Level 6.0	Curriculum Matrix M.Sc. Zoology						
Semester I					Marks Distribution		
Subject Type	**Subject Code**	**Name of Subject**	**Hours/ week**	**Credit (L+T+P)**	**External**	**Internal**	**Total**
Discipline Specific Core Course (DSCC)	MSC DSC - 101	Endocrinology	3	3	70	30	100
	MSC DSC - 102	Animal Physiology	3	3	70	30	100
	MSC DSC - 103	Biochemistry	3	3	70	30	100
	MSC DSC - 104	Bio-Instrumentation	3	3	70	30	100
Laboratory	MSC DSC - 105	Lab Course I	2	1	35	15	50
	MSC DSC - 106	Lab Course II	2	1	35	15	50
Discipline Specific Elective Course (DSEC)	MSC DSE - 101	Animal Biotechnology **OR** Entomology	4	4	70	30	100
	MSC DSE - 102						
Research Work	RM - 02	Research & Publication Ethics	4	4	70	30	100
		Total	**24**	**22**	**490**	**210**	**700**

Level 6.0	Curriculum Matrix M.Sc. Zoology						
Semester II					Marks Distribution		
Subject Type	**Subject Code**	**Name of Subject**	**Hours/ Week**	**Credit (L+T+P)**	**External**	**Internal**	**Total**
Discipline Specific Core Course (DSCC)	MSC DSC - 201	Molecular Biology and Biotechnology	3	3	70	30	100
	MSC DSC - 202	Non Chordata &	3	3	70	30	100

		Chordata					
	MSC DSC - 203	Immunology	3	3	70	30	100
	MSC DSC - 204	Genetics	3	3	70	30	100
Laboratory	MSC DSC - 205	Lab Course III	2	1	35	15	50
	MSC DSC - 206	Lab Course IV	2	1	35	15	50
Discipline Specific Elective Course (DSEC)	MSC DSE - 201	Pisciculture **OR** Apiculture	4	4	70	30	100
	MSC DSE - 202						
OJT/Internship/Project	INT - 01	Internship	4	4	70	30	100
		Total	**24**	**22**	**490**	**210**	**700**

Level 6.5	**Curriculum Matrix M.Sc. Zoology**						
Semester III					**Marks Distribution**		
Subject Type	**Subject Code**	**Name of Subject**	**Hours/ week**	**Credit (L+T+P)**	**External**	**Internal**	**Total**
Discipline Specific Core Course (DSCC)		Developmental Biology	3	3	70	30	100
		Reproductive Biology, Vertebrate and Applied Zoology	3	3	70	30	100
Laboratory		Lab Course V	2	1	35	15	50
		Lab Course VI	2	1	35	15	50
Discipline Specific Elective Course (DSEC)-I		General Parasitology **OR** Animal Behaviour	4	4	70	30	100
Discipline Specific Elective Course (DSEC)-II		Evolutionary Biology and Economic Zoology **OR** Environmental Biology & Wild Life Conservation	4	4	70	30	100

RP		Research Project and Proposal Writing	6	6	105	45	150
		Total	**24**	**22**	**455**	**195**	**650**

Level 6.5	**Curriculum Matrix M.Sc. Zoology**						
Semester IV					**Marks Distribution**		
Subject Type	**Subject Code**	**Name of Subject**	**Hours/ Week**	**Credit (L+T+P)**	**External**	**Internal**	**Total**
Discipline Specific Core Course (DSCC)		Neuroscience: Neuroendocrinology and Non Classical Hormones	3	3	70	30	100
		Toxicology and Medical Zoology	3	3	70	30	100
Laboratory		Lab Course VII	2	1	35	15	50
		Lab Course VIII	2	1	35	15	50
Dissertation		Dissertation Work and Thesis Writing		12	175	75	250
		Dissertation Seminar		1	35	15	50
		Viva- Voce		1	35	15	50
		Total		**22**	**455**	**195**	**650**

SEMESTER I

ENDOCRINOLOGY

Credit: 3

Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge of Endocrinology.
2. To train the students to pursue further education.
3. To be familiar with Endocrinological concepts.
4. To gain experience of Endocrinological concepts.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Endocrinology and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

UNIT I: General characters of hormones, Mechanism of hormone action: Protein hormones, Membrane receptors, G-proteins, biosynthesis and secretion of pituitary gland, Steroid hormones.

UNIT II: Hypothalamus-hypophysial System: General organization, Neurohypophysial hormones: oxytocin and vasopressin, Neural control of adenohypophysis: hypophysiotropic hormones and actions, Adenohypophysial hormones: chemistry and physiological roles of somatotropin and prolactin, Glycoprotein hormones: FSH, LH and TSH and Pro-opiomelanocortin: ACTH, MSH.

UNIT III: Thyroid hormones: biosynthesis, control of secretion and physiological role of thyroid hormones. Parathyroid: Parathormone, calcitonin and vitamin D in calcium homeostasis; Endocrine pancreas: biosynthesis and physiological actions of insulin and glucagon.

UNIT IV: Gonadal hormones: Steroid hormone biosynthetic pathways, Testis: organization and physiological role of androgens, Ovary: organization and physiological role of estrogen, progesterone, relaxin and inhibin.

UNIT V: Adrenal cortex: Organization Mineral corticoid and glucocorticoid hormone: control of secretion and physiological role. Adrenal medulla: catecholamine biosynthesis, release and physiological role.

SUGGESTED READINGS:

1. Bentley: Comparative Vertebrate Endocrinology (1998, Cambridge University Press

2. Norris: Vertebrate Endocrinology (4th ed 2007, Academic press)
3. Hadley: Endocrinology, Prentice Hall (6th ed.2007)
4. Brooks and Marshall: Essentials of Endocrinology (1995,Blackwell Science)
5. Turner and Bagnara: General Endocrinology (1984,Saunders)
6. Larson: Williams Textbook of Endocrinology (10th ed 2002, Saunders)

ANIMAL PHYSIOLOGY

Credit: 3

Total Marks: 100 (70+30)

Course Objectives:

1. Understand the physiological mechanisms in animals at the cellular, organ, and system levels.
2. Analyze the coordination and integration of different physiological processes in vertebrates and invertebrates.
3. Apply knowledge of animal physiology to comprehend adaptations and homeostatic mechanisms.
4. Evaluate the physiological responses to environmental and pathological conditions.
5. Perform and interpret physiological experiments using appropriate tools and techniques.

Course Outcomes:
Skills that students obtain after completion of the course:

1. Describe the structure and function of major physiological systems—nervous, circulatory, respiratory, excretory, digestive, endocrine, and reproductive.
2. Explain the biochemical and biophysical principles underlying physiological functions like muscle contraction, neural transmission, and membrane transport.
3. Demonstrate understanding of regulatory mechanisms such as feedback loops in thermoregulation, osmoregulation, and hormonal control.
4. Compare physiological processes across animal taxa to illustrate evolutionary adaptations.

UNIT I: BLOOD: Blood and circulation - Blood corpuscles, hemopoiesis and formed element, Plasma function, blood volume and blood volume regulation, Blood groups, hemoglobin, immunity and homeostasis. Digestive system - Digestion, absorption, energy balance, BMR.

UNIT II: CARDIOVASCULAR SYSTEM: Comparative anatomy of heart structure, Myogenic heart, specialized tissue and ECG – its principle and significance Cardiac cycle. Heart as a pump, blood pressure, neural and chemical regulation of all above. Muscle Physiology: Types of muscles: skeletal, cardiac, smooth Mechanism of muscle

contraction (sliding filament theory) Neuromuscular junction

UNIT III: RESPIRATORY SYSTEM: Respiratory system - Comparison of respiration in different species, anatomical considerations Transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. Nervous system – Neurons and Action potential Gross neuroanatomy of the brain and spinal cord Central and peripheral nervous system, neural control of muscle tone and posture

UNIT IV: SENSE ORGANS: Sense organs - vision, hearing and tactile response. Excretory system - comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, Regulation of water balance, blood volume, blood pressure, electrolyte balance.

UNIT V: THERMOREGULATION AND ENDOCRINOLOGY: Thermoregulation - comfort zone, body temperature, Physical, chemical, neural regulation, acclimatization. Endocrinology and reproduction - Endocrine glands, basic mechanism of hormone action. Male and female reproductive systems, Gametogenesis, menstrual cycle, fertilization, Hormonal control of reproduction.

SUGGESTED READINGS:

1. Guyton & Hall – Textbook of Medical Physiology

2. Hoar W.S. – General and Comparative Physiology

3. Randall, Burggren & French – Animal Physiology: Mechanisms and Adaptations

4. Eckert – Animal Physiology: Mechanisms and Applications

5. Sherwood – Human Physiology: From Cells to Systems

6. Animal Physiology by P.S. Verma, B.S. Tyagi, and V.K. Agarwal:

BIOCHEMISTRY

Credit: 3

Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge of Biochemistry.
2. To train the students to pursue further education.
3. To be familiar with concepts of Biochemistry.
4. To gain experience of Biochemical techniques.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Biochemistry and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

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 & Functions of carbohydrates, Carbohydrate metabolism (Glycolysis, Kreb's cycle, HMP pathway, Gluconeogenesis).

UNIT-III: Lipids: Structure, classification and functions of lipids. Lipid metabolism (β- oxidation of fatty acids, biosynthesis of fatty acids), Synthesis of triacylglycerols. Lipoproteins.

UNIT IV: Enzymes: Classification and nomenclature, factors affecting enzyme activity, enzyme inhibition, mechanism of action, regulation of enzyme activity and functions of Co-enzymes.

UNIT V: Nucleic acid: Structure and chemistry of DNA, types and chemistry of RNA, Biological importance of nucleic acids, Nucleoproteins, Metabolism of nucleic acids.

SUGGESTED READINGS:

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.

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

5. Experiments in Biochemistry: A Hands-On Approach: Shawn O. Farrell, Ryan T. Ranallo, Publisher: Brooks Cole.

BIO-INSTRUMENTATION

Credit: 3
Total Marks: 100 (70+30)

Course Objectives:

1. To introduce students to the fundamental principles and instrumentation of centrifugation and microscopy, and their applications in biological research.
2. To provide an understanding of radioisotope techniques, radioactive decay, methods of detection, and safety measures along with applications of mass spectrometry in biological sciences.
3. To develop knowledge of spectrophotometric principles, UV–Visible, IR, atomic, and NMR spectroscopy techniques for structural and functional analysis of biomolecules.
4. To familiarize students with different chromatographic techniques, their principles, instrumentation, and applications for separation and purification of biomolecules.
5. To impart theoretical and practical insights into electrophoretic techniques for the separation, identification, and characterization of proteins, nucleic acids, and other macromolecules.

Course Outcome:
Skills that students obtain after completion of the course:

1. Demonstrate knowledge of centrifugation and microscopy principles and apply them in biological sample preparation and analysis.
2. Explain the principles of radioactivity, radioisotope safety, and evaluate the applications of radioisotopes and mass spectrometry in biological research.
3. Apply spectrophotometric laws and interpret data obtained from UV, IR, atomic, and NMR spectroscopy for molecular analysis.
4. Analyze biomolecules using various chromatographic methods and determine their suitability for specific biological applications.
5. Utilize electrophoretic methods for the separation, identification, and characterization of proteins, nucleic acids, and other macromolecules.

UNIT I

Centrifugation techniques: Basic Principles of Sedimentation.
Centrifuge and Rotor: Types, Instrumentation and Applications.
Microscopy: Principles of Microscopy; Types: Bright field, Dark field, Phase contrast, Confocal and Fluorescent, Electron Microscopes (SEM andTEM).

UNIT II

Radioisotopes Techniques: Radioactive decay. Detection and different methods of measurement of radioactivity.Use of radioactive isotopes in biology; Safety aspects.
Mass Spectrometry: Principles, Techniques and Applications;Mass spectrometer, MALDI-TOF.

UNIT III

Spectrophotometric Techniques: - Basic principles; Lambert Beer's Law, Absorbance, Transmittance and Extinction Coefficient.
UV, Visible and Infrared Spectroscopy: Theory, Instrumentation and Applications;
Atomic Spectroscopy and Nuclear Magnetic Resonance (NMR) Spectroscopy: Theory, Instrumentationand Application

UNIT IV
Chromatography Techniques: Basic Principles, Instrumentation and Applications;
Plane Chromatography: Paper and Thin Layer Chromatography (TLC).
Column chromatography: Adsorption, Partition, Gel filtration, Ion exchange, Affinity chromatography,High Performance Liquid chromatography (HPLC).

UNIT V
Electrophoretic Techniques: Theory, Instrumentation and Applications;
Types: Paper, Gel electrophoresis, Isoelectric Focusing, Pulse Field Gel Electrophoresis, Immuno-electrophoresis, Electroblotting techniques.

SUGGESTED READINGS:

1. Biophysical Chemistry Principles and Techniques: Upadhyay, Upadhyay and Nath.
2. Biotechniques Theory and Practice: S V S Rana; Rastogi Publications.
3. Principles and Techniques of Biochemistry and Molecular Biology: K Wilson and J Walkar.
4. Physical Biochemistry Principles and Application: D Sheehan; Wiley
5. Physical Biochemistry and Molecular Biology: Freifelder D.
6. Principles of instrumental analysis: Skoog and West.
7. Biochemical Techniques: Theory and Practice-Robyt and White.
8. Principles and Techniques of Practical Biochemistry: Williams and Wilson.

CO–PO–PSO Attainment Matrix

Subject	Bio-Instrumentation														
Code	MSC DSC - 104														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	3	3	2	1	2	2	3	3	2	2	2
CO2	3	3	3	3	3	3	3	2	3	2	3	3	2	1	2

Subject	Bio-Instrumentation														
Code	MSC DSC - 104														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO3	3	2	3	2	3	3	2	1	2	2	3	3	2	1	2
CO4	3	2	3	2	3	3	2	1	2	2	3	3	3	1	3
CO5	3	2	3	2	3	3	2	1	2	2	3	3	2	1	3

Legend

- **0 = No contribution**
- **1 = Low**
- **2 = Medium**
- **3 = High**

LAB COURSE I
ENDOCRINOLOGY

Credit: 1
Total Marks: 50 (35+15)

The practical work in general shall be based on the syllabus prescribed in theory. The students will be required to show the knowledge of the following:

1. Handling, sexing, numbering and maintenance of rat
2. General survey of endocrine glands in rat
3. Study of vaginal smear preparation in rat
4. Demonstration of the following surgical operations in rat: orchidectomy, ovariectomy
5. Study of histological slides of the following endocrine glands in rat: pituitary, thyroid, adrenal, endocrine pancreas, testis and ovary Demonstration of endocrine glands in cockroach
6. Demonstration of frog metamorphosis by models and charts

LAB COURSE II

ANIMAL PHYSIOLOGY

Credit: 1

Total Marks: 50 (35+15)

The practical work in general shall be based on the syllabus prescribed in theory. The students will be required to show the knowledge of the following:

1. Study of mammalian reproductive organs (slides/specimens).
2. Study of histological slides of liver, kidney, lungs, and intestine, etc.
3. Total erythrocyte count (RBC) and total leukocyte count (WBC) using a hemocytometer.
4. Study of the representative examples of the different chordates (Classification and character)
5. Study of limb girdles and vertebrae of frog, varanus, fowl and Rabbit.

ANIMAL BIOTECHNOLOGY

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. Understand fundamental concepts of animal biotechnology, including molecular biology and cell culture.
2. Analyze and apply gene transfer and transgenic technologies for research and commercial applications.
3. Demonstrate knowledge of techniques used in animal cell culture, cloning, and tissue engineering.
4. Evaluate the role of biotechnology in animal health, diagnostics, conservation, and productivity.
5. Apply bioethical principles, biosafety guidelines, and regulatory aspects in animal biotechnology.

Course Outcomes:

1. Explain the scope, history, and bioethical implications of animal biotechnology.
2. Perform basic molecular techniques like PCR, electrophoresis, and DNA isolation from animal tissues.
3. Describe and differentiate various methods of gene transfer and analyze their outcomes in transgenic animal models.
4. Culture animal cells under aseptic conditions and maintain them for experimental or therapeutic purposes.
5. Apply biotechnology tools for animal disease diagnosis, vaccine development, and genetic improvement.
6. Analyze real-world applications such as animal cloning, conservation, and production of recombinant proteins.
7. Use bioinformatics tools to analyze gene/protein sequences from animal genomes.

Unit I: Introduction to Animal Biotechnology

- History and scope of animal biotechnology
- Ethical and regulatory issues in animal biotechnology
- Laboratory safety, bioethics, and biosafety levels
- Animal cell and tissue culture: media preparation, growth factors, cell lines

Unit II: Molecular Techniques in Animal Biotechnology

- DNA isolation and purification techniques
- PCR and RT-PCR: principles and applications
- Gel electrophoresis and blotting techniques (Southern, Northern, Western)
- Recombinant DNA technology and gene cloning
- CRISPR/Cas9 and genome editing basics

Unit III: Transgenesis and Gene Transfer

- Transgenic animals: mice, sheep, pigs, cattle
- Methods of gene transfer: microinjection, electroporation, viral vectors
- Applications of transgenic animals in research and agriculture
- Knock-in and knock-out models
- Animal cloning: somatic cell nuclear transfer (SCNT), Dolly the sheep case study

Unit IV: Animal Cell Culture and Applications

- Primary cell culture and immortal cell lines
- Culture of specific animal cells (e.g., fibroblasts, lymphocytes, epithelial cells)
- Applications: vaccine production, monoclonal antibodies, stem cell technology
- Organoids and 3D cultures
- Bioreactors for large-scale animal cell culture

Unit V: Applications and Current Trends

- Biotechnology in animal health: diagnostics, vaccines, gene therapy
- Molecular markers in animal breeding (RAPD, AFLP, SSR)
- Conservation biotechnology: DNA barcoding, cryopreservation, cloning endangered species
- Production of recombinant proteins in animals
- Bioinformatics in animal biotechnology

SUGGESTED READINGS:

1. Brown, T.A. – *Gene Cloning and DNA Analysis*
2. Primrose & Twyman – *Principles of Gene Manipulation and Genomics*
3. Freshney, R.I. – *Culture of Animal Cells: A Manual of Basic Technique*
4. Glick & Pasternak – *Molecular Biotechnology*

ENTOMOLOGY

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. Understand insect classification, morphology, and physiology.
2. Explain insect development, reproduction, and metamorphosis.
3. Evaluate the ecological and economic importance of insects.
4. Apply knowledge for pest control and integrated pest management.
5. Develop skills in insect collection, identification, and preservation.

Course Outcomes:

1. Describe the external and internal morphology of insects.
2. Explain the physiological processes such as respiration, circulation, and excretion in insects.
3. Illustrate types of metamorphosis and reproductive strategies.
4. Distinguish between beneficial and harmful insects.
5. Demonstrate methods of insect collection, pinning, and slide mounting.
6. Apply ecological principles in understanding insect behavior and population dynamics.
7. Formulate pest management plans including biocontrol and IPM strategies.

Unit I: Insect Morphology

- General body plan
- Tagmata: Head, thorax, abdomen
- Mouthparts, legs, wings and their modifications
- Integument and molting

Unit II: Insect Physiology

- Digestive, circulatory, respiratory, excretory, and nervous systems
- Endocrine control and hormones
- Sense organs and insect vision

Unit III: Growth and Development

- Metamorphosis: Types and hormonal control
- Reproduction: Male and female reproductive systems
- Oviposition and parental care

Unit IV: Ecology and Economic Importance

- Insects in different habitats (aquatic, terrestrial)
- Beneficial insects: Pollinators, parasitoids, predators
- Harmful insects: Agricultural pests, vectors of diseases

Unit V: Pest Management

- Major crop pests and their management
- Biological control, chemical control
- Integrated Pest Management (IPM)
- Insecticide resistance and environmental impact

SUGGESTED READINGS:

Imms' General Textbook of Entomology – Richards & Davies

Principles of Insect Morphology – R.E. Snodgrass

A Textbook of Entomology – H.H. Ross

Introduction to Insects – Borror, Triplehorn & Johnson

Entomology and Pest Management – Larry P. Pedigo

Insect Physiology and Biochemistry – James L. Nation

Integrated Pest Management – D. Dent

The Insects: Structure and Function – R.F. Chapman

ICAR Publications on Crop Pests and Management

RESEARCH & PUBLICATION ETHICS

Credit: 4

Total Marks: 100 (70+30)

Course Objectives:

1. Understand the philosophy and fundamentals of research ethics.
2. Apply ethical principles in scientific research and publication.
3. Identify unethical practices and avoid research misconduct.
4. Evaluate the credibility of journals and publishers.
5. Interpret research metrics and databases to assess publication quality.

Course Outcomes:

Skills that students obtain after completion of the course:

1. Explain the concept of ethics and philosophy in research.
2. Describe different forms of research and publication misconduct.
3. Recognize predatory journals and unethical publication practices.
4. Utilize tools for plagiarism detection and ethical publication.
5. Analyze impact metrics and databases to improve research dissemination.

UNIT I: Philosophy and Ethics

- Introduction to philosophy: definition, nature, and scope, concept, branches
- Ethics: definition, moral philosophy, nature of moral judgments and reactions

UNIT II: Scientific Conduct

- Ethics in conducting research
- Research misconduct: fabrication, falsification, plagiarism
- Conflict of interest
- Guidelines for ethical research

UNIT III: Publication Ethics

- Publication ethics: definition, importance
- Best practices/standards setting initiatives and guidelines (COPE, WAME, etc.)
- Publication misconduct: types, identification, and prevention
- Predatory publishers and journals

UNIT IV: Publication Misconduct

- Identification of publication misconduct
- Complaints and appeals
- Role of authorship and contribution
- Investigation tools (e.g., Turnitin, iThenticate)

UNIT V: Databases and Research Metrics

- Databases: Indexing databases (Scopus, Web of Science, etc.)
- Research metrics: Impact Factor, h-index, i10 index, altmetrics
- Citation databases and research visibility

SUGGESTED READINGS:

- ***Macrina, F. L.*** *(2014). Scientific Integrity: Text and Cases in Responsible Conduct of Research. ASM Press.*
- ***Resnik, D. B.*** *(2020). The Ethics of Science: An Introduction. Routledge.*
- ***Steneck, N. H.*** *(2007). ORI Introduction to the Responsible Conduct of Research. U.S. Department of Health and Human Services.*
- ***ICMR Guidelines*** *– Ethical Guidelines for Biomedical Research on Human Participants, ICMR, New Delhi.*
- ***COPE (Committee on Publication Ethics)*** *website: https://publicationethics.org/*
- ***Shamoo, A. E., & Resnik, D. B.*** *(2009). Responsible Conduct of Research. Oxford University Press.*
- *UGC E-Content on Research and Publication Ethics (Available on Swayam and UGC portals)*

SEMESTER-II

MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Credit: 3

Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge of Molecular Biology and Biotechnology.
2. To train the students to pursue further education.
3. To be familiar with concepts of Molecular Biology and Biotechnology.
4. To gain experience of standard tools in Molecular Biology and Biotechnology.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Molecular Biology and Biotechnology and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

UNIT I: Biomembranes: Molecular composition and arrangement Transport across membrane, Structure and function 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, Industry

UNIT V: Biotechnology: Scope, Importance and Applications, Animal tissue culture techniques: Importance and application, Scope.

List of Recommended Books

1. Molecular Cell Biology: Lodish, W.H. Freeman & Co. NewYork
2. Lehninger: Principles of biochemistry, Fourth Edition-David L Nelson, Michael M.Cox
3. Molecular Cell Biology: Lodish M. Baltimore, Scientific American books “Essentials Of Cell & Molecular biology” Roberties & Roberties, Halt Saunders International Edition.
4. Cell & Molecular Cell biology: Gerald Karp, Willey & Sons Co.

5. Medical Cell biology: Flickinger E.J. Brown J.C. Halt Saunders International Edition
6. Cell Biology: Powar C.B. Himalaya Publishing House.

NON-CHORDATA AND CHORDATA

Credit: 3

Total Marks: 100 (70+30)

Course Objectives:
1. To impart in-depth knowledge of Non Chordata and Chordata.
2. To train the students to pursue further education.
3. To be familiar with concepts of Non Chordata and Chordata.
4. To gain experience of concepts of Non Chordata and Chordata.

Course Outcome:
Skills that students obtain after completion of the course:
1. Understanding of the fundamentals of concepts of Non Chordata and Chordata and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

UNIT I: Protozoa: Nucleus and reproduction; Origin of metazoans; Porifera: Canal system; Cnidaria: Polymorphism in Siphonophora, Annelida: Adaptive radiation in polychaetes, Trochophore larva.

UNIT II: Mollusca: Torsion in gastropods, larval forms; Arthropoda: Evolutionary significance of Trilobites, Crustacean larvae and their significance. Echinodermata: larval forms and their significance.

UNIT III: Salient features and affinities of Placozoa, Mesozoa, Rotifera, Phoronida, Sipuncula and Hemichordata

UNIT IV: Characteristic features and affinities of Protochordata and Cyclostomata; Origin of the Fish, Amphibian, Special character of amphibian: Parental care

UNIT V: Characteristic features and affinities of Reptile, Bird, Mammal, Adaptive radiations in vertebrates: Aquatic, Terrestrial, Aerial, Arboreal, Fossorial. Special characters: Venom in ophidians, Poisonous and Non-poisonous snakes; Biting mechanisms of snakes, Migration in birds' Flightless birds.

SUGGESTED READINGS:

1. Jordan & Verma: Chordate Zoology (1998,S.Chand),

2. Kotpal: The Birds (4th ed, 1999, Rastogi Publications),

3. McFarland *et.al:* Vertebrate Life (1979, Macmillan Publishing)

4. Parker & Hashwell: Textbook of Zoology, Vol.II (1978, ELBS), Romer & Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan).

5. Sinha, Adhikari & Ganguli: Biology of Animals Vol.II (1988, New Central Book Agency).

IMMUNOLOGY

Credits 3
Total Marks: 100 (70+30)

Course Objectives:

1. To impart through knowledge of Immunology.
2. To train the students to pursue further education.
3. To be familiar with Immunological tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Immunology and key principles of it.
2. Awareness of the major issues at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

UNIT I

Introduction; Cells of the Immune system; Innate and Acquired immunity; Organs and cells involved in immune system and Primary and Secondary immune response; Nature of antigens; Chemical and molecular basis of antigenecity; superantigen, Immunogenicity; Epitopes, Haptens, Adjuvant, Freund's adjuvants and its significance. Immune Responses; Theory of Clonal selection.

UNIT II

B-lymphocytes, their subpopulation and activation; Structure and function of Immunoglobulin; Antigenic determinants on immunoglobulin; Antigen-Antibody interactions; Antibody affinity, avidity; Agglutination; Precipitation; Idiotypic antibodies; Theories of antibody formation, hybridoma technology for monoclonal antibodies and designer monoclonal antibodies. Multiple mylomas and structural basisof antibody diversity; Antibody engineering; Generation of antibody diversity; Major Histocompatibility Complex.

UNIT III

Biology of T lymphocyte; Classification of T lymphocytes; Structure of T Cell Receptor (TCR); TCR diversity and genetics, Antigen processing and presentation; Cytokines; Cell mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis; Hypersensitivity. Non-specific immune mechanism: Surface defenses, Tissue defenses, Opsonization, Inflamatory reaction, and Hormone balance. Tissue metabolites with bactericidal properties (lysozyme, nuclein, histone, protamine, basic peptides of tissues – leukins, phagocytins, lecterins, haemocompounds).

UNIT IV

Expressions and Regulation of Immune Response: Antigen processing and presentation, Generation of humoral and cell mediated immune response, Activation of B and T lymphocytes, Cytokines and their role

in immune regulation, T cell regulation, MHC restriction, Immunological tolerance. Cell mediated cytotoxicity: Mechanism of T cells and NK mediated lysis, antibody dependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity. Complement system, Regulation of complement activation. Transplantation immunology: MHC, Types of grafts, Grafts rejection, GVH reactions, Mechanism of graft rejection and prevention of graft rejection.

UNIT V

Immunity and Immunoassays Defense against bacteria, viruses, fungi and parasites including Immunodiagnostics and immunotherapy. Immuno-assays: SRID, ELISA, ELISA-PCR, RIA, Western Blotting, FACS, Immunofluorescence, Flow cytometry, Immunodiffusion and Immunoelectrophoresis; Hemagglutination; Immunofluroscens and their application.

SUGGESTED READINGS:

- Immunology: Kubey
- Immunology: A short Course; Eli Benjamin, Richard Coico
- Fundamentals of Immunology: William Paul
- Essentials of Immunology (6th Edition): Ivan Riot- Blackwell Scientific Publications, Oxford, 1988.
- Antibodies- A laboratory Manual: Harlow and David Lane (1988), Old Spring harbor Laboratory.
- Immunology: Roitt, Brostoff and Male
- Immunology: C.A. Janeway and Paul Travers.
- Immunology: Weir, D.M. 1992.
- Immunological techniques: I. R. Tizard, Immunology, An Introduction, 1995, 4th edition – Saunder's.

CLASSICAL GENETICS

Credits 3
Total Marks: 100 (70+30)

Course Objectives:

1. To impart knowledge on Mendel's laws and their molecular basis.
2. To study chromosome behavior during meiosis and its impact on inheritance.
3. To understand gene interactions such as epistasis, complementation, and suppression.
4. To introduce the concept of gene mapping and recombination.
5. To explore sex-linked inheritance and mutations in depth.
6. To familiarize students with cytoplasmic inheritance and polygenic traits.
7. To develop hands-on skills through classical genetics practicals and analysis.

Course Outcomes:

1. Understand the principles of Mendelian inheritance and extensions of Mendelian laws.
2. Analyze patterns of gene interaction, linkage, and crossing over.
3. Explain chromosomal basis of inheritance, sex determination, and mutations.
4. Understand cytoplasmic inheritance and quantitative traits.
5. Perform classical genetic experiments and apply statistical tools to interpret results.

Unit I: Mendelian Principles and Gene Interactions

- Mendel's laws of inheritance
- Monohybrid and dihybrid crosses
- Incomplete dominance and codominance
- Multiple alleles (ABO blood groups)
- Epistasis, Complementation, Pleiotropy, Lethal genes

Unit II: Linkage and Recombination

- Chromosomal theory of inheritance
- Linkage: complete and incomplete
- Crossing over and recombination frequency
- Construction of genetic maps
- Interference and coincidence

Unit III: Sex Determination and Sex-Linked Inheritance

- Mechanisms of sex determination (XX-XY, XX-XO, ZW-ZZ)
- Sex-linked, sex-influenced and sex-limited traits
- Dosage compensation and Barr bodies
- Holandric inheritance

Unit IV: Mutations and Chromosomal Aberrations

- Spontaneous and induced mutations
- Mutagenic agents
- Types: point mutations, frameshift mutations
- Chromosomal mutations: deletion, duplication, inversion, translocation
- Aneuploidy and polyploidy (examples: Drosophila, Humans, Plants)

Unit V: Non-Mendelian Inheritance and Quantitative Genetics

- Cytoplasmic inheritance (e.g., mitochondrial and chloroplast DNA)
- Maternal effect genes
- Quantitative traits, polygenic inheritance
- Transgressive variation, heritability, and selection

SUGGESTED READINGS:

1. **Snustad & Simmons** – *Principles of Genetics*
2. **Gardner, Simmons & Snustad** – *Genetics*
3. **Griffiths et al.** – *Introduction to Genetic Analysis*
4. **Strickberger, M.W.** – *Genetics*
5. **Klug & Cummings** – *Concepts of Genetics*
6. **Verma & Agarwal** – *Genetics* (for Indian context)
7. **Lewin's Genes** – *(For molecular insight into classical topics)*
8. **Tamarin R.H.** – *Principles of Genetics*

LAB COURSE III
MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Credit: 1

Total Marks: 50 (35+15)

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

LAB COURSE IV
IMMUNOLOGY

Credit: 1

Total Marks: 50 (35+15)

1. Total and differential counting of leucocytes.
2. Protein estimation by Lowry's method in normal and infected blood sample.
3. Determination of Blood group.
4. Study of permanent slides (for spotting); thymus, lymph nodes, spleen, bone marrow, types of cells squamous, cuboidal, columnar, epithelial cells, blood cells, nerve cells, muscles cells, connective tissue of various types, adipose tissue, mitotic and meiotic chromosomes and their different phases cancer cells of various types etc.

PISCICULTURE

Credit: 4

Total Marks: 100 (70+30)

Course Objectives:

1. Explain the significance and types of fisheries in India
2. Apply knowledge of breeding, nutrition, and disease control in fish farming practices
3. Demonstrate practical skills in fish pond management and ornamental fish keeping
4. Analyze economic aspects and marketing strategies in pisciculture

Course Outcomes:
Skills that students obtain after completion of the course:

1. Identify suitable fish species for aquaculture and their biological requirements
2. Design and manage freshwater ponds for composite fish culture
3. Develop feeding schedules and disease control strategies for healthy fish production
4. Create business plans and assess economic viability of pisciculture projects
5. Demonstrate handling and breeding techniques in ornamental and commercial fish culture settings

UNIT I: Introduction to Pisciculture

- Importance and scope of pisciculture in India
- Types of fisheries: Capture and Culture fisheries
- Fishery resources of India: Inland and marine

UNIT II: Freshwater Aquaculture

- Candidate species for freshwater aquaculture (e.g., Rohu, Catla, Mrigal)
- Composite fish culture system
- Induced breeding techniques (Hypophysation)
- Construction and management of fish ponds

UNIT III: Nutrition and Feeding of Fish

- Types of feeds: Natural and artificial
- Feed formulation and feeding methods
- Feed conversion ratio (FCR)

UNIT IV: Fish Health and Disease Management

- Common fish diseases and parasites
- Disease prevention, control, and treatment
- Use of probiotics and biosecurity measures

UNIT V: Economic and Entrepreneurial Aspects

- Cost-benefit analysis of fish farming
- Government schemes, subsidies, and fishery co-operatives
- Export potential and market linkages

SUGGESTED READINGS:

1. **Jhingran, V.G.** – Fish and Fisheries of India*, Hindustan Publishing*
2. **S.S. Khanna and H.R. Singh** – A Textbook of Fish Biology and Fisheries
3. **A.J. Barman** – Fundamentals of Aquaculture
4. **Balachandran, K.K.** – Aquaculture: Principles and Practices
5. **Santhanam, R.** – Aquaculture Technology and Environment
6. **Boyd, C.E.** – Water Quality Management for Pond Fish Culture

APICULTURE

Credit: 4

Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge of Apiculture.
2. To train the students to pursue further education.
3. To be familiar with concepts of Apiculture.
4. To gain experience of concepts of Apiculture.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Apiculture and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

UNIT I: Biology of Bees: History, Classification and Biology of Honey Bees Social Organization of Bee Colony

UNIT II: Rearing of Bees: Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth Bee Pasturage Selection of Bee Species for Apiculture Bee Keeping Equipment Methods of Extraction of Honey (Indigenous and Modern)

UNIT III: Diseases and Enemies: Bee Diseases and Enemies Control and Preventive measures

UNIT IV: Bee Economy: Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc

UNIT V: Entrepreneurship in Apiculture: Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

SUGGESTED READINGS:

1. Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
2. Bisht D.S., Apiculture, ICAR Publication.
3. Singh S., Beekeeping in India, Indian council of Agricultural Research, New Delhi.

ON JOB TRAINING (OJT)/INTERNSHIP/PROJECT

Credits 4

Total Marks: 100 (70+30)

SEMESTER-III

DEVELOPMENTAL BIOLOGY

Credit: 3

Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge of Development Biology Human.
2. To train the students to pursue further education.
3. To be familiar with concepts of Development Biology.
4. To gain experience of concepts of Development Biology.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Development Biology and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

UNIT I: Fertilization: Biological role of fertilization, Basic requirements of fertilization, Activation of egg metabolism, Biochemistry of fertilization, Capacitation, Cleavage, Characteristics and mechanisms of cleavages.

UNIT II: Formative movements: Fate maps; embryonic induction and differentiation, Utility and comparative topographical relationship of the Presumptive areas in early embryos of Amphioxus, Fishes, Amphibian, Birds, Differentiation

UNIT III: Organogenesis: Development of vertebrate limb; Development of heart and kidney; Organizer, inductive tissue interactions in developments, Primary embryonic induction, Regional specificity in induction; Differentiation of Vertebrate lens.

UNIT IV: Metamorphosis- Hormonal control of metamorphosis in amphibians; Neuro endocrine control of insect metamorphosis; Biochemistry and mechanism of action of hormones during metamorphosis Teratology-teratogenesis-environmental assaults on human development- teratogenic agents like alcohol, retinoic acid etc.

UNIT V: Regeneration: Epimorphic regeneration of reptile (salamander) limb; Morphollaxis regeneration in hydra; embryonic stem cells and their applications. Programmed cell death: apoptosis, autophagy and necrosis.

SUGGESTED READINGS:

1. Animal Gametes: Vishmanath, Asia Publishing House

2. Foundation Of Embrology: Bradley M.Patten, McGrow Publication
3. Fertilization in Animals: Brain Dale, Arlond Heiniman, Gulab Vazerani Publication
4. Development Biology: N.J. Berril, Tata McGraw Hill Publication N. Delhi Embryology of Vertebrates: Nelson.

REPRODUCTIVE BIOLOGY, VERTEBRATE AND APPLIED ZOOLOGY

Credit: 3
Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge of Reproductive Biology, Vertebrate and Applied Zoology.
2. To train the students to pursue further education.
3. To be familiar with concepts of Reproductive Biology, Vertebrate and Applied Zoology.
4. To gain experience of concepts of Reproductive Biology, Vertebrate and Applied Zoology.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Reproductive Biology, Vertebrate and Applied Zoology and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

UNIT I: Gonadotropins and Reproductive cycles: Structure, secretion and regulation of gonadotropins, Estrous and Menstrual cycle, Sexual/Gonadal and brain differentiation and behavior; Hormones of sexual behavior, Sites of action of sex hormones Primer pheromones; Estrous cycle disruption, male induction of estrus (whitten effect), male induced pregnancy block (bruce effect), human reproductive pheromones.

UNIT II: Regulation of gonadal function: Testicular function Spermatogenesis and hormonal regulation, Sertoli cell, Leydig cell, Cell–cell interactions; Epididymis: organization and function, male accessory sex glands: structural organization and endocrine regulation of prostate.

UNIT III: Ovarian function Follicular development and selection, oocyte maturation, mechanism of ovulation, hormonal and molecular changes during periovulatory period, factors involved in follicular rupture, follicular atresia, regulation of steroidogenesis.

UNIT IV: Introduction to Host-parasite Relationship: Host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis.

UNIT V: Poultry farming and Fish technology: Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs; Major and minor carps of economic importance; Induced breeding and transportation of fish seed.

SUGGESTED READINGS:

1. Neerja Kapoor: Practical Zoology(Vertebrates)
2. R. Gupta, N. K. Arora: Animal Behavior
3. R. Radheshyam, N.K. Pandey: Reproductive Endocrinology.

LAB COURSE V
DEVELOPMENTAL BIOLOGY

Credit 1

Total Marks: 50 (35+15)

The practical work in general shall be based on the syllabus prescribed in theory. The students will be required to show the knowledge of the following.

1) Histological study of gonads, ovary/testis at different developmental stages
2) Study of life cycle of Drosophila melanogaster
3) Histological study of Chick: Egg, 24 hrs, 36 hrs, 48 hrs, 72 hrs and 96 hrs developmental stages.
4) Study of Placental types in Mammals.
5) Study of gametogenesis in mammals
6) Window method for studying chick embryo in incubated eggs (24, 48, 72 hours)

LAB COURSE VI
REPRODUCTIVE BIOLOGY, VERTEBRATE & APPLIED ZOOLOGY

Credit 1

Total Marks: 50 (35+15)

The practical work in general shall be based on the syllabus prescribed in theory. The students will be required to show the knowledge of the following.

1. Study of prepared slides histological, as per theory papers.
2. Study of Reproductive cycle in vertebrate. Menstruation, Lactation and pregnancy.
3. Identification of species and individuals of honeybee.
4. Life cycle of honey bee and silkworm

GENERAL PARASITOLOGY

Credit: 4

Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of General Parasitology.
2. To train the students to pursue further education.
3. To be familiar with parasitological tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of General Parasitology and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

UNIT I:

General introduction to parasitology, Definition of terminology, Taxonomy and classification, History and scope, major discoveries, Host and parasite interaction, mechanism of disease produce or cause by parasites, immunity in parasitic infections.

UNIT II:

Taxonomy of protozoa, classification of pathogenic protozoa, Amoebae, life cycle of *Entamoeba histolytica*, other *Entamoeba* species (comparative study), (*Naegleria fowleri* and *Acanthamoeba*), characteristic feature, laboratory diagnosis, serological investigation. Endolimax (*E. nana*).

UNIT III:

Mastigophora: *Giardia lamblia, Giardia intestinalis, Trichomonasvaginalis, Trichomonashominis, Enteromonas, Trypanosomabrucei*, *Trypanosomacruzi* and Other intestinal flagellates (comparative study) Leishmania I: Introduction and classification; coetaneous leishmaniasis, visceral leishmaniasis; Status of Leishmaniasis in India.

UNIT IV:

Sporozoa: Pasmodium (*P. vivax, P. falciparum, P. malariae, P. ovale*), Isospora, Cryptosporidium, Toxoplasma, Babesia. Ciliophora: *Balantidium coli*. Helminths: General features and classification. Intestinal Nematodes, Cestodes (Tapeworms): General features, Intestinal Cestodes. Introduction and classification of trematodes.

UNIT V:

Laboratory diagnosis of Parasitic Diseases: Examination of faeces, blood, tissue, other specimens, immunodiagnosis. Antiparasitic agents: Antiprotozoan agents, intestinal protozoa, Trypanosomes, Leshmania, Malaria, Toxoplasma, Antibacterial antiparasitic agents.

SUGGESTED READINGS:

1. Paniker's Book of Parasitology, 7th edition by C.K. Jayaram Paniker and Sougata Ghosh, Jaypee brothers Medical Publishers (P) Ltd. New Delhi, India.

2. Parasitology (Protozoology and Healminthology), 13th edition by K.D. Chatterjee, EKTA PublishingHouse, Kathmandu, Nepal.

3. Text Book of Medical Parasitology 6th edition by C.K. Jayaram Paniker, Jaypee brothers MedicalPublishers (P) Ltd. New Delhi, India.

4. Parasitology for Medical and Clinical Laboratory Professionals by John W. Ridley.

5. Advance in Parasitology by Das Gupta

6. The Short Textbook of Medical Microbiology (Including Parasitology), 10th edition by Satish Gupte,Jaypee brothers Medical Publishers (P) Ltd. New Delhi, India

7. Veterinary Parasitology by Hany Elsheikha, Jon S Patterson, CRC Press, Taylor & Francis Group

ANIMAL BEHAVIOUR

Credit: 4

Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge of Animal Behaviour.
2. To train the students to pursue further education.
3. To be familiar with concepts of Animal Behaviour.
4. To gain experience of concepts of Animal Behaviour.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Animal Behaviour and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

UNIT I: History of the study of animal behavior; Patterns of behavior, Innate behavior, Learned behavior and types of learning.

UNIT II: Specific behavior pattern- Communications, Auditory, Visual, Chemical, Learning and Memory, Conditioning, Habituation, Reasoning. Mimicry: mimetic releaser and code breakers.

UNIT III: Neural and hormonal control of behavior- Control of hippocampal pyramidal cell discharges; Perceptual mechanisms: Behavioral and cellular responses to novel and repeated stimuli. Hormonal control: Hormones classes: Peptides or proteins, steroids, monoamines and lipid based hormones. Biological rhythms.

UNIT IV: Social behavior, Social organization in honey bee and primates, Schooling in fishes and Flocking in birds, Homing, territoriality, dispersal, Altruism, Host–parasite relation.

UNIT V: Parental care, mating and courtship behavior, altruism: Parental care; Sexual selection: intra sexual selection (male rivalry); inter-sexual selection (female choice); sperm competition; mate guarding; consequences of mate choice for female fitness; monogamous verses polygamous sexual conflict.

SUGGESTED READINGS:

1. Animal Behavior – Mc Farland (English Language Book Society).
2. Animal Behavior – Arora M.P. (Himalaya Publishing House, Mumbai).
3. Animal Behavior - Reena Mathur (Rastogi Publications, Meerut).

EVOLUTIONARY BIOLOGY AND ECONOMIC ZOOLOGY

Credit: 4

Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge of Evolutionary and Economic Zoology.
2. To train the students to pursue further education.
3. To be familiar with concepts of Evolutionary and Economic Zoology.
4. To gain experience of concepts of Evolutionary and Economic Zoology.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Evolutionary and Economic Zoology and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

UNIT I: An overview of evolutionary thoughts, development and the concept of synthetic theory, Population genetics: Gene frequencies in Mendelian population, Hardy-Weinberg equilibrium Conditions for the maintenance of genetic equilibrium. Elemental forces of evolution: Mutation, Selection (types of selection and selection coefficient), Random genetic drift, Migration.

UNIT II: Chromosomal, allozyme and DNA polymorphisms: Adaptive genetic polymorphism, Balanced polymorphism and heterosis, Genetic co-adaptation and linkage disequilibrium. Isolating mechanisms: Concepts of species and models of speciation: allopatric, sympatric and stasipatric.

UNIT III: Evidences of organic evolution. Theories of organic evolution. Variation, Mutation, Isolation and Natural selection. Evolution of Horse, Evolution at molecular level: Genomic and proteomic changes, Molecular phylogenies, Neutral theory, Molecular clock.

UNIT IV: Beneficial and harmful insects, including insect vectors of human diseases. Pests of sugar cane (*Pyrillaper pusilla*), oil seed (*Achaea janata*) and rice (*Sitophilus oryzae*). Insects in forensic investigations; Industrial fish, prawn and molluscs of India. Apiculture, sericulture, lac culture, carp culture, pearl culture, prawn culture.

UNIT V: Major infectious and communicable diseases (small pox, plague, malaria, tuberculosis, cholera and AIDS) their vectors, pathogens and prevention. Cattle and livestock diseases, their pathogens (helminths) and vectors (ticks, mites, Tabanus, Stomoxys).

SUGGESTED READINGS:

1. P A Moody: Introduction to Evolution

2. Rastogi: Organic Evolution (2007, Kedarnath & Ramnath), Strickberger's Evolution

3. Verma and Agrawal, Ecology – 2000, S Chand

4. Kormondy, E.J. Concepts of Ecology, 4th Ed. PHI Learning, 2011.

SUGGESTED READINGS:

1. Shukla and Upadhyaya: Economic Zoology (RastogiPublishers,1999-2000)

2. Shrivastava: Test book of Applied Entomology, Vol. I &II (Kalyani Publishers,1991), Mani: Insects, NBT, India, 2006.

3. Jabde: Text Book of Applied Zoology: Vermi culture, Apiculture, Sericulture, Lac culture, Agricultural Pests and their control, 2005 Discovery Publishing House.

ENVIRONMENTAL BIOLOGY & WILD LIFE CONSERVATION

Credit: 4

Total Marks: 100 (70+30)

Course Objectives:

1. To understand the structure and functioning of ecosystems and the interrelationship among organisms and their environment.
2. To gain knowledge about ecological principles, population dynamics, and community interactions.
3. To study various types of pollution, climate change, and their impact on biodiversity.
4. To understand the principles and practices of wildlife conservation and management.
5. To develop skills for field studies, biodiversity monitoring, and conservation strategies.

Course Outcomes:

Skills that students obtain after completion of the course:

1. Explain ecosystem structure, energy flow, and biogeochemical cycles.
2. Analyze population and community ecology concepts with real-world examples.
3. Evaluate causes and consequences of environmental pollution and global climate change.
4. Apply knowledge of wildlife conservation laws, protected area management, and in-situ and ex-situ conservation.
5. Develop project proposals and conduct biodiversity assessments using modern tools.

Unit I: Ecosystem Ecology

- Structure and function of ecosystems
- Energy flow models — food chains, food webs, ecological pyramids
- Productivity — primary and secondary
- Biogeochemical cycles — carbon, nitrogen, phosphorus, sulfur

Unit II: Population and Community Ecology

- Characteristics of populations — growth models, life tables
- Population regulation — density-dependent & independent factors
- Community structure and succession
- Ecological niches, keystone species, and guilds

Unit III: Environmental Pollution

- Air, water, soil, and noise pollution — sources, effects, control measures
- Bioindicators and biomonitoring
- Eutrophication, biomagnification, acid rain, greenhouse effect

- Climate change — causes, impacts, mitigation

Unit IV: Biodiversity and Conservation

- Levels of biodiversity — genetic, species, ecosystem
- Biodiversity hotspots in India
- Threats to biodiversity — habitat loss, invasive species, overexploitation
- IUCN Red List and threatened species categories

Unit V: Wildlife Conservation and Management

- Principles of wildlife conservation — in-situ and ex-situ
- Protected area networks — sanctuaries, national parks, biosphere reserves
- Wildlife protection legislation — Wildlife Protection Act, CITES
- Conservation projects — Project Tiger, Project Elephant
- Wildlife management techniques — census, camera trapping, radio telemetry

SUGGESTED READINGS:

1. **Odum, E.P. & Barrett, G.W.** — *Fundamentals of Ecology*, 5th Ed.
2. **Dash, M.C.** — *Fundamentals of Ecology*.
3. **Kormondy, E.J.** — *Concepts of Ecology*.
4. **Ramakrishnan, P.S.** — *Ecology and Sustainable Development*.
5. **Primack, R.B.** — *Essentials of Conservation Biology*.
6. **Sutherland, W.J.** — *Ecological Census Techniques: A Handbook*.
7. **Hunter, M.L. & Gibbs, J.P.** — *Fundamentals of Conservation Biology*.
8. **Saharia, V.B.** — *Wildlife in India*.
9. **Rai, S.C.** — *Biodiversity and Environmental Conservation*.
10. **Groom, M.J., Meffe, G.K. & Carroll, C.R.** — *Principles of Conservation Biology*.
11. **Singh, J.S., Singh, S.P. & Gupta, S.R.** — *Ecology, Environmental Science and Conservation*.

RESEARCH PROJECT & PROPOSAL WRITING

Credits 6
Total Marks: 150 (105+45)

Course objectives:

1. Understand principles of scientific research.
2. Equip life science students with skills to design and implement biological research.
3. Enhance scientific writing skills, especially for thesis and funding proposals**.**
4. Design experimental or observational studies suitable for life science research.
5. Write a structured research proposal aligned with life science standards.

Course outcomes:

Skills that students obtain after completion of the course:

1. Define and explain research concepts specific to life sciences.
2. Formulate testable hypotheses and objectives for biological research.
3. Conduct systematic literature reviews using biological databases.
4. Develop laboratory or field-based data collection methods and protocols.
5. Apply appropriate statistical and bioinformatics tools for biological data analysis

Unit I

Introduction to Life Science Research: Nature and purpose of biological research, Types of life science research: experimental, observational, field-based, molecular, etc., Scientific method in biological contexts, Research ethics: animal care, human samples, informed consent, biosafety, institutional review boards (IRBs)

Unit II

Research Problem and Hypothesis Formulation: Identifying gaps in life science research, Researchable questions in biology, biotechnology, ecology, etc., Writing SMART objectives, Formulating null and alternative hypotheses.

Literature Review and Information Management: Accessing life sciences databases: PubMed, Scopus, Web of Science, AGRIS, Reading and synthesizing scientific articles, Critical evaluation of scientific evidence, Writing an annotated bibliography, Referencing tools: Zotero, Mendeley, EndNote, Use of AI and

digital tools responsibly in literature review.

Unit III

Experimental Design and Methodology: Experimental vs observational designs in biology, Designing in-vitro, in-vivo, or field experiments, Controls and replication in biological studies, Sampling methods in biodiversity, ecology, microbiology, Data collection tools: lab protocols, field logs, observation sheets, Pilot studies and protocol standardization, Risk assessment and biosafety level (BSL) protocols.

Unit IV

Writing a Research Proposal: Key sections of a biological research proposal- Background and rationale, Objectives and hypotheses, Experimental/field methodology, Materials, methods, and instrumentation, Ethical considerations and regulatory approvals, Budgeting: lab supplies, fieldwork, sequencing, travel, Work plan (Gantt chart). Review and critique of published proposals (e.g., DBT, DST, CSIR templates). Writing executive summaries and abstracts.

Unit V

Writing the Project Report: Structure of a biological research thesis/project- Abstract, Introduction, Materials & Methods, Results, Discussion, Conclusion. Presenting data with figures and tables. Writing effective figure legends and captions. Common writing errors in biological sciences. Plagiarism detection and referencing styles (e.g., Harvard, APA, Vancouver). Formatting and submission guidelines.

SUGGESTED READINGS:

1. Booth, W. C., Colomb, G. G., & Williams, J. M. (2016). *The craft of research* (4th ed.). University of Chicago Press.
2. Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
3. Day, R. A., & Gastel, B. (2012). *How to write and publish a scientific paper* (7th ed.). Cambridge University Press.
4. Kothari, C. R. (2004). *Research methodology: Methods and techniques* (2nd ed.). New Age International.
5. Kumar, R. (2022). *Research methodology: A step-by-step guide for beginners* (6th ed.). SAGE

Publications.

6. Punch, K. F. (2006). *Developing effective research proposals* (2nd ed.). SAGE Publications.
7. Turabian, K. L., Booth, W. C., Colomb, G. G., & Williams, J. M. (2018). *A manual for writers of research papers, theses, and dissertations: Chicago style for students and researchers* (9th ed.). University of Chicago Press.
8. Singh, Y. K. (2006). *Fundamental of research methodology and statistics*. New Age International.
9. Singh, Y. K. (2006). *Fundamental of research methodology and statistics*. New Age International.

SEMESTER IV

NEUROSCIENCE: NEUROENDOCRINOLOGY AND NON-CLASSICAL HORMONES

Credit: 3

Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge of Neuroscience.
2. To train the students to pursue further education.
3. To be familiar with concepts of Neuroscience.
4. To gain experience of concepts of Neuroscience.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Neuroscience and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

UNIT I: Neuroendocrinology- Hypophysiotropic hormones: localization, secretion and mechanism of action, TRH, GnRH, CRH, GHRH and PACAP, Somatostatin, Monoamines. Pineal gland-Pinealocytes and Synthesis of Melatonin, biological clock and calendar, Melatonin and photoperiodic measurement.

UNIT II: Receptors: Nuclear receptors, Structure, Families (glucocorticoid, thyroid and estrogen), Activation and recycling; Membrane receptors, Enzyme-linked receptors, Cytokine receptors, G-Protein coupled receptors, Ligand-gated ion channels; Hormone signaling receptor tyrosine kinase pathway, Cytokine receptors pathway, Cyclic AMP pathway.

UNIT III: Control of hormone secretion: Synthesis, processing, and sorting of preprohormone Precursor, Sequential stages of the regulated secretory pathway, Dense-cored granule Exocytosis, Regulation of exocytosisby calcium and protein kinase C.

UNIT IV: Non - classical hormones - Growth factors: cellular origin, secretion and functions**,** Epidermal growth factor family (EGF and TGFα)**,** Transforming growth factor β family (TGF β, anti-Mullerian hormone,inhibins and activins) Platelet-derived growth factor family, Fibroblast growth factor family, Insulin family (IGF-1 and IGF-II), Nerve growth factor family, Hematopoietic growth factors, Eicosanoids (prostaglandins, thromboxanes and leukotrines), Leptin.

UNIT V: Hormone signaling pathway:Phospholipid/calcium- protein kinase C pathway, Nitric oxide signaling pathway, MAP kinase pathway; Molecular basis of hormone synergism and antagonism, Glycogen metabolism, Smooth muscle contraction, Termination of hormone action Pathophysiology of hormone receptors, hormone analogues as drug and xenoestrogens.

SUGGESTED READINGS:

1. Bolander: Molecular Endocrinology (3rd ed 2006, Elsevier)
2. De Groot and Jameson: Endocrinology (5th ed 2006, Vol 1, Elsevier-Saunders)
3. Larson. Williams Textbook of Endocrinology (10th ed 2002, Saunders)
4. Norman and Litwack, Hormones (2nd ed 1997, Academic press)
5. Henson and Castracane: Leptin and Reproduction (2003, Plenum, Publishers)
6. Norris and Lopez: Vertebrate Endocrinology (5thed, Vol 5, 2011, Academic press)
7. Brooks and Marshall: Essentials of Endocrinology (1995, Blackwell Science)
8. Bolander: Molecular Endocrinology (3rded 2006, Elsevier)
9. De Groot and Jameson: Endocrinology (5thed 2006, Vol 1,Elsevier-Saunders)
10. Larson. Williams Textbook of Endocrinology (10thed 2002, Saunders)
11. Norman and Litwack. Hormones (2nded 1997,Academic press)
12. Henson and Castracane: Leptin and Reproduction (2003, Plenum Publisher).

TOXICOLOGY AND MEDICAL ZOOLOGY

Credit: 3
Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge of Toxicology and Medical Zoology.
2. To train the students to pursue further education.
3. To be familiar with concepts of Toxicology and Medical Zoology.
4. To gain experience of concepts of Toxicology and Medical Zoology.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Toxicology and Medical Zoology and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

UNIT I: Introduction to toxicology: History and scope of toxicology; Different areas of modern toxicology; Classification of toxic substance; various definitions of toxicological significance.

UNIT II: Exposure and response to toxicants: Types and characteristics of exposure; routes and site, dose, duration and frequency; Dose–response relationship; LD50, LC50, TD50 and therapeutic index, Variation in toxic responses; Aquatic toxicology: Bioaccumulation and biomagnification.

UNIT III: Modes of chemically induced cyto-toxicity: General response patterns and morphological aspects for cytopathology; Mechanisms of apoptosis, autosis and necrosis; Atrophy, Hypertrophy, Hyperplasia and Regeneration.

UNIT IV: General and Applied microbiology, Microbiology of Domestic water and sewage, Microbiology of milk and milk products, Industrial microbiology.

UNIT V: Brief introduction to pathogenic microorganism, *Rickettsia, Spirochaetes* and Bacteria, Brief account of life-history and pathogenicity of the following pathogens with reference to man; Prophylaxis and treatment - (a) Pathogenic Protozoans - *Entamoeba, Trypanosoma*, and *Giardia* (b) Pathogenic helminths - *Schistosoma* (c) Nematode Pathogenic parasites of man. Vector insects.

SUGGESTED READINGS:

1. P. D. SHARMA: ecology and environment
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin, Cummings.
3. Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc

LAB COURSE VII
NEUROSCIENCE: NEUROENDOCRINOLOGY AND NON-CLASSICAL HORMONES

Credit: 1

Total Marks: 50 (35+15)

1. Study of pituitary and pineal cell types through prepared slides.
2. In situ study of pituitary gland for portal circulation.
3. Transplantation of pituitary in kidney capsule.
4. In situ study of pineal gland and associated epithalamic complex.
5. Anatomical mapping of hypothalamic centres (SON, PVN, AR, VMO mammillary nucleus, medianeminence).
6. Ascorbic acid depletion bioassay for LH.
7. ELISA/RIA of TSH or gonadotropins.

LAB COURSE VIII
TOXICOLOGY AND MEDICAL ZOOLOGY

Credit: 1
Total Marks: 50 (35+15)

The Practical work in general shall be based on syllabus prescribed in theory. The candidates will be required to show knowledge of the following:

1. Estimation of population density, Percentage frequency, Relative density.
2. Analysis of Producers and consumers in grassland.
3. Detection of gram-negative and gram-positive bacteria.
4. Blood group detection (A, B, AB &O).
5. R.B.C., W.B.C. count.
6. Blood coagulation time.

DISSERTATION

Credit: 12
Total Marks: 350 (250+50+50)

(A) : Dissertation work and Thesis Writing
Topic will be based on the major elective opted by students. Project will include laboratory/field- based work followed by submission of report and presentation.

(B) : Dissertation Seminar
Students are required to deliver a seminar on a current topic related to the subject and to be evaluated by a panel of examiners.

(C) : Viva -Voce