- Qualitative zooplankton analysis
- Nutrient analysis of water
- Analysis of gut contents
- Microtomy of fish materials
- Other exercise related to theory paper

Examination Scheme

Based on Paper III	30
Based on Paper IV	30
Viva	10
Sessional (Internal)	30
<b>Total</b>	<b>100</b>

OR

Dissertation

Report/Dissertation	55
Presentation	10
Viva	5
Sessional (Internal)	30
<b>Total</b>	<b>100</b>

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2024 - 2026

*Prakash*

### PAPER—III(B) CELL BIOLOGY

- Study of mitosis from onion root tip.
- Study of meiosis in grasshopper testis.
- Study of polytene chromosome in Dipteran Larvae.
- Demonstration of Barr-Body in Human Cheek cell.
- Estimation of DNA.
- Estimation of RNA.
- Other exercise related to theory paper.

### PAPER-IV(B) CELLULAR ORGANIZATION AND MOLECULAR ORGANIZATION

- Histochemical demonstration of Mitochondria
- Histochemical demonstration of Golgi complex
- Histochemical demonstration of Lactate dehydrogenase
- Histochemical demonstration of Succinate dehydrogenase
- Isolation and characterization of Nuclei from liver
- Isolation and characterization of Mitochondria
- Isolation of DNA from any tissue
- Separation of lipids using thin layer chromatography
- Separation of various proteins using column chromatography
- Study of metaphase chromosomes from rat bone marrow
- G banding of metaphase chromosomes
- C- banding of metaphase chromosomes
- Estimation of Mitotic Index
- Measurement of cell size using oculometer.
- Other exercise related to theory paper

#### Examination Scheme

Based on Paper III	30
Based on Paper IV	30
Viva	10
Sessional(Internal)	30
<b>Total</b>	<b>100</b>

OR

#### Dissertation

Report/Dissertation	55
Presentation	10
Viva	5
Sessional(Internal)	30
<b>Total</b>	<b>100</b>

### PAPER —III(C) ENTOMOLOGY

- Anatomy of common grasshopper, cockroach, honey bee, wasp
- Dissection and mounting of:
- Sting apparatus of honey bee and wasp.
- Tympanal organs of grasshoppers.
- Testes of cockroach
- Aristae of house fly.
- Different types of mouthparts of insects.
- Different types of wings and antennae of insects.
- Tentorium of grasshopper.
- Identification and comment on insects of different orders and families.
- Identification with the help of keys of common insects from different orders and families.
- Other exercise related to theory paper.

### PAPER- IV(C) APPLIED ENTOMOLOGY

- Insect collection and preservation for systematic studies
- Identification of different insects upto orders
- Identification of insects upto families of economically important insect orders
- Identification of insects upto species: Mosquitoes, honeybees, stored grain beetles, aquatic insects, important crop and household pests
- Analysis of honey and its quality control
- Field studies of insects to understand their habit, habitat environmental impact, beneficial and harmful activities etc.
- Study of beneficial insects, benefits derived from them and useful products
- Study of destructive insects, damage caused by them and damaged products
- Study of insecticidal formulations and insect control appliances
- Experiments on insect control like LC-50 /LD-50, knock down and recovery effect, repellency/antifeedance tests, percentage damage tests for leaf eating insects, and stored grain pests
- Other exercise related to theory paper

#### Examination Scheme

Based on Paper III	30
Based on Paper IV	30
Viva	10
Sessional (Internal)	30
<b>Total</b>	<b>100</b>

OR

#### Dissertation

Report/Dissertation	55
Presentation	10
Viva	5
Sessional (Internal)	30
<b>Total</b>	<b>100</b>

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### PAPER-III(D) WILD LIFE CONSERVATION

- Visit to an area to document environmental assets including natural resources/flora fauna, etc. . Identification and study of common insects, fish, birds, mammals of a particular area.
- To determine the physical conditions of water: Depth, Viscosity, Density, Buoyancy.
- To determine the chemical conditions of water: pH, dissolved oxygen and carbon-di-oxide, hardness etc.
- To determine Cl, SO<sub>4</sub>, NO<sub>3</sub> in soil and water samples from different locations.
- To study acidity and alkalinity of sample water by methyl orange and phenolphthalein
- Visit to a local polluted site (Urban/Rural/Industrial/Agricultural).

### PAPER-IV(D) Environment and BioDiversity conservation

- There are no structured class lab experiments involved. However the students are expected to visit various sites on the web, make teams for group-discussion indulge in debates, collect justifiable information from various sources, make historical report on the following major global environmental issues :
- 1 Atmosphere Management: Pollution, global warming/climate change, Stratospheric ozone depletion its impact and possible solutions
- Fresh water Management: Pollution, reasons, severity of problem, impact for the present and the future, its impact and possible solutions
- Marine Ecosystem: Pollution of marine ecosystem, its impact and possible solutions
- Soil degradation and Desertification
- Solid Waste Management
- Human health and Toxicology

#### Examination Scheme

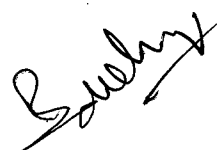
Based on Paper III	30
Based on Paper IV	30
Viva	10
Sessional(Internal)	30
<b>Total</b>	<b>100</b>

#### OR Dissertation

Report/Dissertation	55
Presentation	10
Viva	5
Sessional(Internal)	30
<b>Total</b>	<b>100</b>



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### PAPER-III(E)Biology of Vertebrate Immune System

- Dissection of primary and secondary immune organs from fish/fowl- Preparation and study of cell suspension from spleen (splenocytes) of Fish / fowl.
- Total and differential counting of leucocytes.
- Protein estimation by Lowry's method in normal and infected blood sample.
- Determination of Blood group.
- Study of permanent slides (for spotting); thymus, lymph nodes, spleen, bone marrow, types of cells of various types, adipose tissue, mitotic and meiotic chromosomes and their different phases cancer cells of various types etc.
- Study of parasites in fish
- Study of various parasites through slides and specimen.
- Other exercises related to theory paper.

### PAPER-IV(E) Molecular Endocrinology and Reproductive Technology

- Dissection and demonstration of Endocrine glands in laboratory bred rat\*.
- Study of the permanent slides of all the endocrine glands.
- Compensatory ovarian/ adrenal hypertrophy in vivo bioassay in laboratory bred rat\*.
- Demonstration of Castration/ ovariectomy in laboratory bred rat\*.
- Estimation of plasma level of any hormone using ELISA.
- Designing of primers of any hormone.
- Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems;
- Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
- Sperm count and sperm motility in rat

#### Examination Scheme

Based on Paper III	30
Based on Paper IV	30
Viva	10
Sessional(Internal)	30
<b>Total</b>	<b>100</b>

OR

#### Dissertation

Report/Dissertation	55
Presentation	10
Viva	5
Sessional(Internal)	30
<b>Total</b>	<b>100</b>

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**Paper III (F) Ornithology (Avian Biology)**

- Systematic identification of birds with particular reference to C.G.
- Anatomy of various organ systems and mounting of Cranial nerves of fowl
- Osteology of fowl
- Study of histological slides (Permanent).
- Microtomy of fish materials
- Study of museum specimen of Birds/Digital Specimen.
- Collection of various bird species (Digital).
- Other exercise related to theory paper

Note: (Birds materials should be collected from local chicken market)

**Paper – IV (F) Avian Biology and Ecological Importance**

- Identify and classify the local bird species and submit report to the department.
- Count bird species in campuses using point count and line transect method.
- Count bird species in your own house and backyard using line transect and point count method.
- Calculate the Shannon-Weiner index for Bird diversity in Campus and local habitat.
- Study of bird diseases.
- Study of adaptive characteristics of birds.
- Identify the problems of bird population in local area.
- Identify the issues and challenges in bird conservation at local habitat.
- Other exercise related to theory paper

**Examination Scheme**

Based on Paper III	30
Based on Paper IV	30
Viva	10
Sessional(Internal)	30
<b>Total</b>	<b>100</b>

OR

**Dissertation**

Report/Dissertation	55
Presentation	10
Viva	5
Sessional(Internal)	30
<b>Total</b>	<b>100</b>

