

CHAITANYA SCIENCE AND ARTS COLLEGE

(AUTONOMOUS)

PAMGARH, JANJGIR-CHAMPA (C.G.)



ACCREDITED "A" GRADE BY NAAC

DEPARTMENT OF ZOOLOGY
COURSE CURRICULUM & MARKING SCHEME

POSTGRADUATE PROGRAMME
MASTER OF SCIENCE (ZOOLOGY)
PROGRAM CODE: CCMSO5
THIRD & FOURTH SEMESTER

Approved By	Board of Studies	Academic Council
Date	16/8/2026	

ACADEMIC YEAR 2025-26

Website: <https://chaitanyacg.ac.in/> Email: principalchaitanya417@gmail.com

Master of Science (Zoology)

ABOUT THE PROGRAM:

The **Master of Science (M.Sc.) in Zoology** at **Chaitanya Science and Arts College (Autonomous)** is a two-year postgraduate program that provides students with advanced knowledge of animal biology. Zoology is a vital branch of life sciences that studies the structure, physiology, genetics, evolution, ecology, and behavior of animals.

A distinctive feature of the program is its emphasis on **research, innovation, entrepreneurship, and experiential learning**. Students are encouraged to explore applied aspects of zoology in fields such as **aquaculture, apiculture, sericulture, biotechnology, and environmental management**. This approach not only develops academic and research excellence but also nurtures entrepreneurial abilities and scientific innovation.

Graduates of this program are well-prepared for careers in **teaching, research institutions, environmental consultancies, forest and wildlife services, biotechnology industries, and healthcare sectors**. The program also equips students for higher studies and competitive examinations, enabling lifelong professional growth. In essence, the M.Sc. Zoology program creates skilled, innovative, and socially responsible zoologists committed to science and sustainability.

PROGRAM OUTCOMES (POs):

By the end of the Master of Science (Zoology) program, students will demonstrate the ability to:

PO 1	In-depth Knowledge of Zoology – Develop advanced understanding of animal biology, including physiology, genetics, evolution, ecology, and conservation.
PO 2	Research and Analytical Skills – Gain ability to design experiments, analyze biological data, and conduct independent research with scientific rigor.
PO 3	Practical and Observational Competence – Acquire laboratory techniques, field survey methods, and animal observation skills for real-world biological studies.
PO 4	Environmental and Ethical Awareness – Understand the importance of biodiversity conservation, sustainable development, and ethical practices in biological research.
PO 5	Career and Professional Development – Prepare for diverse careers in teaching, research, biotechnology, healthcare, and environmental management, as well as competitive examinations.

PROGRAM SPECIFIC OUTCOMES (PSOs): After successfully completing the program, students will have the ability to:

PSO 1	Disciplinary Knowledge: Demonstrate in-depth understanding of fundamental and advanced concepts of Zoology including taxonomy, physiology, ecology, genetics, molecular biology, and evolution.
PSO 2	Laboratory and Research Skills: Apply scientific methods, laboratory techniques, and modern analytical tools for experimental design, data analysis, and interpretation in biological sciences.
PSO 3	Critical Thinking and Problem-Solving: Analyze biological problems, propose hypotheses, and develop innovative approaches for sustainable solutions in environmental and health-related issues.
PSO 4	Application of Knowledge: Integrate theoretical concepts with practical skills to pursue careers in teaching, research, environmental management, wildlife conservation, and applied biosciences.
PSO 5	Ethics and Sustainability: Exhibit professional ethics, concern for biodiversity conservation, and commitment to sustainable development while applying zoological knowledge to real-world challenges.

SESSION 2026-27

Proposed Scheme For 2-Year Postgraduate Program

PROGRAMME STRUCTURE: PART	YEAR	SEMESTER	SEMESTER
Part-I	First Year	Semester-I	Semester-II
Part-II	Second Year	Semester-III	Semester-IV

SEMESTER -III

SR. NO.	COURSE CODE	TITLE OF COURSE
1.	MZOT301	Comparative anatomy of vertebrates
2.	MZOT302	Biosystematics, taxonomy & biodiversity
3.	MZOT303	Immunology and developmental biology
4.	MZOT304	Population genetics & evolution
5.	MZOP301	M.Sc. Zoology Lab Course I
6.	MZOP302	M.Sc. Zoology Lab Course II

SEMESTER – IV

SR. NO.	COURSE CODE	TITLE OF COURSE
1.	MZOT401	General physiology and neurophysiology (<i>compulsory</i>)
2.	MZOT402	Biochemistry and metabolic regulation and cell function (<i>compulsory</i>)
CHOOSE ANY ONE GROUP		
Optional Group-I		
3.	MZOT403	Wildlife conservation
4.	MZOT404	Environment and biodiversity conservation
	MZOP405	M.Sc. Zoology Lab Course I
	MZOP406	M.Sc. Zoology Lab Course II
Optional Group-II		
5.	MZOT403	Fish (Ichthyology) structure and function
6.	MZOT404	Applied Fisheries

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	MZOP405	M.Sc. Zoology Lab Course I Or Dissertation Seminar, viva
	MZOP406	M.Sc. Zoology Lab Course II
Optional Group-III		
7.	MZOT403	Cell biology
8.	MZOT404	Cellular organization and molecular organization
	MZOP405	M.Sc. Zoology Lab Course I
	MZOP406	M.Sc. Zoology Lab Course II
Optional Group-IV		
9.	MZOT403	Entomology
10	MZOT404	Applied Entomology
11.	MZOP405	M.Sc. Zoology Lab Course I
12.	MZOP406	M.Sc. Zoology Lab Course II

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SR. NO.	COURSE CODE	TITLE OF COURSE	ESE	CIE (IA)	TOTAL MARKS
1.	MZOT301	Comparative anatomy of vertebrates	70	30	100
2.	MZOT302	Biosystematics, taxonomy & biodiversity	70	30	100
3.	MZOT303	Immunology and developmental biology	70	30	100
4.	MZOT304	Population genetics & evolution	70	30	100
5.	MZOP301	M.Sc. Zoology Lab Course I	-	-	100
6.	MZOP302	M.Sc. Zoology Lab Course II	-	-	100
TOTAL				600	

SEMESTER-IV

SR. NO.	COURSE CODE	TITLE OF COURSE	ESE	CIE *(IA)	TOTAL MARKS
1.	MZOT401	General physiology and neurophysiology (compulsory)	70	30	100
2.	MZOT402	Biochemistry and metabolic regulation and cell function (compulsory)	70	30	100
ANY ONE GROUP					
Optional Group-I					
3.	MZOT403	Wildlife conservation	70	30	100
4.	MZOT404	Environment and biodiversity conservation	70	30	100
Optional Group-II					
5.	MZOT403	Fish (Ichthyology) structure and function	70	30	100
6.	MZOT404	Applied Fisheries	70	30	100
Optional Group-III					
7.	MZOT403	Cell biology	70	30	100
8.	MZOT404	Cellular organization and molecular organization	70	30	100
Optional Group-IV					
9.	MZOT403	Entomology	70	30	100
10.	MZOT404	Applied Entomology	70	30	100
PRACTICAL					

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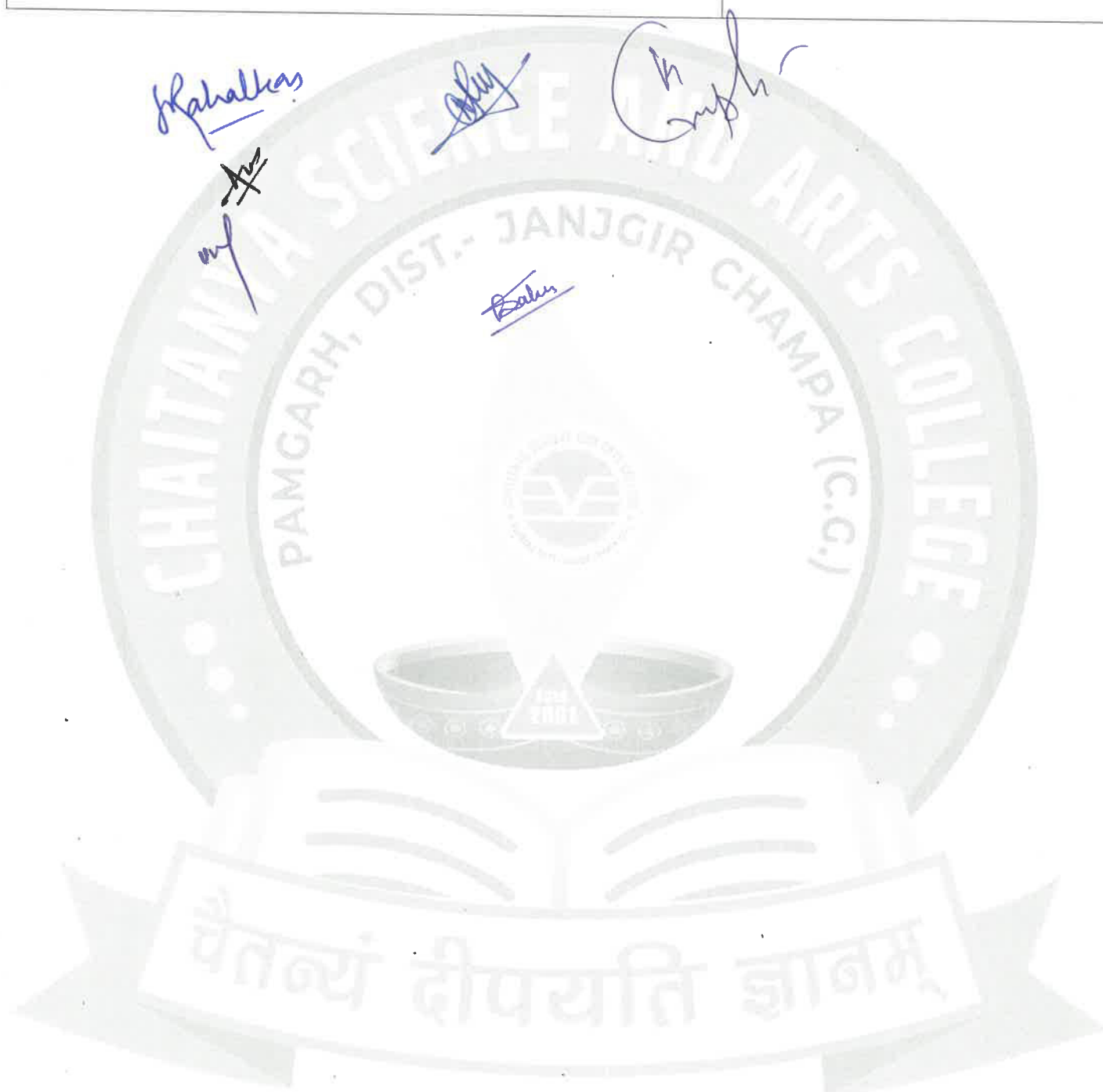
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11	MZOP405	M.Sc. Zoology Lab Course I Or Dissertation Seminar, viva			100
12	MZOP406	M.Sc. Zoology Lab Course II			100
TOTAL			600		



SEMESTER III
PAPER -I

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – III	
CORE COURSE	COURSE CODE: MZOT301	
TITLE	COMPARATIVE ANATOMY OF VERTEBRATES	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	• To understand the origin and classification of vertebrates. • To study the integument and its derivatives with heart evolution. • To compare digestive, respiratory, and skeletal systems. • To analyse the urinogenital, nervous systems, and sensory receptors. • To explore the relationship between anatomical structures and environmental adaptation	
Course Outcome	CO 1: Students will learn to classify vertebrates and trace their evolutionary history. CO 2: Students will gain knowledge of skin development and the evolution of the circulatory system. CO 3: Students will master comparing respiratory, digestive, and skeletal adaptations across species. CO 4: Students will analyse the complexity of nervous, sensory, and reproductive systems in vertebrates. CO 5: Students will understand how anatomical structures enable the survival and function of organisms.	
Syllabus	Description	No. of Lectures / Hours
UNIT - I	• Origin of Chordates- Amphibians, Reptiles , Birds and Mammals • Classification of vertebrates up to orders with examples.	15
UNIT - II	• Vertebrate integument and its derivatives. – Development and general structure of skin – Function of skin and its derivatives. – Glands, Scales, Horns, laws, Nails, Hoofs, Feathers and Hairs. • Comparative account of Circulatory System – Evolution of Heart, – Evolution of aortic arches. – Structure and function of blood and Lymph	15

UNIT - III	• Comparative account of digestive organs. – General organization of the digestive system – Alimentary canal in vertebrates – Digestive glands in vertebrates • Respiratory system: Comparative account of respiratory organs. – Respiratory organs in vertebrates – Cutaneous respiration – Bronchial respiration (gills) – Pulmonary respiration (lungs) • Skeletal system: – Comparative account of Jaw Suspensorium, – Vertebral column- Development of vertebra and vertebral column – Types of vertebra, – Limbs and Girdles.	15
UNIT - IV	• Comparative account of urinogenital system in vertebrate series. – Male reproductive organs – Female reproductive organs – Kidney types and their evolution: Pronephros, Mesonephros, Metanephros • Comparative account of Nervous system – Brain and Spinal cord in vertebrate series. – Sensory receptors	15

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Text Books, Reference Books:

1. Alexander, R.M. The Chordata. Cambridge University Press, London
2. Bourne,, G.H. The structure and functions of nervous tissue. Academic Press, NY
3. Carter, G.S. Structure and habit in vertebrate evolution - Sedgwick & Jackson, London
4. Kingsley, J.S. Outlines of Comparative Autonomy of Vertebrates, Central Book Depot, Allahabad.
5. Malcom Jollie, Chordata morphology, East-West Press Pvt., New Delhi.
6. Milton Hilderbrand. Analysis of vertebrate structure. IV Ed. John Wiley, NY
7. Tansley, K. Vision in Vertebrate. Chapman and Hall Ltd., London.
8. Walters, H.E. and Sayles, L.D. Biology of Vertebrates. Macmillan & Co., NY
9. Romer, A.S. Vertebrate Body, IIIrd Ed. W.B. Saunders Co., Philadelphia.
10. Young, J.Z. Life of Vertebrates. Oxford University Press, London.
11. Montagna, W. Comparative anatomy. John Wiley & Sons Inc.
12. Andrews, S.M. Problems in Vertebrate Evolution. Academic Press, NY
13. Waterman, A.J. Chordata structure and function. Macmillan Co., New York
14. Lovtrup, S. The Phylogeny of Vertebrate, John Wiley & Sons, London.

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M.Sc. ZOOLOGY SEMESTER – III

PAPER-II

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – III	
CORE COURSE	COURSE CODE: MZOT302	
TITLE	BIOSYSTEMATICS, TAXONOMY & BIODIVERSITY	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	- To understand the basic concepts, history, and importance of biosystematics and taxonomy in biology. - To study modern trends in classification including chemo, cyto, and molecular taxonomy. - To analyse the dimensions of speciation, species concepts, and various taxonomic characters. - To master taxonomic procedures, including collection, preservation, and the use of identification keys. - To evaluate biodiversity types, hotspots, threats, and mathematical indices like Shannon-Weiner.	
Course Outcomes	CO 1: Students will classify organisms using modern taxonomic trends. CO 2: Students will understand speciation and biological classification theories. CO 3: Students will master specimen collection and identification keys. CO 4: Students will apply ICZN rules for scientific naming. CO 5: Students will calculate biodiversity indices and conservation plans.	
Syllabus	Description	No. of Lectures / Hours
UNIT - I	Definition and basic concepts of biosystematics and taxonomy. - Historical resume of systematics - Importance and applications of biosystematics in biology Trends in biosystematics concepts of different conventional and newer aspects - - Chemotaxonomy, Cytotaxonomy, Molecular taxonomy - Cladistics, phylogeny and Numerical taxonomy - DNA barcoding and Molecular markers - Bioinformatics in systematics	15
UNIT - II	Dimensions of speciation - Mechanisms of speciation in panmictic and apomictic species	15

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	– Species concepts and species category • Theories of biological classification • Taxonomic characters and different kinds – Types of taxonomic characters – Qualitative and quantitative characters – Diagnostic and key characters • Taxonomic Procedure – Collection and preservation of specimens – Identification, Classification and nomenclature – Preparation and use of taxonomic keys – Type specimens and their significance	
UNIT - III	• Procedure keys in taxonomy – Taxonomic procedures-taxonomic collections, preservation, curation – Taxonomic keys - different kinds of taxonomic keys, their merits and demerits • Process of typification and different Zoological types • International Code of Zoological Nomenclature (ICZN)	15
UNIT - IV	• Biodiversity – Types of Biodiversity – Hot spots of Biodiversity – Threats to Biodiversity – Conservation of Biodiversity • Evaluation of biodiversity – Diversity indices – Shannon-Weiner index • Role of museums, herbaria and zoological surveys in taxonomy	15

Text Books, Reference Books:

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

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M.Sc. ZOOLOGY SEMESTER – III
PAPER-III

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – III	
CORE COURSE	COURSE CODE: MZOT303	
TITLE	IMMUNOLOGY AND DEVELOPMENTAL BIOLOGY	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	• To learn the basics of immunity and the organization of the immune system. • To study antibody functions and the activation of B and T lymphocytes. • To analyse the complement system, MHC molecules, and hypersensitivity. • To understand early embryonic stages like cleavage, gastrulation, and tubulation. • To study the formation and development of the heart and nervous system.	
Course Outcomes	CO 1: Students will identify immune cells and lymphoid organ structures. CO 2: Students will explain antibody classes and immune response mechanisms. CO 3: Students will describe MHC roles and immune reactions to infections. CO 4: Students will understand the transition from embryos to body forms. CO 5: Students will analyze how the cardiovascular and nervous systems develop.	
Syllabus	Description	No. of Lectures / Hours
UNIT - I	• Innate and Acquired immunity • Cell and Organs of Immune System • Organization and Structure of Lymphoid organs • Cells of the immune system & their differentiation • Lymphocyte traffic • Nature of Immune response • Nature of Antigens • Antigenicity and Immunogenicity • Factor influencing immunogenicity • Antigenic determinates/epitopes adeptness	15
UNIT - II	• Antibodies (Immunoglobulins) • Structure & Function of antibodies • Immunoglobulin Classes & Subclasses • Antigen- Antibody interaction • B Cell Maturation, Activation and Differentiation	15

	• B- Cell Receptors • B- Cell Activation and Proliferation • Humoral Immune Response Kinetics • T- Cell maturation activation and differentiation • T- Cell Receptors • T- Cell Activation and Proliferation • T- Cellular Immune Response • Currently available vaccines	
UNIT - III	• Compliment System & it regulation Consequence of Compliment Activation • Major and Minor Histo- compatibility Complex • Classical and non classical MHC genes • Structure of MHC molecule Peptide interaction with MHC molecule Cellular distribution and regulation of MHC expression MHC & Susceptibility to infections disease • Hyper sensitivity and immune responses to infection agents especially intra cellular parasites	15
UNIT - IV	• Extra embryonic membranes • Cleavage (Segmentation) and its Significance • Tubulation and extension of the Major Organ- forming Areas: Development of Primitive body form • Basic Feature of Vertebrate Morphogenesis • Histogenesis and Morphogenesis of the Organ System • The Cardio Vascular Special System (check it) • The Nervous System • Teratology	15

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- immunology by Kuby, W. H. Froeman USA
- Fundamental of Immunology by W. Paul
- Essential Immunology by M. Rohit, ELBs Edition
- Immunology by Richard M. Hyde, Robert A. Patnode, A Wiley Medical Publications
- Immunology by Dulsy Fatima and N Arumugam. Saras Publication
- Sunil Kumar Mohanty, Dr. Sai Leela-Text book of immunology Jaypee Brothers Medical Publishers (P) Ltd.
- Reproductive Physiology by Guyton
- The Elements of Immunology” by Fahim Halim Khan. Pearson Education India

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M.Sc. ZOOLOGY SEMESTER – III
PAPER-IV

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – III	
CORE COURSE	COURSE CODE: MZOT304	
TITLE	POPULATION GENETICS & EVOLUTION	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	• To understand principles of evolution and population genetics. • To study forces of evolution and speciation. • To explain molecular evolution and phylogeny. • To develop knowledge of genetic variation and adaptation. • To apply evolutionary concepts in conservation studies.	
Course Outcomes	CO1: Explain theories and mechanisms of evolution. CO2: Analyse factors affecting genetic variation in populations. CO3: Describe speciation and molecular evolution. CO4: Interpret phylogenetic relationships using genetic data. CO5: Apply population genetics in evolutionary and conservation studies.	
Syllabus	Description	No. of Lectures / Hours
UNIT - I	• Concept of Evolution and theories of Organic Evolution with an emphasis on Darwinism, Neutral Theory of Evolution • Neo-Darwinism • Hardy-Weinberg Law of genetic equilibrium • A detailed account of destabilizing forces: (i) Natural Selection (ii) Mutation (iii) Genetic drift (iv) Migration (v) Meiotic drive	15
UNIT - II	• Genetics of speciation • Models of speciation (Allopatric, Sympatric and Parapatric) • Patterns and mechanisms of reproductive isolation • Genetics of Quantitative traits in population • Analysis of quantitative traits • Inbreeding depression and heterosis	15
UNIT - III	• Molecular Evolution • Gene Evolution • Origin of Higher categories • Major trends in origin of higher categories • Macro and micro Evolution • Molecular phylogenetics	15

	• How to construct Phylogenetic trees? • Amino acid sequence and phylogeny • Molecular Clock	
UNIT - IV	• Quantifying genetic variability • Genetic structures of natural population • Phenotypic variation • Molecular population Genetics • Patterns of change in nucleotide and amino acid sequence • Emergence of non-Darwinism- Neutral theory • Genotype-environment interaction • Population Genetics and ecology • Metapopulations: Why small populations become extinct • Conservation of genetic resources in diverse taxa	15

Text Books, Reference Books

1. Dobzhansky, Th. *Genetics and Origin of Species*. Columbia University Press.
2. Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valentín. *Evolution*. Surjeet Publication, Delhi.
3. Futuyma, D.J. *Evolutionary Biology*. Sinauer Associates, INC Publishers, Sunderland.
4. Hartl, D.L. *A Primer of Population Genetics*. Sinauer Associates Inc., Massachusetts.
5. Jha, A.P. *Genes and Evolution*. John Publication, New Delhi.
6. King, M. *Species Evolution - The role of chromosomal change*. Cambridge University Press, Cambridge.
7. Merrel, D.J. *Evolution and Genetics*. Holt, Rinehart and Winston Inc.
8. Smith, J.M. *Evolutionary Genetics*. Oxford University Press, New York.
9. Strickberger, M.W. *Evolution*. Jones and Bartlett Publishers, Boston, London.

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M.Sc. ZOOLOGY SEMESTER – III
Zoology Practical Lab-course I

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – III		
CORE COURSE	COURSE CODE: MZOP301		
TITLE	LAB COURSE - I		
Total Marks	Total: 100 Marks, Minimum Passing Marks: 40		
PRACTICAL			
Course Outcomes	CO 1: Students will perform dissections and prepare microscopic slides of biological materials. CO 2: Students will identify and compare skeletal systems across different vertebrate classes. CO 3: Students will gain expertise in collecting, identifying, and naming local animal species. CO 4: Students will construct and use taxonomic keys for effective species identification. CO 5: Students will evaluate the health of ecosystems using quantitative biodiversity indices.		
Syllabus	Description	No. of Lectures / Hours	
	Comparative Anatomy - Dissection of animals: Amphioxus, Scoliodon, Electric ray, Sting ray, Calotis, Bird head, Rat (Subject to availability of material) / study through alternative methods of dissection. - Micro preparation of suitable and available material. - Study of the representative examples of different classes of Chordates. - Study of permanent slides showing whole mount or section as per Theory syllabus, including embryological slides of Frog and Chick. - Osteology of Amphibia, Reptile, Bird, Mammal. - Study of animal diversity by field trip and excursion, Extension activity to spread health awareness. Students have to submit project report. Biosystematics, Taxonomy & Biodiversity - 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.	30	

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- Taxonomic key formation and conversion.
- Study of biodiversity in grassland and pond water by using Shannon-Weiner index.

Note-

1. Use of animal for dissection and practical work is subject to the conditions that they are not banned under the wildlife protection act.
2. External features and anatomy should be studied by digital techniques and the alternatives. Wherever live animals is studies it should be either pest or colorable species without painning them.

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M.Sc. ZOOLOGY SEMESTER – III
LAB COURSE – I
Marks Distribution of Practical Exam

Time – 6 Hrs.

(Total Marks: 100)

Sr. No.	Practical Exercise	Marks
1	Dissection of Vertebrate (virtual/other method)	10
2	Spotting 1 to 10	20
3	Micro preparation	10
4	Exercises related to Taxonomy (Three)	30
5	Viva	10
6	Project	10
7	Sessional	10
	TOTAL MARKS	100

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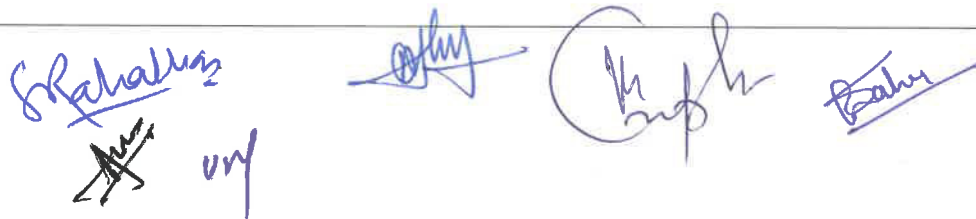
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M.Sc. ZOOLOGY SEMESTER – III
Zoology Practical Lab-course II

TITLE	LAB COURSE – II (MZOP302)		
Total Marks	Total: 100 Marks, Minimum Passing Marks: 40		
PRACTICAL			
Course Outcomes	CO1: Master immune organ dissection and cell viability assessment. CO2: Execute ELISA and Ouchterlony assays for antibody analysis. CO3: Perform embryological staining and in vitro culture techniques. CO4: Prepare and analyse mitotic and meiotic chromosomal slides. CO5: Apply Hardy-Weinberg and Natural Selection laws to genetic data.		
Syllabus	Description	No. of Lectures / Hours	
	Immunology and developmental Biology 1. Dissection of Primary and secondary immune organ from mice a. Preparation of single suspension from bone marrow b. Cell counting and viability testing of the solenocytes prepared 2. Preparation and study of phagocytosis by splenic peritoneal microphase. 3. Raising polyclonal antibody in mice, serum collection and estimating antibody titre in serum by following method a. Ouchterlony (double diffusion) assay for antigen-antibody specificity and titre. b. ELISA 4. Antibody purification from the serum collected from immunized mice, affinity purification chromatography 5. Blood group testing A, B ,O ,AB AND Rh factor 6. Induced Breeding in Frog 7. Culture of chick Embryo in Vitro 8. Study of chick embryos by vital staining 9. The Technique for the whole mount preparation of chick embryo 10. Demonstration of Cell death 11. Study of Mitosis (a) Techniques for chromosomes preparation (b) Preparation of Meiotic chromosomes for Grasshopper testis (c) Auto Radiography	30	



	Population Genetics and Evolution a. i. An experiment related to quantitative genetics, genotypic frequencies in light of hardy Weinberg law b. ii. ABO blood group data b. Numeric exercise related to i. Natural selection ii. Changing gene frequency Chromosomal Polymorphism.	
	Note- 1. Use of animal for dissection and practical work is subject to the conditions that they are not banned under the wildlife protection act 2. External features and anatomy should be studied by digital techniques and the alternatives. Wherever live animals is studies it should be either pest or culturable species without painning them	

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M.Sc. ZOOLOGY SEMESTER – III
LAB COURSE – I
Marks Distribution of Practical Exam

Time – 6 Hrs.

(Total Marks: 100)

Sr. No.	Practical Exercise	Marks
1	Dissection showing primary and secondary immune organ of mice (virtual / other method)	10
2	Exercise related to immune response	20
3	Exercise related to developmental biology / Preparation of egg window and Blastodisc	10
4	Exercises related to quantitative genetics / Hardy Weinberg law	20
5	Viva	10
6	Project	10
7	Sessional	10
	TOTAL MARKS	100

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SEMESTER – IV

PAPER-I

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – IV	
CORE COURSE	COURSE CODE: MZOT401	
TITLE	GENERAL PHYSIOLOGY AND NEUROPHYSIOLOGY	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	- To study spinal cord anatomy and nerve impulse conduction. - To understand synaptic transmission and autonomic nervous control. - To learn the mechanisms of digestion, absorption, and respiration. - To examine blood composition, cardiac cycles, and ECG regulation. - To study muscle contraction, urine formation, and temperature control.	
Course Outcomes	CO1: Identify nervous tissue structure and mechanisms of nerve conduction. CO2: Distinguish between sympathetic and parasympathetic nervous system functions. CO3: Explain the chemical digestion of nutrients and respiratory gas transport. CO4: Analyse blood clotting, heart sounds, and the cardiac cycle. CO5: Describe the physiology of muscle contraction and renal excretion.	
Syllabus	Description	No. of Lectures / Hours
UNIT - I	- Central Nervous System Gross Anatomy of Spinal Cord. - Histological structure of Nervous tissue Neurons and Neuroglia & its function. - The Meninges, Neurotrophins & Cerebro spinal Fluid (CSF) and its function. - Physiological Properties of nerve fibres and mechanism of conduction of Nerve Impulses in Non-medullated and medullated Nerve fibers. - Nerve endings (Bio-Analysers)	15
UNIT - II	Synapse – structure, Properties and its reuptake mechanism. Neurotransmitters: Classification, structure, receptors, function and metabolism. - The Cranial and spinal Nerves.	15

	• Autonomic Nervous system: Sympathetic and parasympathetic systems with special comparison to hormonal mechanism of transmission through autonomic nerves system .	
UNIT - III	• Feeding Mechanism and comparative Physiology of Digestion. • Various digestive juices, its composition, function and mechanism of secretion. • Physiology of digestion for carbohydrate, Protein, fat & Nucleic acid and its absorption. • Circulation of Body Fluid and its regulation. • Structure, function, synthesis & composition of Blood, Blood group system. Blood Coagulation & De-fibrilization. Cardiac cycle Heart sound and ECG. Respiratory system and Physiology of Respiration . • Structure of respiratory track. • Breathing Physiology. • Transport of Gases ▪ Oxygen carriage ▪ Carriage of Carbon di-oxide. Tissue Respiration .	15
UNIT - IV	• Contractile elements and its Physiology. • Properties of Skeletal, Smooth & Cardiac Muscle. • Structure of Muscle. ▪ Ultra & Molecular of Structure of Muscle. • Structure of Sarcoplasmic reticulum & its role in Muscle Contraction. • Theories and Physiology of muscle contraction. • Changes during muscle contraction. • Enzyme used in muscle contraction. • Pattern of Nitrogen Excretion and its Physiology. Excretory Substance . Physiology of liver for excretion. Structure of kidney and its Excretory Physiology. • Formation of Urine. • Regulation of body temperature. ▪ Pyrexia ▪ Hypothermia.	15



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Text Books, Reference Books

1. The Brain : Our Nervous System by Seymour Simon
2. Mass Action in the Nervous system by Walter J. Freeman
3. Human Anatomy and Physiology with Interactive physiology 10-system Suite, 8th Edition by Elaine N. Marieb and Katja N. Hoehn (jan 10, 2010)
4. Neuroanatomy by H. G. Snell
5. Clinical Neurophysiology- Guide for Author- Slsevier
6. Foundations of cellular Neurophysiology (Bradford Books) Daniel Johnston
7. Medical physiology by Ganong
8. Medical physiology by Gyaton
9. Human Anatomy and Physiology by Tor Tora
10. Human Physiology by G. C. Chatterji

E-Resources:

<https://e pg inflibnet.ac.in>

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SEMESTER – IV

PAPER-II

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – IV	
CORE COURSE	COURSE CODE: MZOT402	
TITLE	BIOCHEMISTRY AND METABOLIC REGULATION AND CELL FUNCTION	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	- To understand the structure, properties and functions of biomolecules. - To explain metabolism and regulation of carbohydrates, lipids and proteins. - To study nucleic acids, vitamins and their physiological significance. - To understand enzyme action and biochemical reactions in living systems. - To develop knowledge of biological oxidation and cellular energy production.	
Course Outcomes	CO1: Explain the chemistry and biological importance of major biomolecules. CO2: Describe metabolic pathways of carbohydrates, lipids, proteins and nucleic acids. CO3: Analyze the structure, properties and functions of enzymes and vitamins. CO4: Interpret mechanisms of biological oxidation and energy generation in cells. CO5: Apply biochemical concepts to understand molecular and metabolic processes in organisms.	
Syllabus	Description	No. of Lectures / Hours
UNIT - I	Water the solvent of life Chemistry of water Function and regulation of water balance General Structure of Monosaccharide Nomenclature, Definition and Classification Formation of Monosaccharide – Formation of glucose ▪ Linear form ▪ Ring form Haworth perspective formate ▪ Occurrence, Chemistry, Properties & hydrolysis of Oligosaccharides (Sucrose, Lactose, Maltose, Cellobiose, Isomaltose & Trehalose) Structure of Polysaccharides (Starch, Glycogen, Cellulose, Hyaluronic acid, Chondroitin and Heparin) - Metabolism of Carbohydrate – – – – – General Structure, Classification and function of Lipids Lipid Metabolism.	15
UNIT - II	Biosynthesis of Amino Acids and Structure & Properties Chemical bond – Peptide Bond o Secondary bond – Disulfide, Hydrogen, Non polar or hydrophobic and Ionic or Electrostatics bond o Characteristic of Chemical	15

	bond • Protein Configuration (a) Primary Structure (b) Secondary Structure (c) Tertiary Structure (d) Quaternary Structure • Biological function and metabolism of Protein • Metabolism of Inorganic elements 1. Macro- Minerals 2. Micro – Minerals	
UNIT - III	○ Nucleic Acid Chemistry of DNA & RNA, Nucleo Proteins • Metabolism of Nucleic Acid (Anabolism & Catabolism) 1. Biological importance of Nucleic Acid • Eicosanoids • Vitamin : Water & Fat Soluble Vitamin Chemistry, Occurrence and Physiological role of Vitamins	15
UNIT - IV	Enzymes • Nomenclature and Classification • Co- enzyme, Isoenzyme or Isozyme & Lysozyme • Biological role of enzyme • Properties and Characteristics of enzyme • Three-Dimensional Structure of enzyme • Enzyme Inhibitors and activators • Mechanism of enzyme action Biological Oxidation • Mitochondrial Electron Transport Chain • Oxidative Phosphorylation • Utilization of Krebs Cycle	15

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Text Books, Reference Books:

1. Lehninger Principles of Biochemistry, Fourth Edition

David L. Nelson, Michael M. Cox Publisher : W. H. Freeman

2. Biochemistry

Donald Voet, Hardcover : 1616 Pages Publisher : Wiley, 3rd Edition

3. Principles of Biochemistry with a Human Focus

Reginald H. Garrett, Charles M. Grisham Publisher : Brooks Cole

4. The Molecular Basis of Cell Cycle and Growth Control

Gray S. Stein (Editor), Renato Baserga, Antonio Giordano, David T. Denhardt, Publisher : Wiley- Liss

5. Experiments in Biochemistry : A Hands – on Approach

Shawn o. Farrell, T. Ranallo Publisher : Brooks Cole

6. Analysis of CD Effect on liver, Stomach and Intestine of Carp Fish by Hundet, A.

7. Histological and Histochemical staining techniques by Homason

8. fundamentals of Biochemistry - J.L Jain, S. Jain, N. Jain

E-Resources:

1. <https://e pg infibnet.ac.in>

SEMESTER – IV

PAPER-III

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – IV Optional Group I	
CORE COURSE	COURSE CODE: MZOT403	
Course Credits	04 Credits	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	- To understand the ethical, ecological, and economic values of wildlife conservation. - To master habitat evaluation using biological parameters and GIS technology. - To learn scientific methods for population estimation and field tracking. - To study wildlife laws, legislation, and national conservation organizations. - To gain expertise in managing protected areas and tiger conservation challenges.	
Course Outcomes	CO-1: Identify wildlife values and create strategies to prevent species loss. CO-2: Evaluate and manage habitats using GIS and Remote Sensing tools. CO-3: Conduct accurate population counts using tracking and census methods. CO-4: Understand and apply the Wildlife Protection Act and legal frameworks. CO-5: Manage tiger reserves, eco-tourism, and wildlife health protocols.	
Syllabus	Description	No. of Lectures / Hours
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 - Grazing logging - Mechanical treatment - Advancing the successional process - Cover construction - Preservation of general genetic diversity	15
UNIT - II	❖ Population estimation. - Population density, Natalty, Birth rate, Mortality, fertility schedules and sex ratio computation. - Faecal analysis of ungulates and carnivores - Faecal samples, slide preparation, Hair identification, Pug marks and census method. ❖ National Organization	15

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	• 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. Estimation of carrying capacity	
UNIT - III	Cave Biology ♦ Cave Biology: Concept, definition, and characteristic features of cave ecosystems ♦ Definition and characteristic features of caves ♦ Origin and scope of Biospeleology ♦ Classification of cave fauna: Classification and ecological categories of cave-dwelling animals ♦ Troglomorphism and adaptations of cave organisms: adaptive morphological, physiological, and behavioral modifications in cave organisms	15
UNIT - IV	▲ Quarantine. ▲ Common diseases of wild animal ▲ Protected areas - National parks & sanctuaries, Community reserve ▲ Important features of protected areas in India. ▲ Tiger conservation - Tiger reserve in M.P, in India. ▲ Management challenges in Tiger reserve. ▲ Stress physiology in wild animals ▲ Conservation Ethics in Biodiversity	15

Text Books, Reference Books:

1. . Gopal Rajesh : Fundamentals of wild life management
2. Agrawal K.C : Wild life India
3. Dwivedi A.P (2008) : Management wild life in India
4. Asthana D.K : Environment problem and solution
5. Rodgers N.A & Panwar H.S : Planning of wild life / Protected area Network in India vol. the report, wild life Institute of India Dehradun
6. Odum E.P : Fundamentals of Ecology
7. Saharia V.B : Wild life in India
8. Tiwari S.K : Wild life in Central India

9.

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9. E.P Gee : Wild life of India

9. Negi S.S : Wild life conservation (Natraj Publishers)

10. Verma, P.S.

E-Resources:

1. <https://e pg inflibnet.ac.in>

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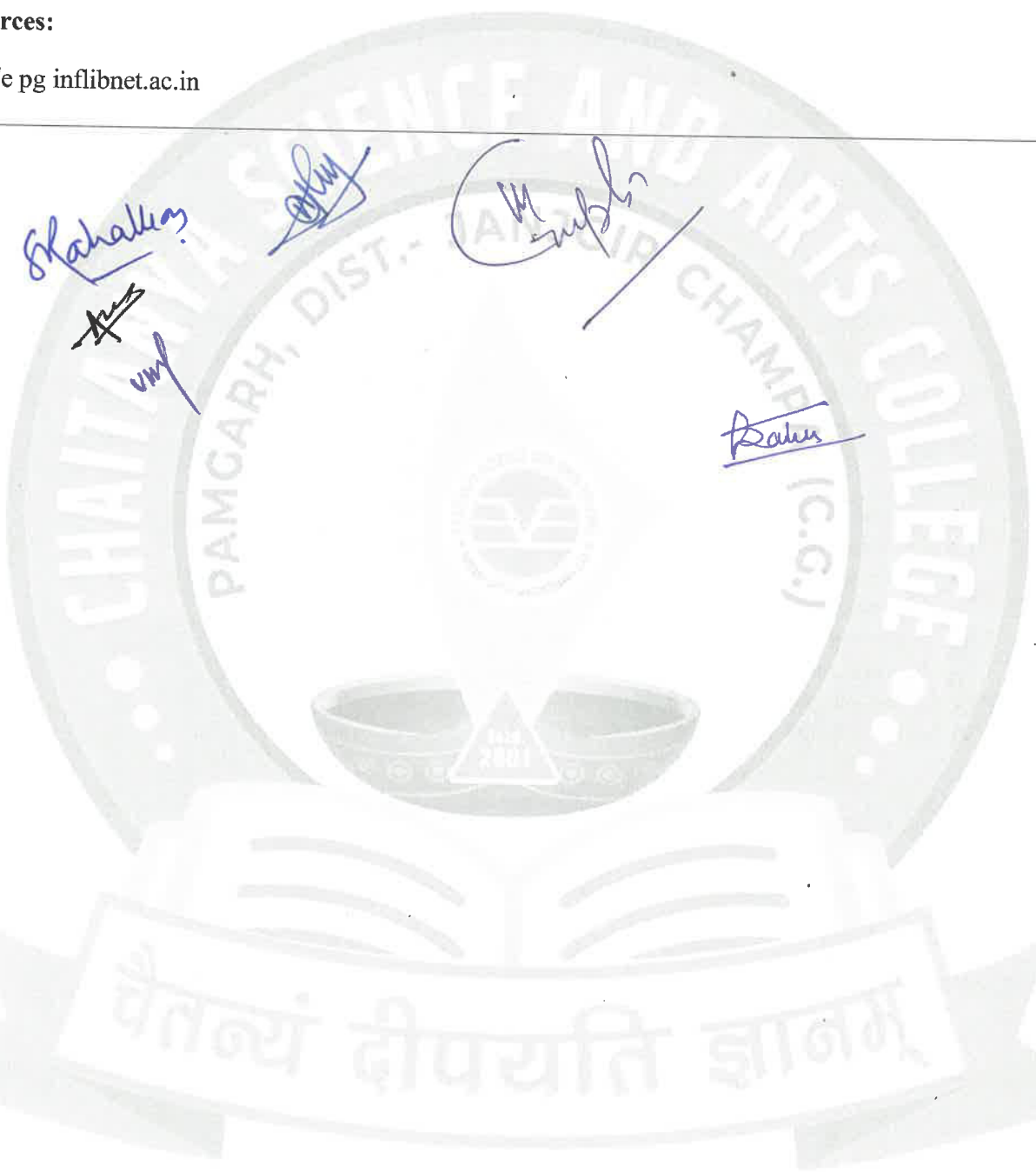
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**SEMESTER – IV
PAPER -IV**

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – IV Optional Group I	
CORE COURSE	COURSE CODE: MZOT404	
TITLE	ENVIRONMENT AND BIODIVERSITY CONSERVATION	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	- To understand the uses and impacts of over-exploiting natural resources. - To study the environmental effects of mining, modern agriculture, and dams. - To compare conventional and renewable energy sources for sustainability. - To learn the causes of biodiversity loss and conservation methods. - To promote equitable resource use and the individual's role in conservation.	
Course Outcomes	CO-1: Identify causes of forest, land, and water degradation and suggest remedies. CO-2: Evaluate the environmental impact of mineral extraction and intensive farming. CO-3: Propose the use of alternate energy sources for sustainable development. CO-4: Implement <i>in-situ</i> and <i>ex-situ</i> strategies to protect biodiversity and prevent poaching. CO-5: Apply the principles of equitable resource sharing in socio-economic contexts.	
Syllabus	Description	No. of Lectures / Hours
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. Bioremediation Biomagnification	15
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	15
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	15

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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 problems ▪ Effects of modern agriculture and overgrazing ❖ Energy ▪ Conventional and nonconventional energy resources ▪ Using of alternate energy sources ▪ 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 • Red data book	15
	Suggested Reading Materials: 1. Arora : Fundamentals of environmental biology 2. Anathakrishnan : Bio-resources ecology 3. Bottain : Environmental studies 4. Bouhey : Ecology of populations 5. Clark : Elements of ecology 6. Dowdoswell : An introduction to animal ecology 9. May : Model ecosystems 10. Odum : Ecology 11. Perkins : Ecology	

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| <p>12. Simmons : Ecology of estuaries and costal water</p> <p>13. Pawlosuske : Physico-chemical methods for water</p> <p>14. South Woods : Ecological methods</p> <p>15. Trivedi and Goel : Chemical and biological methods for water pollution studies</p> <p>16. Willington : Fresh water biology</p> <p>17. Wetzel : Limnology</p> <p>18. Welch : Limnology Vols. I-II</p> <p>7. Goldman : Limnology</p> <p>8. Kormondy : Concepts of ecology</p> | |
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**SEMESTER – IV
LAB COURSE - I**

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – IV Optional Group I		
CORE COURSE	COURSE CODE: MZOP401		
TITLE	LAB COURSE – I		
Total Marks	Total: 100 Marks, Minimum Passing Marks: 40		
PRACTICAL			
Course Outcomes	CO-1: Accurately quantify proteins, lipids, and carbohydrates using biochemical assays. CO-2: Identify and separate amino acids using chromatography and Sanger’s reagent. CO-3: Analyze hypothalamic nuclei and pituitary cells using histochemical staining. CO-4: Perform full hematological analysis including cell counts and serum biochemistry. CO-5: Record and interpret physiological diagnostics including ECG, EEG, and Blood Pressure.		
Syllabus	Description	No. of Lectures / Hours	
	1. Estimation of Protein by the Biuret, Lowry, Brad ford and Eosine-a comparasion 2. Determination of N-terminal Amino acids by the Sangers reagent (FDND) 3. Paper chromatographic separation of Amino acids 4. Quantitative estimation of Protein, carbohydrate, Mucosaccharide, Lipids and Enzyme (Bromophenol blue, PAS, Alcian blue, aldehyde fucsin, Acetylcholinesterase technique) 5. Identification of hypothalamic nuclei histological, hystochemical and Immunocytochemical method 6. Isolation and characterization of Pituitary cell 7. Estimation of MAC, MCH and MCHC 8. Total count of WBC and RBC 9. Differential count of WBC 10. Haemoglobin estimation and PCV estimation or ESR estimation 11. Quantitative estimation of blood serum by Colorimetry (I) Blood Urea (II) Blood glucose (III) Blood Calcium (IV) Blood Creatine (V) Blood cholesterol (VI) Blood Protein (VII) Blood Albumin 12. Blood clotting time 13. ECG Recording 14. Blood Pressure estimation 15. EEG	30	

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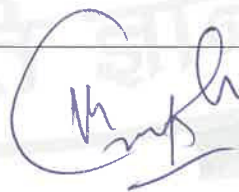
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Note:

1. Use of animals for dissection and practical work is subject to conditions that they are **not banned under the Wildlife Protection Act**.
2. External features and anatomy should be studied using **digital techniques or alternative methods**. Wherever live animals are used, they should be **pest or culturable species**, and no pain should be inflicted on them.

**SEMESTER-II
LAB – COURSE I****Time: 06 Hours****Maximum Marks: 100****Practical Exam Marks Distribution**

S. No.	Exercise / Component	Marks
1	Estimation of Protein	10
2	Estimations of Carbohydrate, Monosaccharide, Lipids and Enzyme (Two exercises)	20
3	Exercise based on Histochemical and Immuno-cytochemical method	10
4	Exercises based on Haematology (Two exercises)	20
5	Exercise based on ECG/EEG	10
6	Viva	10
7	Project	10
8	Sessional	10
	Total Marks	100



**SEMESTER-IV
LAB-COURSE II:**

Distribution of Marks in Practical Exam

Time: 6 Hours

Maximum Marks: 100

S. No.	Practical Examination Component	Details / Activities Included	Max. Marks
1	Paper III – Wildlife Conservation	Wildlife identification, study of endangered species, food chain & food web, protected areas, field survey, specimen study, charts/models, conservation techniques	35
2	Environmental Science & Biodiversity Conservation	Soil and water analysis, pond ecosystem study, biodiversity indices, pollution study, vermicomposting, flora & fauna identification, ecological survey	35
3	Project Work	Field report, biodiversity survey, environmental awareness project, conservation-based mini research/project file	10
4	Viva-Voce	Questions based on practicals, project work, specimens, instruments and basic concepts	10
5	Sessional	Practical record	10
	Total		100

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**SEMESTER – IV
LAB COURSE - II**

TITLE	LAB COURSE – II (MZOP402) Optional Group I	
Total Marks	Total: 100 Marks, Minimum Passing Marks: 40	
PRACTICAL		
Course Outcomes	CO1: Understand the basic concepts of Wildlife Conservation and biodiversity protection. CO2: Perform environmental and ecological practical experiments effectively. CO3: Identify local flora, fauna, and endangered species using scientific methods. CO4: Analyse environmental problems and suggest conservation measures. CO5: Develop practical skills through field survey, project work, and viva presentation.	
Syllabus	Description	No. of Lectures / Hours
	Part A: Biodiversity & Wildlife Assessment 1. To provide a comprehensive set for your M.Sc. Zoology practical record, I have integrated your specific experiments with additional advanced techniques required at the post-graduate level. 2. Here is the finalized list of experiments: 3. Part A: Biodiversity & Wildlife Assessment 4. Biodiversity Assessment Methods: To study and implement various sampling techniques (Line Transects, Point Counts, and Belt Transects) for recording the diversity of flora and fauna in a selected habitat. 5. Pitfall Trapping Method: To collect, identify, and assess the population density of ground-dwelling invertebrates (Arthropods) and study their micro-habitat preferences. 6. Avian Nesting Ecology: To identify and monitor bird nests in a selected habitat, recording parameters such as nest architecture, materials used, height from ground, and nesting success. . 7. Species Diversity Indices: To calculate the species richness, evenness, and diversity of a given area using the Shannon-Wiener Diversity Index (\$H'\$) and Simpson’s Index. 8. Faecal Scat & Pellets Analysis: To identify wild mammals through morphological examination of scats and analyse their seasonal diet composition (Scatology). 9. Microscopic Hair Analysis: To identify wild animal species based on the	

cuticular and medullary patterns of hair samples collected from the field.

Part B: Environmental Biology & Pollution Ecology

10. Lichens as Bio-indicators: To compare the growth, abundance, and diversity of lichens in industrial vs. residential areas to assess \$SO_2\$ pollution levels and air quality.
11. Physio-chemical Analysis of Water: To analyse water samples from wildlife habitats for parameters including pH, Turbidity, Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), and Total Dissolved Solids (TDS).
12. Physio-chemical Analysis of Soil: To determine the physical properties (texture, moisture, temperature) and chemical properties (pH, organic carbon, Nitrogen, Phosphorus, and Potassium) of soil samples.
13. Bioaccumulation Assessment: To detect and quantify heavy metal or pesticide residues in the tissues of aquatic bio-indicators (e.g., Fish or Molluscs).
14. Plankton Community Analysis: To study the trophic status of a freshwater ecosystem by estimating the density and diversity of Phyto- and Zoo-plankton using a Sedgwick-Rafter counting cell.
15. Noise Pollution Mapping: To monitor decibel levels in protected areas and "Silent Zones" using a Sound Level Meter to evaluate the impact of anthropogenic noise on wildlife communication.

Note:

1. Use of animals for dissection and practical work is subject to the condition that they are not banned under the Wildlife Protection Act.
2. External features and anatomy should be studied by digital techniques or alternative methods. Wherever live animals are used, they should be pest or culturable species, and care must be taken not to harm them.

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PROGRAMME	M.Sc. ZOOLOGY SEMESTER – IV (Optional Group II)	
TITLE	Fish (Ichthyology) Structure and Function	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	- To understand the diversity and evolution of fishes. - To study the structure and functions of fish organ systems. - To learn adaptations of fishes to aquatic environments. - To understand fish reproduction and development. - To appreciate the ecological and economic importance of fishes.	
Course Outcomes	CO1: Explain fish evolution and classification. CO2: Describe major organ systems of fishes. CO3: Identify adaptations in different fish habitats. CO4: Understand fish reproduction and development. CO5: Evaluate the significance of fishes in ecosystems and fisheries.	
Syllabus	Description	No. of Lectures / Hours
UNIT - I	Origin, Evolution and Classification of Fishes - Origin and evolution of fishes - Classification of fishes as proposed by Berg - Fish integument - Locomotion in fishes - Acoustic-lateral line system	15
UNIT - II	Digestive, Respiratory and Excretory Systems of Fishes (15 Lectures) - Alimentary canal and digestion - Accessory respiratory organs - Air bladder and its functions - Weberian ossicles: homologies and functions - Excretion and osmoregulation	15
UNIT - III	Adaptations and Special Organs in Fishes - Colouration in fishes - Luminous organs in fishes - Sound-producing organs - Deep-sea adaptations - Hill-stream adaptations	15

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UNIT - IV	Reproduction, Development and Migration in Fishes • Migration in fishes • Sexual cycle and fecundity • Parental care in fishes • Early development and hatching • Poisonous fishes	15
	Suggested Reading Materials 1. Jhingran, V.G. – Fish and Fisheries of India 2. Lagler, K.F. – Fish Biology 3. Carlander, K.D. – Freshwater Fishery Biology 4. Nikolsky, G.V. – The Ecology of Fishes / Fish Biology 5. Day, F. – The Fauna of British India: Fishes 6. Khanna, S.S. – An Introduction to Fishes 7. Parihar, N.S. – Fish Biology and Fisheries 8. Norman, J.R. – A History of Fishes / Introduction to Fishes 9. Mishra, K.S. – Identification of Fishes of India	



PROGRAMME	M.Sc. ZOOLOGY SEMESTER – IV (Optional Group II)	
TITLE	Applied Fisheries	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	• To understand fish biology and fisheries resources. • To study fish health, culture and management practices. • To learn different types of inland and marine fisheries. • To understand fish farming and breeding techniques. • To explore the economic importance of fisheries.	
Course Outcomes	CO1: Explain fish biology, colouration and diseases. CO2: Describe freshwater, marine and riverine fisheries. CO3: Understand reservoir, lacustrine and estuarine fisheries. CO4: Apply principles of fish farming and culture practices. CO5: Evaluate aquarium management, induced breeding and fisheries resources.	
Syllabus	Description	No. of Lectures / Hours
UNIT - I	Fish Biology, Health and Economic Importance 1. Introduction to Fisheries Science 2. Colouration in Fishes ○ Physical colours, chemical colours, mixed colours ○ Factors affecting colouration: temperature, stimulation, light and adaptive significance 3. Common Diseases of Fishes and Their Management ○ Skin parasites and diseases ○ Diseases of gills ○ Diseases caused by bacteria and viruses 4. Economic Value of Fishes ○ Fishes as human food ○ Fish meal for cattle ○ Fish manure, fish glue and isinglass	15

	○ Fish leather 5. Luminous Organs in Fishes	
UNIT - II	Freshwater and Marine Fisheries 1. Freshwater Fishes of Chhattisgarh and Their Culture 2. Maintenance of Nursery, Rearing and Stocking Ponds 3. Marine Fisheries ○ Deep-sea, coastal and offshore fisheries 4. Fishing Methods in Sea Coast ○ Crafts of east and west coast ○ Nets and gears, electric fishing and light fishing 5. Riverine and Cold-Water Fisheries	15
UNIT - III	Inland Fisheries and Fish Farming 1. Reservoir Fisheries ○ Distribution of reservoir fisheries 2. Lacustrine Fisheries ○ Types of lakes and principal lake fisheries 3. Estuarine Fisheries 4. Fish Farming (Pisciculture) 5. Principal Cultivable Fishes	15
UNIT - IV	Applied Fisheries and Aquarium Management (15 Lectures) 1. Larvivores Fishes 2. Exotic and Transplanted Fishes 3. Plankton and Its Role in Water Pollution and Fisheries 4. Preparation and Maintenance of Aquarium 5. Induced Breeding of Fishes	15
	Suggested Reading Materials 10. Jhingran, V.G. – Fish and Fisheries of India 11. Lagler, K.F. – Fish Biology 12. Carlander, K.D. – Freshwater Fishery Biology 13. Nikolsky, G.V. – The Ecology of Fishes / Fish Biology 14. Day, F. – The Fauna of British India: Fishes 15. Khanna, S.S. – An Introduction to Fishes 16. Parihar, N.S. – Fish Biology and Fisheries 17. Norman, J.R. – A History of Fishes / Introduction to Fishes 18. Mishra, K.S. – Identification of Fishes of India	

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TITLE	LAB COURSE – II Optional Group II		
Total Marks	Total: 100 Marks, Minimum Passing Marks: 40		
PRACTICAL			
	- To study the anatomy of freshwater fishes through dissection. - To understand the osteology of fishes. - To develop skills in microscopic slide preparation. - To learn taxonomic identification of fishes using museum specimens. - To gain field-based knowledge of freshwater fishes and fisheries practices.		
Course Outcomes	CO1: Demonstrate dissection techniques and identify major organ systems of fishes. CO2: Describe the skeletal structure and osteological features of fishes. CO3: Prepare and examine microscopic slides of fish tissues. CO4: Identify freshwater fishes of Chhattisgarh up to species level. CO5: Apply field and laboratory skills in fisheries studies and record preparation.		
Syllabus	Description	No. of Lectures / Hours	
	- Anatomy of different systems of Fresh water Fishes through dissections - Osteo logy of Fishes - Microscopic Preparation - Taxonomic study of Fishes through Museum specimen and collection - Identification of Fresh water Fishes of Chhattisgarh up to species level - Field work/ Industry visit and preparation of Record		
	Note: - Use of animals for dissection and practical work is subject to the condition that they are not banned under the Wildlife Protection Act. - External features and anatomy should be studied by digital techniques or alternative methods. Wherever live animals are used, they should be pest or culturable species, and care must be taken not to harm them.	30	

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SEMESTER-IV
Optional Group II
LAB – COURSE II

Time: 06 Hours

Maximum Marks: 100

Maximum Marks: 100

S. No.	Particulars	Marks
1	Dissection of Freshwater Fish / Virtual Dissection	10
2	Spotting (1–10)	20
3	Slide Preparation	10
4	Identification of Freshwater Fishes	20
5	Project Report and Field Visit	10
6	Viva-Voce	10
7	Sessional	20
Total		100

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – IV (Optional Group III)	
TITLE	Cell Biology	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	• To understand the molecular organization of chromosomes and chromatin. • To study gene structure, regulation and expression in eukaryotes. • To learn the role of transposable elements and transcription factors. • To understand environmental control of gene activity and genetic disorders. • To explain molecular mechanisms of development and gene regulation.	
Course Outcomes	CO1: Describe chromosome organization and specialized chromosomes. CO2: Explain gene structure, gene families and transposable elements. CO3: Analyze eukaryotic transcription and gene regulation mechanisms. CO4: Understand molecular basis of genetic disorders and DNA rearrangements. CO5: Explain developmental genetics using the Drosophila model system.	
Syllabus	Description	No. of Lectures / Hours
UNIT - I	Chromosome Organization and Specialized Chromosome 1. Molecular organization of eukaryotic chromosomes ○ Structure of nucleosome particles ○ Higher-order compaction of mitotic chromosomes ○ Chromatin remodelling 2. Specialized chromosomes I ○ Structural organization and functional significance of polytene chromosomes 3. DNA methylation and epigenetic regulation 4. Specialized chromosomes II ○ Structural organization and functional significance of lampbrush chromosomes	15
UNIT - II	Gene Organization and Regulation 1. Structural organization of eukaryotic genes	15

	○ Interrupted genes and overlapping genes ○ Evolution of genes 2. Gene families ○ Organization, evolution and significance 3. Transposable genetic elements of prokaryotes and eukaryotes 4. Organization of eukaryotic transcriptional machinery ○ Promoters, enhancers, transcription factors ○ RNA polymerase, activators and repressors 5. DNA-binding domains of transcription factors ○ Zinc finger, steroid receptor, homeodomain ○ Helix-loop-helix and leucine zipper	
UNIT - III	Gene Expression and Environmental Regulation 1. Eukaryotic transcription and its regulation 2. Environmental modulation of gene activity 3. Molecular basis of genetic disorders ○ Thalassaemia ○ Muscular dystrophy ○ Cystic fibrosis 4. DNA rearrangement 5. Gene amplification during development	15
UNIT - IV	Developmental Genetics 1. Drosophila development ○ Cleavage and gastrulation 2. Origin of anterior-posterior polarity ○ Maternal effect genes and segmentation genes 3. Origin of dorsal-ventral polarity 4. Homeotic (selector) genes 5. Homeotic mutations and their significance	15
	Suggested Reading Materials 1. De Robertis, E.D.P. and De Robertis, E.M.F. – <i>Cell and Molecular Biology</i>, Lea & Febiger. 2. Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M. – <i>Molecular Biology of the Gene</i>, Benjamin/Cummings Publishing Company. 3. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. – <i>Molecular Biology of the Cell</i>, Garland Publishing. 4. Watson, J.D., Gilman, M., Witkowski, J. and Zoller, M. – <i>Recombinant DNA</i>, Scientific American Books. 5. Karp, G. – <i>Cell and Molecular Biology: Concepts and Experiments</i>. 6. Lewin, B. – <i>Genes VII</i> (or latest edition). 7. King, R.C. – <i>Cell Biology</i>. 8. Hartl, D.L. and Jones, E.W. – <i>Genetics: Principles and Analysis</i>, Jones & Bartlett Publishers. 9. Kuby, J. – <i>Immunology</i>, W.H. Freeman and Company. 10. Roitt, I.M., Male, D. and Snustad, D.P. – <i>Immunology</i>.	

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – IV (Optional Group III)	
TITLE	Cellular and Molecular Organisation	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	- To provide knowledge of the structure and organization of viruses, yeast, and cellular components. - To develop understanding of intracellular organelles and their functions. - To explain mechanisms of cell cycle regulation and protein transport. - To introduce concepts of genome complexity and DNA organization. - To familiarize students with the molecular basis of cancer and cell signalling.	
Course Outcomes	CO1: Describe the structure and functions of viruses, yeast, and major cell organelles. CO2: Explain cell cycle control, protein trafficking, and secretory pathways. CO3: Interpret genome complexity, Cot analysis, and DNA sequence organization. CO4: Distinguish normal cells from cancer cells using cellular and genetic characteristics. CO5: Analyze the molecular mechanisms involved in cancer initiation and progression.	
Syllabus	Description	No. of Lectures / Hours
UNIT - I	Viruses, Yeast and Cell Organization - General organization and characteristics of viruses (SV40 and HIV). - Structure, reproduction, chromosome organization, and cloning applications of yeast. - Molecular organization of respiratory chain assemblies. - Cell cycle and its regulation in mammalian cells and <i>Xenopus</i>. - Cytochemistry of the Golgi complex and its role in cell secretion.	15
UNIT - II	Cell Organelles and Protein Trafficking - Structure and functions of peroxisomes and targeting of peroxisomal proteins. - Structure, biogenesis, and functions of the nucleolus. - Ultrastructure, functions, and role of lysosomes in intracellular digestion. - Synthesis and targeting of mitochondrial proteins. - Secretory pathways and translocation of secretory proteins across the endoplasmic reticulum membrane.	15
UNIT - III	Genome Organization and Cancer Cell Biology Genome complexity, C-value paradox, and Cot value.	15

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	• DNA sequences of different complexity. • Differences between normal and cancer cells: biochemical, cytoskeletal, and cell surface changes. • Genetic basis of human cancer.	
UNIT - IV	Molecular Basis of Cancer and Cell Signaling • Chromosomal abnormalities in human cancer. • Oncogenes, proto-oncogenes, and their role in cancer development. • Transforming agents and mechanisms of oncogenesis. • Tumor suppressor genes and their functions. • Receptor–ligand interactions, signal transduction, and cross-talk among signal pathways.	15
	Suggested Reading Materials 1. De Robertis, E.D.P. & De Robertis, E.M.F. <i>Cell and Molecular Biology</i>. Lea & Febiger. 2. Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A. & Weiner, A.M. <i>Molecular Biology of the Gene</i>. Benjamin/Cummings Publishing Company. 3. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. & Watson, J.D. <i>Molecular Biology of the Cell</i>. Garland Publishing Inc. 4. Gupta, P.K. <i>Molecular Cell Biology</i>. Rastogi Publications. 5. Watson, J.D., Gilman, M., Witkowski, J. & Zoller, M. <i>Recombinant DNA</i>. Scientific American Books. 6. Karp, G. <i>Cell Biology</i>. John Wiley & Sons. 7. Lewin, B. <i>Genes VII</i>. Oxford University Press. 8. King, R.C. <i>Cell Biology</i>. McGraw-Hill. 9. Hartl, D.L. & Jones, E.W. <i>Genetics: Principles and Analysis</i>. Jones and Bartlett Publishers. 10. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. & Darnell, J. <i>Molecular Cell Biology</i>. W.H. Freeman and Company. 11. Travers, P. <i>Immunology</i>. Current Biology Ltd. 12. Kuby, J. <i>Immunology</i>. W.H. Freeman and Company. 13. Riott, I.M., Male, D. & Snustad, D.P. <i>Principles of Genetics</i>. John Wiley & Sons Inc. Learning Resources • Textbooks on Cell Biology, Molecular Biology, Genetics, and Immunology. • Scientific journals and review articles related to Cell and Molecular Biology. • Online databases such as NCBI Bookshelf and PubMed for current research literature. • Laboratory manuals and practical guides in Cell and Molecular Biology.	

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TITLE	LAB COURSE – II Optional Group III		
Total Marks	Total: 100 Marks, Minimum Passing Marks: 40		
PRACTICAL			
Course Objective	• To study vertebrate cells and tissues. • To learn cytological and chromosomal techniques. • To understand microscopy and photomicrography. • To perform histochemical and microbial studies. • To apply chromatography and electrophoresis methods		
Course Outcomes	CO1: Identify vertebrate cells and tissues using microscopic techniques. CO2: Prepare and analyse chromosomes, karyotypes, and cellular structures. CO3: Operate microscopy and photomicrography techniques effectively. CO4: Perform microbial culture and histochemical studies. CO5: Apply chromatography and electrophoresis for molecular separation.		
Syllabus	Description	No. of Lectures / Hours	
	1. Examination of different cell types in vertebrate tissues. 2. Study of permanent cytological preparations. 3. Contrast microscopy. 4. Photomicrography. 5. Squash preparation of chromosomes and karyotype analysis. 6. Preparation of giant chromosomes and demonstration of chromosomal puffs. 7. Demonstration of Barr body and drumstick appendages. 8. Preparation and study of Golgi bodies and mitochondria. 9. Histochemical demonstration of RNA, DNA, phospholipids, and enzymes. 10. Preparation of microbial culture media and study of microbial growth. 11. Molecular separation techniques: Chromatography and electrophoresis.		

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Suggested Reading Materials / Books

1. **Karp, G.** – *Cell and Molecular Biology: Concepts and Experiments.*
2. **De Robertis, E.D.P. & De Robertis, E.M.F.** – *Cell and Molecular Biology.*
3. **Alberts, B. et al.** – *Molecular Biology of the Cell.*
4. **Lodish, H. et al.** – *Molecular Cell Biology.*
5. **Gupta, P.K.** – *Cell and Molecular Biology.*
6. **Freshney, R.I.** – *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.*
7. **Wilson, K. & Walker, J.** – *Principles and Techniques of Biochemistry and Molecular Biology.*

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SEMESTER-IV
Optional Group III
LAB – COURSE II

Time: 06 Hours

Maximum Marks: 100

Distribution of Marks in Practical Examination

S. No.	Component	Marks
1	Spotting	20
2	Cytology Exercise	10
3	Histochemistry Exercise	10
4	Chromatography & Electrophoresis	20
5	Microbiology / Karyotype	10
6	Viva-Voce	10
7	Sessional	20
Total		100

PROGRAMME	M.Sc. ZOOLOGY SEMESTER – IV (Optional Group IV)	
TITLE	Entomology (Morphology and Physiology of Insects)	
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40	
Course Objective	- To provide knowledge of insect morphology and cephalization. - To develop understanding of the structure and functions of insect organ systems. - To explain sensory mechanisms, reproduction, metamorphosis, and diapause in insects. - To study the reproductive biology, development, and endocrine regulation in insects. - To familiarize students with the diversity of larval and pupal forms in insects	
Course Outcomes	CO1: Describe the morphology of insect head, thorax, appendages, integument, and wings. CO2: Explain the digestive, excretory, respiratory, and circulatory systems of insects. CO3: Interpret the structure and functions of insect nervous and sensory systems. CO4: Analyze insect reproduction, metamorphosis, diapause, and endocrine regulation. CO5: Differentiate various types of insect larvae, pupae, and developmental stages.	
Syllabus	Description	No. of Lectures / Hours
UNIT - I	Insect Morphology and Adaptations - Cephalization and theories of cephalization. - Head capsule, antennae, and mouthpart modifications. - Thorax, legs, locomotion, and functional adaptations. - Integument, sclerotization, and moulting. - Wing venation in major insect orders.	15
UNIT - II	Physiology of Insects - Digestive system and digestion. - Excretory organs, excretion, and osmoregulation. - Respiratory structures and respiration. - Respiratory adaptations in aquatic and endoparasitic insects. - Circulation, haemocytes, and blood coagulation.	15
UNIT - III	Sensory Physiology and Metamorphosis - Nervous system and its modifications. - Photoreception, mechanoreception, and chemoreception. - Sound-producing organs and their functions. - Bioluminescence, reproduction, metamorphosis, and diapause.	15
UNIT - IV	Reproduction and Development - Internal and external reproductive organs. - Endocrine control of reproduction and metamorphosis.	15

- Embryonic and post-embryonic development.
- Types of larvae.
- Types of pupae.

Suggested Books

1. Chapman, R.F. – *The Insects: Structure and Function*.
2. Snodgrass, R.E. – *Principles of Insect Morphology*.
3. Gullan, P.J. & Cranston, P.S. – *The Insects: An Outline of Entomology*.
4. Richards, O.W. & Davies, R.G. – *Imms' General Textbook of Entomology*.
5. Wigglesworth, V.B. – *The Principles of Insect Physiology*.
6. Nayar, K.K., Ananthakrishnan, T.N. & David, B.V. – *General and Applied Entomology*.
7. Atwal, A.S. & Dhaliwal, G.S. – *Agricultural Pests of South Asia and Their Management*.
8. Pedigo, L.P. & Rice, M.E. – *Entomology and Pest Management*.

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PROGRAMME	M.Sc. ZOOLOGY SEMESTER – IV (Optional Group IV)		
TITLE	Entomology (Taxonomy, Economic Entomology and Pest Control)		
Total Marks	IA: 30 Marks, ESE 70 Marks, Total: 100 Marks, Minimum Passing Marks: 40		
Course Objective	- To provide knowledge of insect classification and taxonomy. - To understand the diversity of major insect orders. - To study the biology and economic importance of insect pests. - To explain insect behavior and parasitic adaptations. - To familiarize students with pest management strategies.		
Course Outcomes	CO1: Classify insects based on taxonomic characters. CO2: Describe the characteristics of major insect orders and families. CO3: Explain the life cycle and management of important insect pests. CO4: Analyse insect behaviour, social life, and parasitism. CO5: Evaluate different methods of pest control and integrated pest management.		
Syllabus	Description	No. of Lectures / Hours	
UNIT - I	Insect Classification and Diversity - History and basis of insect classification. - Overview of major insect orders. - Classification and characteristics of Thysanura, Collembola, Orthoptera, Hemiptera, Mallophaga, Lepidoptera, Diptera, Hymenoptera, and Coleoptera. - Classification based on Essig's College Entomology.	15	
UNIT - II	Agricultural Insect Pests - Classification, life cycle, economic importance, and control of paddy pests. - Classification, life cycle, economic importance, and control of sugarcane pests. - Classification, life cycle, economic importance, and control of pulse pests (Gram, Pea, Arhar). - Classification, life cycle, economic importance, and control of vegetable pests (Brinjal, Cabbage, Cauliflower, Lady Finger, and Cucumber).	15	
UNIT - III	Stored Grain Pests and Insect Behaviour - Classification, life cycle, economic importance, and control of stored grain pests. - Biology, damage potential, and management of aphids. - Locust phases and phase theory. - Social life in insects.	15	

	Parasitism in insects.	
UNIT - IV	Pest Management - Physical and cultural methods of pest control. - Chemical methods of pest control. - Biological control of insect pests. - Integrated Pest Management (IPM).	15
	Suggested Books - Essig, E.O. – <i>College Entomology</i>. - Richards, O.W. & Davies, R.G. – <i>Imms' General Textbook of Entomology</i>. - Chapman, R.F. – <i>The Insects: Structure and Function</i>. - Gullan, P.J. & Cranston, P.S. – <i>The Insects: An Outline of Entomology</i>. - Atwal, A.S. & Dhaliwal, G.S. – <i>Agricultural Pests of South Asia and Their Management</i>. - Pedigo, L.P. & Rice, M.E. – <i>Entomology and Pest Management</i>. - Nayar, K.K., Ananthakrishnan, T.N. & David, B.V. – <i>General and Applied Entomology</i>. - Hill, D.S. – <i>Agricultural Insect Pests of the Tropics and Their Control</i>.	

TITLE	LAB COURSE – II Optional Group IV		
Total Marks	Total: 100 Marks, Minimum Passing Marks: 40		
PRACTICAL			
Course Objective	- To develop skills in insect collection, preservation, and classification. - To understand the anatomy of economically important insects through dissection. - To study the morphology of insects using whole-mount preparations. - To learn basic histological and physiological techniques in entomology. - To identify common insect pests and their life cycles.		
Course Outcomes	CO1: Collect, preserve, and classify insects belonging to major orders. CO2: Demonstrate the anatomy of selected insects through dissection. CO3: Prepare and identify different insect appendages and whole mounts. CO4: Perform basic microtomy and insect physiology experiments. CO5: Identify common insect pests and document their life cycles.		
Syllabus	Description	No. of Lectures / Hours	
	1. Collection, preservation and classification of insects Collection, preservation and classification of insects belonging to the orders Thysanura, Collembola, Orthoptera, Hemiptera, Lepidoptera, Mallophaga, Diptera, Hymenoptera and Coleoptera. 2. Dissection of insects Dissection of Grasshopper, Cockroach, Cricket, Wasp and Honey Bee with special reference to nervous system, salivary glands, endocrine glands, sting apparatus of honey bee, and reproductive organs of Grasshopper and Cockroach. 3. Whole mount preparations of insects Whole mount preparation of small insects such as Collembola, Thysanura, Bedbug, Louse and stored grain pests. 4. Whole mount preparations of insect organs Whole mount preparation of different types of legs, antennae, wings, mouthparts, salivary glands and scales. 5. Microtomy techniques Microtomy of insect materials. 6. Insect physiology Simple experiments on insect physiology.		

	7. Identification of insect pests Identification and study of common insect pests. 8. Life cycle studies Collection and study of the life cycle of a pest associated with any economically important crop.	
	Suggested Books 1. Chapman, R.F. – <i>The Insects: Structure and Function</i>. 2. Richards, O.W. & Davies, R.G. – <i>Imms' General Textbook of Entomology</i>. 3. Gullan, P.J. & Cranston, P.S. – <i>The Insects: An Outline of Entomology</i>. 4. Snodgrass, R.E. – <i>Principles of Insect Morphology</i>. 5. Nayar, K.K., Ananthakrishnan, T.N. & David, B.V. – <i>General and Applied Entomology</i>. 6. Atwal, A.S. & Dhaliwal, G.S. – <i>Agricultural Pests of South Asia and Their Management</i>. 7. Pedigo, L.P. & Rice, M.E. – <i>Entomology and Pest Management</i>. 8. Triplehorn, C.A. & Johnson, N.F. – <i>Borror and DeLong's Introduction to the Study of Insects</i>.	

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SEMESTER-IV
Optional Group IV
LAB – COURSE II

Time: 06 Hours

Maximum Marks: 100

Distribution of Marks in Practical Examination

S. No.	Practical Component	Marks
1	Dissection of Available Insect Pests / Virtual Dissection	10
2	Spotting (1–10)	20
3	Micro Preparation	10
4	Experiment Based on Insect Physiology	10
5	Identification of Common Insect Pests	10
6	Project Report and Field Visit	10
7	Viva-Voce	10
8	Sessional	20
Total		100

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IMPORTANT NOTES:

1. **From the academic session 2026–2027**, all question papers in the first and second semesters of the M.Sc. Zoology program will be compulsory.
2. **Evaluation Structure (Semesters I & II):**
 - Total Theory Papers: 04 (280Marks), Internal Assessment: 120 Marks, Practical/Lab Course: (200)
 - **Total Marks: 600**
 - **Minimum Passing Marks: 40** in each course including External and Internal Exam.
3. **Elective Selection (Semesters III & IV):**
 - Students may choose any **one elective paper** from options A / B / C / D
4. **Examination Scheme:**
 - **Each paper will be evaluated as follows:**
 - End-Semester Examination: 70 Marks
 - **Section A** – 10 objective-type questions, one from each unit, without internal choice ($1 \times 10 = 10$ marks).
 - **Section B** – 4 short-answer questions, 5 marks each, one from each unit with internal choice ($5 \times 4 = 20$ marks). At least one question from every unit must be included.
 - **Section C** – 4 long-answer questions, 10 marks each, one from each unit with internal choice ($10 \times 4 = 40$ marks). At least one question from every unit must be included.
 - Continuous Internal Evaluation (CIE)/Internal Assessment includes: 30 Marks
 - Two tests (20 marks each), 10 marks for assignment, attendance, group discussions, and presentations, and as decided by the institution.
5. **Project Work (Semester I, II, III, IV):**
 - A **project report** must be submitted in the Each Semester, the report will be evaluated in two stages by an external examiner:
 - Evaluation of Project Report: 10 Marks, Viva-Voce Examination: 10 Marks.

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