Optional - Zoology (40 credits)

Structured syllabus under CBCS for 2025-26 onwards to Under Graduate Course

I. Core Course: (5 credits each) [All courses compulsory; one (1) each in I, II, III, IV, and V Semester]

1. Animal Diversity – Invertebrates & Vertebrates
2. Comparative Anatomy of Vertebrates and Developmental Biology
3. Animal Physiology and Animal Behaviour
4. Cell and Molecular Biology &Genetics
5. Immunology and Animal Biotechnology

II. Discipline Specific Elective: (5 credits each)[Any one (1) of the following courses in VI Semester)

1. Physiological Chemistry and Endocrinology
2. Laboratory Animals Maintenance and Applications
3. Fisheries and Limnology
4. Ecology, Zoogeography and Evolution

III. Skill Enhancement Course: (2 credits) in VI Semester

1. Sericulture
2. Ecotourism
3. Public Health and Hygiene
4. Apiculture
5. Medical Diagnostics
6. Environmental Impact Assessment
7. Aquaculture
8. Poultry and Animal Husbandry
9. Vector Biology

IV. Multidisciplinary Course – (4 credits)[any one (1) in V Semester]

1. Preventive Medicine
2. Integrated Pest Management
3. Biomaterial from Animal Source
4. Vermiculture
5. Aquarium Fish Keeping

VI. Project/Internship(4 credits)[only in VI Semester)

CURRICULUM FOR OPTIONAL - ZOOLOGY
IN UNDER-GRADUATE DEGREE PROGRAMME
CBCS SYLLABUS- SCHEMA

Year	Semester	COURSE		Title of the COURSE	No. of Credits	Exam Hrs.	Max. Marks		
							I.A	End Exam	Total
I	I	COURSE - I	DSC-I Theory	Animal Diversity – Invertebrates & Vertebrates	4	2	20	80	100
			DSC-I Practical*	Animal Diversity – Invertebrates & Vertebrates	1	2	-	50	50
	II	COURSE – II	DSC-II Theory	Comparative Anatomy of Vertebrates and Developmental Biology	4	2	20	80	100
			DSC-II Practical*	Comparative Anatomy of Vertebrates and Developmental Biology	1	2	-	50	50
II	III	COURSE – III	DSC-III Theory	Animal Physiology and Animal Behaviour	4	2	20	80	100
			DSC-III Practical*	Animal Physiology and Animal Behaviour	1	2	-	50	50
	IV	COURSE - IV	DSC-IV Theory	Cell and Molecular Biology & Genetics	4	2	20	80	100
			DSC-IV Practical*	Cell and Molecular Biology & Genetics	1	2	-	50	50
III	V	COURSE - V	DSC-V Theory	Immunology and Animal Biotechnology	4	2	20	80	100
			DSC-V Practical*	Immunology and Animal Biotechnology	1	2	-	50	50
			MDC Theory	Preventive Medicine / Integrated Pest Management / Biomaterials from Animal Sources/ Aquarium Fish Keeping	4	2	20	80	100
	VI	COURSE - VI	DSE-I Theory	Physiological Chemistry & Endocrinology / Laboratory Animals Maintenance and Applications /Fisheries and Limnology / Ecology, Zoogeography and Evolution	4	2	20	80	100
			DSE-I Practical*	Physiological Chemistry & Endocrinology / Laboratory Animals Maintenance and Applications /Fisheries and Limnology / Ecology, Zoogeography and Evolution	1	2	-	50	50
			SEC-I	Sericulture / Ecotourism / Public Health and Hygiene / Apiculture / Medical Diagnostics / Environmental Impact Analysis / Poultry and Animal Husbandry / Aquaculture / Vector Biology	2	2	10	40	50
			PRO	Project / Internship	4	2	20	80	100
					40		**200**	**1100**	**1300**

DSC – Discipline Specific Core; **DSE –** Discipline Specific Elective**; SEC –** Skill Enhancement Course; MDC Multidisciplinary Course (Open Stream); **SEM** – Seminar; **PRO** – Project; *****Practical one credit equal to 2 hours of instruction

B.Sc. ZOOLOGY I YEAR
SEMESTER-I
DISCIPLINE SPECIFIC CORE COURSE – I
ANIMAL DIVERSITY – INVERTEBRATES & VERTEBRATES

Instructions: 4 hr. per week
No. of period: 60
No. of credits: 4

UNIT I: INVERTEBRATES - PROTOZOA TO PLATYHELMINTHES (15 Periods)

1.1 Concepts of: Multicellularity; Diploblastic and triploblastic organization; Symmetries; Body cavities.
1.2 Protozoa: General characteristics and classification up to classes; Locomotory organelles and locomotion in Protozoa.
1.3 Porifera: General characteristics and classification up to classes; Canal system in sponges and spicules; Evolutionary significance of sponges as early metazoans.
1.4 Cnidaria: General characteristics and classification up to classes; Polymorphism in Hydrozoa and Siphonophora; Coral reef formation and ecological significance.
1.5 Helminthes: General characteristics and classification up to classes of Platyhelminthes and Nemathelminths; Parasitic adaptations in helminths; Regeneration in Turbellarians.

UNIT II: INVERTEBRATES – ANNELIDA TO HEMICHORDATA (15 Periods)

2.1 Annelida: General characteristics and classification up to classes; Metamerism and its evolutionary significance; Coelom and coelomocytes.
2.2 Arthropoda: General characteristics and classification up to classes; Vision in arthropods and metamorphosis in insects; Economic importance of insects.
2.3 Mollusca: General characteristics and classification up to classes; Torsion and detorsion in gastropods; Pearl formation and economic importance of molluscs.
2.4 Echinodermata: General characteristics and classification up to classes; Water vascular system in starfish; Larval forms of echinoderms.
2.5 Hemichordata: General characteristics and affinities of Hemichordata.

UNIT III: VERTEBRATES - PROTOCHORDATES TO AMPHIBIANS (15 Periods)

3.1 General characteristics of Urochordata and Cephalochordata; Retrogressive metamorphosis in Urochordata.
3.2 Cyclostomata: General characteristics and classification; Evolutionary status and affinities of cyclostomes.
3.3 Pisces: General characteristics and classification up to classes and major orders; Migration and osmoregulation in migratory fishes; Parental care in fishes.
3.4 Amphibia: General characteristics and classification up to orders; Parental care, neoteny, and paedogenesis in amphibians.
3.5 Evolutionary Trends in Early Vertebrates: Transition from water to land; Adaptive features in early tetrapod.

UNIT IV: VERTEBRATES - REPTILIA TO MAMMALIA (15 Periods)

4.1 Reptilia: General characteristics and classification up to orders; Biting mechanism in snakes and temporal fossae in reptiles; Adaptive radiations in Mesozoic reptiles.

4.2 Aves: General characteristics and classification up to orders; Flight adaptations and migration in birds; Evolutionary significance of birds as theropod ancestors.

4.3 Mammalia: General characteristics and classification up to orders; Origin of mammals: Monotremes, marsupials, and placentals; Dentition and aquatic adaptations in mammals.

4.4 Evolutionary Trends in Vertebrates: Origin of amniotes and evolutionary significance of amniotic egg; Primate evolution and human ancestry.

4.5 Conservation of Vertebrate Diversity: Threats to vertebrate diversity; Conservation strategies for endangered species.

Suggested Readings:

1. Ruppert, E.E., Fox, R.S., Barnes, R.D. (2004). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India
2. Barrington, E.J.W. (2012). Invertebrate Structure and Functions, II Edition, ELBS and Nelson.
3. Pechenik, J. A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education
4. Hickman, C., Keen, S., Larson, A., Eisenhour, D. (2018). Animal Diversity, 9th Edition, McGraw-Hill.
5. Young, J.Z. (2004). The Life of Vertebrates, III Edition, Oxford University Press.
6. Kardong, K.V. (2009). Vertebrates: Comparative Anatomy, Function, Evolution, 4th Edition, McGraw-Hill.
7. Pough F.H., Janis, C.M., Heiser, J.B., Heiser, C.B. (2009). Vertebrate Life, VIII Edition, Benjamin Cummings.
8. L.H. Hyman 'The Invertebrates' Vol I, II and V. – M.C. Graw Hill Company Ltd.
9. Kotpal, R.L. Protozoa, Porifera, Coelenterata, Helminthes, Arthropoda, Mollusca, Echinodermata. Rastogi Publications, Meerut.
10. E.L. Jordan and P.S. Verma 'Invertebrate Zoology' S. Chand and Company.
11. R.D. Barnes 'Invertebrate Zoology' by: W.B. Saunders CO., 1986.
12. P.S. Dhami and J.K. Dhami. Invertebrate Zoology. S. Chand and Co. New Delhi.
13. Parker, T.J. and Haswell 'A text book of Zoology' by, W.A., Mac Millan Co. London.
14. Mohan P.Arora. 'Chordata – I, Himalaya Publishing House Pvt.Ltd.
15. Marshal, Parker and Haswell 'Text book of Vertebrates'. ELBS and McMillan, England.
16. J.W. Young, The Life of Vertebrates, 3rd ed, Oxford University press.
17. Harvey Pough F, Christine M. Janis, B. Heiser, Vertebrate Life, Pearson, 6th ed, Pearson Education Inc.2002.

B.Sc. ZOOLOGY I YEAR
PRACTICAL SYLLABUS
DISCIPLINE SPECIFIC CORE COURSE – I
ANIMAL DIVERSITY – INVERTEBRATES & VERTEBRATES

Instructions: 2hr per week
No. of credits: 1

1. Study of Museum Specimens/Slides/Models (with Classification of animals)
    1. Protozoa: *Amoeba*, *Paramecium*, *Plasmodium vivax*
    2. Porifera: *Sycon*, *Spongilla*
    3. Cnidaria: *Obelia*, *Aurelia*
    4. Platyhelminthes: *Fasciola*, *Taeniasolium*
    5. Nemathelminths: *Ascaris*, *Wuchereria*
    6. Annelida: *Nereis*, *Hirudinaria*
    7. Arthropoda: Prawn, *Periplaneta*
    8. Mollusca: *Pila*, *Sepia*
    9. Echinodermata: *Asterias*, *Echinus*
    10. Protochordates: *Balanoglossus*, *Amphioxus*
    11. Cyclostomata: *Petromyzon*, *Myxine*
    12. Pisces: *Scoliodon*, *Labeo*
    13. Amphibia: *Hoplobatrachus*, *Bufo*
    14. Reptilia: *Calotes*, *Naja*
    15. Aves: *Columba*, *Passer*
    16. Mammalia: *Pteropus*, *Oryctolagus*, *Funambulus*

2. Dissections
    Prawn: Appendages, digestive system, nervous system, mounting of statocyst.
    Insect: Mouthparts of Anopheles, Culex, housefly, and butterfly.
    Virtual dissection of Labeo/Tilapia: Digestive system, brain, and cranial nerves (demonstration only).

3. Key for identification of venomous and non-venomous snakes
4. First aid for snake bite mitigation
5. Animal Album: Mandatory submission of an "Animal album" containing photographs, cut-outs, and write-ups about the studied taxa.
6. Visit to Zoological Park or Natural History Museum
7. Computer-Aided Techniques : Use of virtual dissections and animations for better understanding of anatomical structures.

Suggested manuals:
1. Lal, S.S. Practical Zoology – Invertebrates, Rastogi Publications.
2. Verma, P.S. Practical Zoology – Invertebrates, S. Chand Publications.
3. Verma, P.S. A Manual of Practical Zoology – Chordata, S. Chand Publications.
4. S.S.Lal, Practical Zoology – Vertebrata
5. Freeman & Bracegirdle, An atlas of embryology

B.Sc. ZOOLOGY I YEAR
SEMESTER-II
DISCIPLINE SPECIFIC CORE COURSE – II
COMPARATIVE ANATOMY OF VERTEBRATES AND DEVELOPMENTAL BIOLOGY

Instructions: 4 hours per week
No. of period: 60
No. of credits: 4

UNIT – I: Integumentary, Skeletal, and Muscular Systems (15 Periods)

1.1 Comparative study of structure and function of integument and its derivatives (glands, scales, feathers, and hair) from fishes to mammals.
1.2 Comparative study of axial skeleton in fishes to mammals (skull and vertebrae).
1.3 Comparative study of appendicular skeleton in fishes to mammals (pectoral and pelvic girdles; limbs).
1.4 Comparative anatomy of axial, appendicular, branchiomeric, and integumentary muscles.
1.5 Comparative study of adaptive modifications in vertebrate locomotion (swimming, walking, and flying).

UNIT – II: Digestive, Respiratory, Circulatory, and Excretory Systems (15 Periods)

2.1 Evolution of the Digestive System – Structural and functional modifications of the alimentary canal and digestive glands from fishes to mammals.
2.2 Respiratory System Adaptations – Comparative study of respiratory structures (gills, swim bladders, lungs, and air sacs) and their evolutionary significance.
2.3 Circulatory System Variations – Morphological and functional diversity of the heart, aortic arches, and major blood vessels in vertebrates.
2.4 Excretory System and Osmoregulation – Evolution of kidneys, urinary bladders, and their ducts in different vertebrate groups with adaptations to aquatic and terrestrial environments.
2.5 Nephron and Kidney Evolution – Comparative anatomy of nephron structure, types of kidneys (pronephros, mesonephros, metanephros), and their evolutionary succession.

UNIT – III: Reproductive, Nervous, and Sensory Systems (15 Periods)

3.1 Evolution of Reproductive Organs – Structural and functional modifications in male and female reproductive organs from fishes to mammals.
3.2 Modifications in Vertebrate Genital Structures – Evolutionary adaptations in gonads, accessory reproductive structures, and reproductive strategies across vertebrates.
3.3 Comparative Anatomy of the Nervous System – Structural variations in the vertebrate brain and cranial nerves from fishes to mammals.
3.4 Spinal Cord and Peripheral Nervous System – Comparative study of the spinal cord and spinal nerves, their structural and functional modifications in vertebrates.
3.5 Sensory Organs and Receptor Systems – Comparative study of sensory organs (vision, hearing, taste, smell, and touch) and sensory receptors (special somatic and special visceral receptors)from fishes to mammals.

UNIT – IV: Developmental Biology (15 Periods)

4.1 Early Embryonic Development: Gametogenesis (spermatogenesis and oogenesis) in mammals; vitellogenesis in birds; Fertilization mechanisms, and blocks to polyspermy.

4.2 Cleavage and Gastrulation: Structure of the fertilized chick egg; Patterns of cleavage, presumptive areas, fate maps.
4.3 Late Embryonic Development: Implantation of the rabbit embryo; Extraembryonic membranes; Placenta and types.
4.4 Organogenesis: Morphogenetic movements; Neurulation and notogenesis in frogs.
4.5 Basic principles of Evolutionary Developmental Biology Hox genes, and their role in vertebrate development and evolution.

SUGGESTED READINGS:

1. E.L.Jordan and P.S. Verma 'Chordate Zoology' -. S. Chand Publications.
2. Mohan P. Arora. 'Chordata – I, Himalaya Publishing House Pvt.Ltd.
3. Marshal, Parker and Haswell 'Text Book of Vertebrates'. ELBS and McMillan, England.
4. Alfred Sherwood Romer. Thomas S. Pearson 'The Vertebrate Body, Sixth edition, CBS College Publishing, Saunders College Publishing
5. George C. Kent, Robert K. Carr. Comparative Anatomy of the Vertebrates, 9th ed. McGraw Hill.
6. Kenneth Kardong Vertebrates: Comparative Anatomy, Function and Evolution, 4th ed, McGraw Hill.
7. J.W. Young, The Life of Vertebrates, 3rd ed, Oxford University Press.
8. Harvey Pough F, Christine M. Janis, B. Heiser, Vertebrate Life, Pearson, 6th ed, Pearson
9. Education Inc.2002.
10. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc.,
11. Publishers, Sunderland, Massachusetts, USA.
12. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press.
13. Carlson, R. F: Patten's Foundations of Embryology
14. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers.
15. Berril. N.J. and Karp: Developmental Biology. McGraw Hill, New York.

B.Sc. ZOOLOGY I YEAR
PRACTICAL SYLLABUS
DISCIPLINE SPECIFIC CORE COURSE - II
COMPARATIVE ANATOMY OF VERTEBRATES AND DEVELOPMENTAL BIOLOGY

Instructions: 2hr per week
No. of credits: 1

1. Comparative Study of Vertebrate Skeletons: Observation and identification of skeletal structures from different vertebrate groups (fishes, amphibians, reptiles, birds, mammals).
2. Histological Examination of Tissues: Microscopic study of integumentary, muscular, and glandular tissues in different vertebrates.
3. Virtual Dissection and Organ System Comparison: Dissection of representative vertebrates to study the digestive, respiratory, circulatory, nervous and urogenital systems.
4. Comparison of the anatomy of locomotory appendages in different groups of vertebrates .
5. Developmental Biology Experiments: Study of frog/chick embryology through prepared slides, observation of cleavage, gastrulation, and neurulation stages.

Suggested Manuals

1. Freeman & Bracegirdle, An atlas of embryology
2. George C. Kent, Robert K. Carr. Comparative Anatomy of the Vertebrates, 9th ed. McGraw Hill.
3. Kenneth Kardong Vertebrates: Comparative Anatomy, Function and Evolution, 4th ed, McGraw Hill.

B.Sc. ZOOLOGY II YEAR
SEMESTER-III
DISCIPLINE SPECIFIC CORE COURSE – III
ANIMAL PHYSIOLOGY AND ANIMAL BEHAVIOUR

Instructions: 4 hr. per week
No. of period: 60
No. of credits: 4

UNIT – I: Digestion, Respiration, and Circulation (15 Periods)

1.1 Digestion: Biological significance of nutrients (carbohydrates, proteins, lipids, vitamins, and minerals); digestion, absorption, and assimilation of macronutrients; Role of gastrointestinal hormones in digestion.
1.2 Respiration: Types of respiration (external, internal, and cellular); respiratory pigments, oxygen transport, oxygen dissociation curves, Bohr's effect; carbon dioxide transport and chloride shift.
1.3 Regulation of Respiration: Neural and chemical control of respiration.
1.4 Circulatory System: Types of circulation (open vs. closed); mammalian heart structure, conduction system, and regulation of heartbeat.
1.5 Cardiac Cycle: Regulation of heart rate, cardiac output, blood clotting mechanism, and conditions such as tachycardia and bradycardia.

UNIT – II: Homeostasis, Excretion, and Osmoregulation (15 Periods)

2.1 Homeostasis: Concept and mechanism of homeostasis; thermoregulation in poikilotherms and homeotherms.
2.2 Excretion: Classification of animals based on nitrogenous waste products (ammoniotelic, uricotelic, ureotelic); structure and function of nephrons; urine formation, counter-current mechanism in urine formation.
2.3 Hormonal Control of Excretion: Role of ADH and RAAS in osmoregulation and urine concentration.
2.4 Osmoregulation: Water and ionic regulation in stenohaline and euryhaline animals; osmoregulatory strategies in freshwater, brackish water, and marine animals.

UNIT – III: Muscle Physiology, Nervous System, and Endocrine System (15 Periods)

3.1 Muscle Contraction: Types of muscles; ultrastructure of skeletal muscle fibers; sliding filament theory, energetics of contraction.
3.2 Neural Function: Structure of neurons; resting potential, threshold potential, action potential, and conduction of nerve impulses.
3.3 Synaptic Transmission: Mechanisms of Synaptic Transmission; Neurotransmitters, Excitatory Postsynaptic Potential (EPSP), Inhibitory Postsynaptic Potential (IPSP), Reflex Action.
3.4 Sensory Organs: Vision, hearing, taste, smell, and touch in chordates.
3.5 Endocrine System: Structure and function of major endocrine glands (pituitary, thyroid, parathyroid, adrenal, pancreas); hormonal control of the menstrual cycle; mechanism of hormone action through secondary messengers.

UNIT – IV: Animal Behaviour and Biological Rhythms (15 Periods)

4.1 Types of Behavior: Instinctive vs. acquired behaviour; behavioural responses (taxes, reflexes, tropisms).

4.2 Learning and Memory: Types of learning (trial and error, imprinting, habituation, conditioning); Pavlov's experiment.

4.3 Social Behavior and Communication: Social organization in bees and termites; pheromonal communication.

4.4 Biological Rhythms: Biological clocks, circadian, circumlunar, and circannual rhythms; behavioural adaptations to environmental cycles.

4.5 Neuroethology: Neural basis of behaviour; interactions between nervous and endocrine systems in behavioural regulation.

Suggested readings

1. **Gerard J. Tortora and Sandra Reynolds Garbowski** *Principles of Anatomy and Physiology*, Tenth Ed., John Wiley & Sons
2. **Arthur C. Guyton MD**, *A Text Book of Medical Physiology,* Eleventh ed., JohnE. Hall, Harcourt Asia Ltd.
3. **William F. Ganong**, *A Review of Medical Physiology*, 22 ed, McGraw Hill, 2005
4. **Sherwood, Klandrof, Yanc,** *Animal Physiology*, Thompson Brooks/Coole, 2005.
5. **Sherwood, Klandrof, Yanc,** *Human Physiology*, Thompson Brooks/Coole, 2005.
6. **Knut Scmidt-Nielson,** *Animal Physiology***,** 5th ed, Cambridge Low Price Edition.
7. **Roger Eckert and Randal,** *Animal Physiology***,** 4th ed, Freeman Co, New York**.**
8. **Singh. H.R,** Text Book of Animal Physiology and Biochemistry
9. **Nagabhushanam**, Comparative Animal Physiology
10. **Veer Bal Rastogi,** Text Book of Animal Physiology

B.Sc. ZOOLOGY PRACTICAL SYLLABUS
SEMESTER-III
DISCIPLINE SPECIFIC CORE COURSE – III
ANIMAL PHYSIOLOGY AND ANIMAL BEHAVIOUR

Instructions: 2hr per week
No. of credits: 1

1. Identification of carbohydrates, proteins, and lipids in biological samples.
2. Detection of ammonia, urea, and uric acid from excretory products.
3. Comparative study of digestive systems and gut zonation from fishes to mammals using models.
4. Effect of pH and temperature on salivary amylase activity.
5. Examination of permanent histological sections of endocrine glands (pituitary, thyroid, pancreas, adrenal glands).
6. Estimation of hemoglobin using Sahli's method; counting different types of blood cells using a hemocytometer.
7. Measurement of blood clotting time and factors affecting clot formation.
8. Estimation of unit oxygen consumption in fish with reference to body weight.
9. Study of permanent slides of neurons and glial cells.
10. Observational experiments on learning and memory in animals.

Note: Laboratory record work shall be submitted at the time of practical examinations. Computer-aided techniques shall be adopted as per UGC guidelines.

B.Sc. ZOOLOGY II YEAR
SEMESTER-IV
DISCIPLINE SPECIFIC CORE COURSE – IV
CELL AND MOLECULAR BIOLOGY &GENETICS

Instructions: 4hr per week
No. of period: 60
No. of credits: 4

UNIT – I: Cell Biology (15 Periods)

1.1 Cell Structure and Organization: Prokaryotic vs. eukaryotic cells, organelles, and their functions.
1.2 Membrane Biology: Structure and functions of biological membranes, transport mechanisms, and cell signaling.
1.3 Cell Cycle and Cell Division: Phases of the cell cycle, mitosis, and meiosis, regulation, and significance.
1.4 Cytoskeleton and Cellular Motility: Microtubules, microfilaments, intermediate filaments, and their roles in intracellular transport.
1.5 Cellular Communication: Signal transduction pathways, receptors, and second messengers.

UNIT – II: Molecular Biology (15 Periods)

2.1 DNA Structure and Function: Double helix model, types of DNA, organization of prokaryotic and eukaryotic genomes.
2.2 DNA Replication: Mechanism, enzymes involved, prokaryotic vs. eukaryotic replication.
2.3 Transcription and RNA Processing: Mechanism of transcription, types of RNA, post-transcriptional modifications.
2.4 Translation and Protein Synthesis: Genetic code, ribosomes, initiation, elongation, and termination of protein synthesis.
2.5 Gene Regulation: Operon concept, epigenetics, and post-transcriptional gene regulation.

UNIT – III: Genetic Engineering and Applications (15 Periods)

3.1 Mutations and DNA Repair: Types of mutations, mutagens, mechanisms of DNA repair.
3.2 Recombinant DNA Technology: AI-Driven Innovations in Recombinant DNA Technology: Enhancing Gene Cloning, PCR Optimization, and Vector Design
3.3 Genetic Engineering in Biology: Gene therapy, transgenic animals, CRISPR technology.
3.4 Genomics and Proteomics: Human Genome Project, applications of genomics, and proteomics in biotechnology.
3.5 Applications of Molecular Biology: Forensic science, genetic testing, and synthetic biology.

UNIT – IV: Principles of Genetics (15 Periods)

4.1 Mendelian Genetics: Laws of inheritance, monohybrid and dihybrid crosses, test cross, and back cross.
4.2 Non-Mendelian Genetics: Incomplete dominance, codominance, multiple alleles, and epistasis.
4.3 Chromosomal Basis of Inheritance: Chromosome theory, linkage, crossing over, and gene mapping.
4.4 Sex Determination and Sex-Linked Inheritance: Chromosomal and environmental sex determination, X-linked, Y-linked, and sex-limited traits.
4.5 Genetic Disorders and Pedigree Analysis: Autosomal and sex-linked genetic disorders, pedigree construction, and interpretation.

Suggested readings:

1. Lodish, Berk, Zipursky, Matsudaria, Baltimore, Darnell 'Molecular Cell Biology' W.H. Free man and company New York.
2. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India.
3. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
4. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings.
5. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
6. Molecular Biology of the Cell – Alberts et al.
7. Molecular Biology of the Gene – James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick.
8. Lewin's Genes XII – Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick.
9. Molecular Cell Biology – Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, et al.
10. Molecular Biology – Robert Weaver.
11. Fundamental Molecular Biology – Lizabeth A. Allison.
12. The Cell: A Molecular Approach – Geoffrey M. Cooper, Robert E. Hausman.
13. Molecular Biology of RNA – David P. Clark.
14. Molecular Biology by Freifelder D. 2nd ed.
15. Molecular Biotechnology: Principles and Applications of Recombinant DNA – Bernard R. Glick, Cheryl L. Patten.
16. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.
17. Gupta P.K., 'Genetics'.

B.Sc. ZOOLOGY II YEAR PRACTICAL SYLLABUS
SEMESTER-IV
DISCIPLINE SPECIFIC CORE COURSE – IV
CELL AND MOLECULAR BIOLOGY&GENETICS

Instructions: 2hr per week
No. of credits: 1

1. ABO blood grouping and Rh factor determination.
2. Study of Cell Organelles: Microscopic observation of cell structures using prepared slides.
3. Observation of dividing cells in onion root tips/grasshopper testis to study mitosis and meiosis.
4. Extraction of DNA from animal cells and quantification using spectrophotometry.
5. Separation and visualization of DNA fragments by Agarose Gel Electrophoresis.
6. Basic principles and demonstration of Polymerase Chain Reaction.
7. Quantification of proteins in biological samples using Biuret/Bradford Method.
8. Demonstration of thin-layer chromatography for amino acid separation.
9. Study of monohybrid and dihybrid crosses in *Drosophila*.
10. Identification of normal and abnormal karyo types (Down syndrome, Turner syndrome, Klinefelter syndrome).

B.Sc. ZOOLOGY III YEAR
SEMESTER-V
DISCIPLINE SPECIFIC CORE COURSE – V
IMMUNOLOGY AND ANIMAL BIOTECHNOLOGY

Instructions: 4hr per week
No. of period: 60
No. of credits: 4

UNIT - I: Basics of Immune system (15 Periods)

1.1 Cells of the immune system and the lymphoid organs(Primary and secondary).
1.2 First line of defense mechanism - Physical and chemical barriers; Second line of defense mechanism - Inflammation and phagocytosis; Cytokines/ Interleukins / Interferons.
1.3 Types of immunity-Inherent(Active and passive) and acquired immunity(Active and passive) Humoral and cell mediated immunity
1.4 Major histocompatibility complex (MHC) – definition, structure and function of Class I and Class II proteins.
1.5 Significance of MHC, Role in organ transplantation, Graft vs. rejection; MHC restriction.

UNIT - II: Antibodies and Antigens and Immune System Diseases (15 Periods)

2.1 Antibodies/immunoglobulins - Structure, functions and classification; Monoclonal and Polyclonal antibodies and applications.
2.2 Antigens structure, antigenic determinants/epitopes, haptens, adjuvants and antigenicity.
2.3 Antigen-antibody reactions-agglutination, precipitation, opsonization, cytotoxicity.
2.4 Hypersensitivity reactions – their types and mechanisms.
2.5 Autoimmunity – Definition and examples (SLE, RA & HT), and Immunodeficiency diseases – Definition and examples (CVID, SCID & HIV).

UNIT – III: Animal Biotechnology and Genetically Modified Organisms (15 Periods)

3.1 Concept and Scope of Animal Biotechnology.
3.2 Recombinant DNA technology and its applications.
3.3 Cloning vectors – Plasmids (PBR-322, POC18/19), Cosmids and Shuttle vectors, Yeasts (YEPS); Cloning methods (Gene, Cell, and Animal cloning).
3.4 Transgenesis – Methods of Transgenesis; Production of Transgenic animals - sheep and fish.
3.5 Vaccine Development – Recombinant and mRNA vaccines.

UNIT – IV: Applications of Biotechnology (15 Periods)

4.1 In vitro fertilization and embryo transfer.
4.2 Hybridoma technology – concepts and applications.
4.3 Stem cells –types and their applications.
4.4 Biopesticides; *Bacillus thuringiensis* – mode of action of toxin.
4.5 Animal Bioreactors – concepts and applications.

Reference Books:

1. Text book of immunology-Ivan Riott
2. Text book of immunology-C.V.Rao
3. Text book of immunology-Nandini Shetty

4. Text book of immunology-Kubey
5. Culture of Animal cells. R. Ian Freshney, Wiley Liss.
6. Biotechnology – S. Mitra.
7. Animal Cell culture – Practical Approach – Ed. John R W Masters, Oxford.
8. Biotechnology – B. D. Singh

B.Sc. ZOOLOGY III YEAR PRACTICAL SYLLABUS
SEMESTER-V
DISCIPLINE SPECIFIC CORE COURSE – V
IMMUNOLOGY AND ANIMAL BIOTECHNOLOGY

Instructions: 2hr per week
No. of credits: 1

I. Immunology

1. Study agglutination of blood or ABO-blood grouping using kit.
2. Demonstration of Widal Test using kit.
3. Demonstration of precipitation(VDRL/RPR test) using kit.
4. Enumeration of WBC and Differential Count of Leucocytes using hemocytometer.
5. Histology of lymphoid organs - Spleen, Thymus, Lymph node, Bone marrow.

II. Animal Biotechnology

1. Study the following techniques through photographs / virtual lab
   a. Identification of Vectors
   b. Identification of Transgenic animals
   c. DNA sequencing (Sanger's method)
   d. DNA finger printing
   e. Southern blotting
   f. Western blotting

2. PCR demonstration /virtual lab

- Laboratory Record work shall be submitted at the time of practical examination
- Computer aided techniques should be adopted as per UGC guidelines.

Reference Books:

1. A hand book of practical immunology-Ivan Riott
2. Animal Biotechnology – PK Gupta

B.Sc. ZOOLOGY III Year
SEMESTER-V
MULTIDISCIPLINARY COURSE
PREVENTIVE MEDICINE

Instructions: 4hr per week
No. of period: 60
No. of credits: 4

UNIT-I: Man and Medicine: Health for all (15 Periods)

1.1. Antiquity medicine, types of medicine.
1.2. Dawn of scientific medicine, modern medicine – curative medicine, preventive medicine and social medicine.
1.3. Definition of health, dimensions of health – Physical, Mental, Social Spiritual, Emotional and Vocational health,
1.4. Determinants of health – Biological, Behavioural, Environmental, Socio-economic and Health services
1.5. One Health Policy; Concept of well-being - Standard of living, level of living and quality of life.

UNIT-II: Principles of Epidemiology (15 Periods)

2.1. Definition of epidemiology, measurements in epidemiology- rates, ratio and proportion.
2.2. Epidemiologic methods- observational and experimental studies.
2.3. Uses of epidemiology and definitions of infectious disease epidemiology.
2.4. Dynamics of disease transmission – source and reservoirs.
2.5. Epidemiological triad, modes of disease transmission – direct and indirect.

UNIT-III: Concept of Disease Causation (15 Periods)

3.1. Classical Theories of Diseases – Germ Theory & Miasma Theory
3.2. Disinfection - Types and procedures
3.3. Immunity - Active Immunity, Passive immunity, immunizing agents.
3.4. Nutrition and Health – Classification of foods; Nutritional requirements.
3.5. Screening of disease – Uses of screening, types of screening.

UNIT-IV: Disease Control & Prevention Measures (15 Periods)

4.1. Health care of the community – Levels of health care systems.
4.2. Modes of health interventions: Health promotion, specific protection, early diagnosis and treatment, disability limitations, and rehabilitations.
4.3. Concepts of disease control - Monitoring and surveillance.
4.4. Concepts of disease prevention and its types.
4.5. Health programmes in India.

References

1. Park's Textbook of Preventive and Social Medicine.

B.Sc. ZOOLOGY III Year
SEMESTER-V
MULTIDISCIPLINARY COURSE
INTEGRATED PEST MANAGEMENT

Instructions: 4 hr. per week
No. of period: 60
No. of credits: 4

UNIT-I: Insect Pests Surveillance (15 Periods)

1.1 Pest Surveillance: Definition, importance in IPM – Advantages – components of pest surveillance.
1.2 Insect Pest: Definitions, Minor and Major pests; different categories of pests
1.3 Insect Pest Ecology: Definition of insect pests; Ecological role of insect pests
1.4 Pest forecasting: Types of forecasting
1.5 Economic Injury Level, General Equilibrium Position, Economic Threshold Levels

UNIT-II: Integrated Pest Management (15 Periods)

2.1 IPM: Introduction, importance and evolution of IPM
2.2 Components of IPM: Practices, scope and limitations of IPM
2.3 Major IPM Strategies: Mechanical, physical and Cultural
2.4 Strategies for IPM: Microbial control and Chemical control
2.5 Plant-derived insecticides: Neem-based products

UNIT-III: Biological and Genetic Control (15 Periods)

3.1 Introduction: Types of biological control
3.2 Bio-control Agents: Parasites, Parasitoids and Parasitism
3.3 Predators and pathogens: NPV, Bacteria, Fungi and Nematodes
3.4 Merits and demerits of biological control
3.5 Genetic Control: Sterile insect technique (SIT); Sterile insect release method (SIRM)

UNIT-IV: Chemical Control (15 Periods)

4.1 Classification of Insecticides: Based on chemical composition; Based on mode of action
4.2 Insecticide Formulations: Adjuvants; Types of formulations (liquid, granular, etc.)
4.3 Chemical Control Methods: Organochlorides; Organophosphates; Carbamates
4.4 Advanced Chemical Control: Synthetic pyrethroids; Fumigants; Pheromones
4.5 Regulatory Control: Quarantine acts; Legal frameworks for pest control

REFERNCES

1. K. P. Srivastava: A Text Book of applied Entomology Vol. i & ii. Kalyani Publishers New Delhi.
2. B. V. David and Kumaraswamy. Elements of Economic Entomology
3. Pedigo, L. P. Entomology and Pest Management .Prentice-Hall ,New Delhi
4. Pradhan, S. Insect Pests of Crops, National Book Trust, New Delhi
5. Atloal A.S. Agricultural Pests of India and South East Asia. Kalyani Publisher, New Delhi

B.Sc. ZOOLOGY III Year
SEMESTER-V
MULTIDISCIPLINARY COURSE
BIOMATERIALS FROM ANIMAL SOURCES

Instructions: 4hrs per week
No. of period: 60
No. of credits: 4

UNIT-I: Fundamentals of Biomaterials (15 Periods)

1.1 Introduction to Biomaterials – Definition, classification, biocompatibility, and interaction with medical devices.
1.2 Biomaterial-Host Interactions – Immune response, foreign body reaction, and factors affecting compatibility.
1.3 Types of Biomaterials – Natural vs. synthetic biomaterials, degradable vs. resorbable biomaterials, applications in tissue engineering.
1.4 Metallic and Ceramic Biomaterials – Titanium, stainless steel, cobalt-chromium alloys (orthopedic and dental applications); Hydroxyapatite, bioactive glasses, zirconia (bone and dental implants).
1.5 Polymeric and Composite Biomaterials – Applications in prosthetics, drug delivery, and soft tissue repair.

UNIT-II: Applications of Biomaterials in Medicine and Drug Delivery (15 Periods)

2.1 Biomaterials in Musculoskeletal Systems – Bone grafts, scaffolds, joint replacements (hip, knee), soft tissue repair, and ligament regeneration.
2.2 Biomaterials in Cardiovascular and Neural Applications – Stents, heart valves, vascular grafts, and neural implants.
2.3 Biomaterials in Drug Delivery – Controlled drug release mechanisms, polymer-based drug carriers, hydrogels for sustained drug release.
2.4 Biomaterial-Based Wound Healing Strategies – Applications in tissue regeneration, bioactive dressings, and antimicrobial wound care.
2.5 Nanobiomaterials in Medicine – Role in targeted drug delivery, nanoscaffolds, and theranostics (therapeutic + diagnostic applications).

UNIT-III: Biomaterials from Animal Sources (15 Periods)

3.1 Collagen-Based Biomaterials – Structure, function, biomedical applications, injectable biomaterials.
3.2 Silk Biomaterials – Properties of silk fibroin and sericin, spider silk strength, and biocompatibility; Applications in sutures, artificial ligaments, and 3D tissue grafts.
3.3 Chitin and Chitosan-Based Biomaterials – Structural properties, conversion of chitin to chitosan (chemical and enzymatic methods), biomedical applications.
3.4 Hyaluronic Acid-Based Biomaterials – Structure, synthesis, biological properties, applications in ophthalmology, dermatology (anti-aging treatments), and joint health.
3.5 Elastin-Based Biomaterials – Structure, function, role in tissue elasticity, and applications in vascular grafts and regenerative medicine.

UNIT-IV: Emerging Trends and Future Perspectives in Biomaterials (15 Periods)

4.1 Smart and Responsive Biomaterials – Shape-memory polymers, stimuli-responsive biomaterials, bioelectronics.

4.2 3D Bioprinting and Tissue Engineering – Scaffold design, biocompatible printing materials, and organ-on-a-chip technology.

4.3 Biodegradable and Eco-Friendly Biomaterials – Sustainable alternatives, challenges in waste management, and green biomaterials.

4.4 Regulatory Aspects and Safety of Biomaterials – FDA and ISO guidelines, clinical trials, and ethical concerns.

4.5 Future Applications and Innovations – AI in biomaterial design, biohybrid materials, and advancements in personalized medicine.

Suggested Readings:

1. Ratner, B.D., et al. Biomaterial Science: An Introduction to Materials in Medicine, Elsevier, 3rd Edition.
2. Ambrosio, L. Biomaterial Composites, CRC Press.
3. Bhat, S.V. Biomaterials, 2nd Edition, Narosa Publishing House, New Delhi.
4. Gad, S.C., Gad-McDonald, S. Biomaterials, Medical Devices, and Combination Products: Biocompatibility Testing and Safety Assessment.
5. Antoniac, I. Biologically Responsive Biomaterials for Tissue Engineering.
6. Peppas, N.A., Langer, R. Advances in Biomaterials for Drug Delivery and Regenerative Medicine, Wiley.

B.Sc. ZOOLOGY III YEAR
SEMESTER-V
MULTIDISCIPLINARY COURSE
AQUARIUM FISH KEEPING

Instructions: 4hrs per week
No. of periods: 60
No. of credits: 4

UNIT-I: Introduction to Aquarium Fish Keeping and Design (15 Periods)

1.1 Introduction to Aquarium Fish Keeping – Importance, history, and commercial scope as a cottage industry and sustainable livelihood.
1.2 Global and Indian Ornamental Fish Trade – Market trends, trade regulations, and economic significance.
1.3 Aquarium Tank Fabrication and Setup – Shape, size, volume, material selection (glass, acrylic), construction techniques (cutting, sealing, reinforcement).
1.4 Substrate Selection and Decoration – Types and benefits of pebbles, gravels, sands, and bacterial-enriched substrates; aesthetic enhancements.
1.5 Aquarium Plants and Their Role – Types (submerged, rooted, floating, emergent), benefits (oxygenation, ammonia absorption), comparison of live vs. artificial plants.

UNIT-II: Aquarium Equipment, Water Quality, and Maintenance (15 Periods)

2.1 Aquarium Equipment and Accessories – Filtration systems (biological, chemical, mechanical); aerators, lighting, heating, and feeding trays.
2.2 Advanced Aquarium Technologies – Smart systems, automated filtration, temperature control, IoT-based monitoring.
2.3 Water Quality Management – Water sources and treatment (dechlorination, UV sterilization), key parameters (temperature, pH, dissolved oxygen, ammonia, hardness, salinity, turbidity).
2.4 Biofiltration and Nitrogen Cycle – Role of beneficial bacteria, ammonia and nitrate management, impact on fish health.
2.5 Routine Aquarium Maintenance – Cleaning schedules, water changes, algae control, troubleshooting common problems.

UNIT-III: Biology, Nutrition, and Breeding of Aquarium Fishes (15 Periods)

3.1 Biology and Sexual Dimorphism of Aquarium Fish Species – Freshwater species (Guppy, Molly, Swordtail, Goldfish, Angelfish, Betta), Marine species (Blue Morph, Clownfish, Butterfly fish).
3.2 Reproductive Behavior and Genetic Selection – Color variations, hybridization, and selective breeding techniques.
3.3 Nutrition and Feeding Strategies – Live feed (Artemia, Infusoria, Daphnia, Spirulina), formulated feed (pellet diets, freeze-dried feed, probiotic-enriched diets).
3.4 Broodstock Management and Breeding Conditions – Optimal breeding parameters (pH, temperature, sex ratio), hormonal induction, and larval rearing.
3.5 Pigment Enhancement and Growth Optimization – Techniques for improving fish coloration and growth rate through diet and environmental factors.

UNIT-IV: Health Management and Commercial Aspects of Aquarium Fish Farming (15 Periods)

4.1 Common Diseases of Aquarium Fishes – Viral, bacterial, fungal, protozoan, and parasitic infections.

4.2 Diagnosis and Treatment – Symptoms, disease identification, treatment using natural and synthetic remedies.
4.3 Preventive Health Management – Quarantine procedures, probiotics, herbal treatments, and vaccination approaches.
4.4 Entrepreneurial Aspects of Aquarium Fish Farming – Setting up a small-scale fish farm, cost estimation, business planning.
4.5 Marketing and Trade Strategies – Supply chain management, pricing, online vs. offline sales, role of government schemes and export potential.

Suggested Readings:

1. Hansen, J. Making Your Own Aquarium, Bell and Hyman Ltd., London.
2. Axelord, H.R. Breeding Aquarium Fishes, T.F.H. Publications.
3. Lovell, T. Nutrition and Feeding of Fish, 2nd Ed., Kluwer Academic Publishers.
4. Mills, D. and Vevers, G. The Practical Encyclopedia of Freshwater & Tropical Aquarium Fishes, Salamander Books Ltd., London.
5. Brunner, G. Aquarium Plants, T.F.H. Publications Inc. Ltd., Hong Kong.
6. Mills, D. Aquarium Fishes, Arco Publishing.
7. Gahlawat, S.K., et al. Manual of Experimental Ichthyology, Daya Publishing House, Delhi.
8. Talwar, P.K., and Jhingran, A.G. Inland Fishes of India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Timmons, M.B. Recirculating Aquaculture Systems, NRAC Publication.
10. Fish Health Management and Water Quality (FAO Aquaculture Guidelines).

B.Sc. ZOOLOGY III Year
SEMESTER-V
MULTIDISCIPLINARY COURSE
VERMICULTURE

Instructions: 4 hours per week
No. of period: 60
No. of credits: 4

UNIT-I: Fundamentals of Vermiculture and Vermicomposting (15 Periods)

1.1 Introduction to Vermitechnology – Definition, Scope, Importance, and Applications of Vermiculture and Vermicomposting.
1.2 Differences Between Vermiculture and Vermicomposting – Concept and comparative advantages.
1.3 Role of Earthworms in Sustainable Waste Management – Contribution to soil fertility, decomposition, and organic waste recycling.
1.4 Earthworm Diversity and Biology – Ecological groups of earthworms: Epigeic, Endogeic, and Anecic species.
1.5 Life Cycle and Important Composting Earthworm Species – Biology, reproductive strategies, and key species (Eiseniafetida, Eudriluseugeniae, Perionyxexcavatus).

UNIT-II: Soil, Organic Waste Management, and Vermicomposting Techniques (15 Periods)

2.1 Soil Characteristics for Vermiculture – Physical, Chemical, and Biological properties essential for vermiculture.
2.2 Microbiota and Decomposition – Role of soil microbiota, bioenzymes, and microbial interactions in vermicomposting.
2.3 Organic Waste Classification and Management – Types of organic waste (agricultural, kitchen, industrial) and their significance.
2.4 Traditional Composting vs. Vermicomposting – Problems in traditional composting (odor, pathogens, nutrient loss) and advantages of vermicomposting.
2.5 Vermicomposting Methods – Pit Method, Heap Method, Windrow Method, Bed Method; Factors affecting vermicomposting (Temperature, Moisture, pH, Aeration).

UNIT-III: Techniques and Processing of Vermiculture (15 Periods)

3.1 Vermiculture Unit Setup – Site selection, Construction of vermiculture units, Selection of Earthworm Species (Monoculture vs. Polyculture).
3.2 Vermiculture Maintenance – Feeding practices, Moisture, Temperature, and Aeration control.
3.3 Bedding Materials and Harvesting Methods – Suitable materials (coconut coir, peat moss, organic residues); Harvesting techniques (Manual, Self-harvesting, Mechanical methods).
3.4 Processing and Storage of Vermicompost – Composition, Nutritional benefits, and Role in soil fertility improvement.
3.5 Vermicompost Packaging and Shelf Life – Storage techniques, Preservation methods, and Quality control.

UNIT-IV: Applications and Economics of Vermiculture (15 Periods)

4.1 Agricultural and Horticultural Applications – Use in Organic Farming, Sustainable Agriculture, and Soil Health improvement.

4.2 Role in Plant Growth and Disease Suppression – Impact on crop yield, disease resistance, and water retention.
4.3 Integration with Biofertilizers and Mycorrhizae – Synergistic benefits of vermiculture with other biological enhancers.
4.4 Entrepreneurship in Vermiculture – Cost-Benefit Analysis, Business models, Marketing strategies, and Industry demand.
4.5 Environmental and Economic Impact – Carbon sequestration, Climate Change Mitigation, and Government schemes (NABARD, MSME, State Agricultural Departments).

Suggested Readings:

1. Lee, K.E. (2020) - Earthworm Ecology – Springer.
2. Stevenson, J. (2018) - Biology of Earthworms – Elsevier.
3. Ranganathan, L.S. (2022) - Vermicomposting Technology: Soil Health to Human Health – Scientific Publishers.
4. Edwards, C.A. & Arancon, N.Q. (2019) - Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management – CRC Press.
5. Domínguez, J., & Edwards, C.A. (2021) - Biology and Ecology of Earthworms in Organic Waste Management – Academic Press.

B.Sc. ZOOLOGY III YEAR
SEMESTER-VI
DISCIPLINE SPECIFIC ELECTIVE I
PHYSIOLOGICAL CHEMISTRY AND ENDOCRINOLOGY

Instructions: 4hr per week
No. of period: 60
No. of credits: 4

UNIT-I: Biomolecules of Importance (15 Periods)

1.1 Types of biomolecules –Carbohydrates, Proteins, Lipids, Nucleic acids, Vitamins and their significance in biological systems.
1.2 Classification of protein; Function of proteins based on their chemical nature
1.3 Protein metabolism: Transamination, deamination, urea cycle; Synthesis and catabolism of Histidine and Proline.
1.4 Classification and function of carbohydrates
1.5 Carbohydrate metabolism: Glycolysis, Kreb's cycle, electron transport and oxidative phosphorylation.

UNIT-II: Lipids and Enzyme Classification (15 Periods)

2.1 Lipids: nomenclature and classification of lipids
2.2 Fatty acid synthesis and beta-oxidation of lipids
2.3 Cholesterol synthesis and metabolism of steroidal hormones
2.4 Enzyme definition, nomenclature, classification and Enzyme kinetics, Lineweaver-Burk plot
2.5 Mechanism of enzymes: Action, enzyme inhibition, coenzymes

UNIT - III: Introduction to Endocrinology (15 Periods)

3.1 Concept and scope of endocrinology; Hormones as chemical messengers.
3.2 Classification of hormones
3.3 Mechanism of action of aminoacid derivatives; Peptide hormones and steroid hormones.
3.4 Positive feedback mechanism and Negative feedback control
3.5 Hormonal regulation of protein, carbohydrate and lipid metabolism.

UNIT - IV: Endocrine Glands and their Hormones (15 Periods)

4.1 Hypothalamus and its Hormones.
4.2 Structure, hormones and functions of Pituitary gland.
4.3 Structure, hormones and functions of Thyroid, Parathyroid, and Thymus glands.
4.4 Structure, hormones and functions of Adrenal, Pancreas, and Pineal glands.
4.5 Role of hormones in human reproduction.

REFERENCE BOOKS:

1. Text book of biochemistry
2. Text book of physiology and biochemistry
3. Comparative Endocrinology of Invertebrates by Highman and Hill.
4. Comparative Vertebrate Endocrinology by P. J. Bentley, Cambridge Univ. Press
5. Text Book of Endocrinology by Turner and Bangnara (W.B.Sanders)
6. Essential Endocrinology by JoenLaycock and Peter Loise Oxford Univ. Press.
7. Text Book of Endocrinology by R. H. Williams (W. B. Saunders).

B.Sc. ZOOLOGY III YEAR
PRACTICAL SYLLABUS
SEMESTER-VI
DISCIPLINE SPECIFIC ELECTIVE I
PHYSIOLOGICAL CHEMISTRY AND ENDOCRINOLOGY

Instructions: 2hr per week
No. of credits: 1

1. Identification of carbohydrates –Molisch test, Benedict's/Fehling's test,Iodine test,Barfoed's test.
2. Identification of proteins-Biuret test, Sodium hydroxide test
3. Identification of amino acids-Xanthoproteic test, Nin-hydrin test, Millon's test.
4. Identification of lipids-Sudan-IV test.
5. Histology of endocrine glands - Pituitary, Thyroid, Parathyroid, Thymus, Adrenal Pancreas, Ovary & Testis, Uterus.
6. Effect of eye stalk ablation on blood glucose levels in crab.
7. Identification of gonadotrophin in human urine samples.
8. Effect of thyroxine and thiourea (antithyroid agent) on oxygen consumption in fish.

- Laboratory record work shall be submitted at the time of practical examinations
- Computer-aided techniques shall be adopted as per UGC guidelines

B.Sc. ZOOLOGY III YEAR
SEMESTER-VI
DISCIPLINE SPECIFIC ELECTIVE I
LABORATORY ANIMALS MAINTENANCE AND APPLICATIONS

Instructions: Theory: 4 hrs per week
No. of period: 60
No. of credits: 4

UNIT I: Introduction to Laboratory Animals & Animal Ethics (15 Periods)

1.1 Overview of Laboratory Animals, Introduction to terrestrial and aquatic laboratory animals; Commonly used species: Rodents (mice, rats, guinea pigs), Rabbits, Primates, Zebrafish, Xenopus, *Caenorhabditiselegans*; Genetically modified laboratory animals (CRISPR, Knockout models)

1.2 Animal Experimentation: Principles &ethical Considerations; Historical background and implications of animal research; Alternatives to animal research (cell cultures, organoids, computer simulations); Standardized models for human diseases

1.3 Animal Ethics and Welfare, Ethical theories: Virtue ethics, Utilitarianism, Capabilities theory, Animal rights vs. scientific benefits debate

1.4 Regulations & Policies Governing Animal Research: Indian Laws - Prevention of Cruelty to Animals Act, 1960; International Guidelines - Institutional Animal Care and Use Committee (IACUC); OECD guidelines; Use of 3Rs (Replacement, Reduction, Refinement) in animal research

1.5 Standard Operating Procedures (SOP) for Animal Facilities; Role of CPCSEA (Committee for the Purpose of Control and Supervision of Experiments on Animals); Institutional Animal Ethics Committee (IAEC) guidelines; Risk assessment and safety procedures

UNIT II: Maintenance, Quality Control & Welfare of Laboratory Animals (15 Periods)

2.1 Laboratory Animal Housing & Facility Management; Housing conditions for terrestrial (rodents, rabbits, primates) and aquatic animals (fish, amphibians); Environmental factors - Temperature, humidity, air exchange, lighting cycles

2.2 Nutrition & Feeding Strategies: Nutrient requirements, metabolic needs, and specialized diets; Impact of nutrition on experimental outcomes

2.3 Genetic Standardization of Laboratory Animals: Inbred strains vs. outbred stocks; Hybridization techniques and genetic drift control; Quality control in transgenic and knockout models.

2.4 Microbiological Standardization, Pathogen-Free Animal Maintenance; Zoonotic risks and biosecurity measures.

2.5 Animal Welfare: Stress & Pain Management - Indicators of stress, pain, and distress in laboratory animals; Humane endpoints and euthanasia protocols

UNIT III: Housing &Management of Laboratory Animals (15 Periods)

3.1 Comprehensive management of laboratory animals; Animal welfare concerns & public perception of animal research; Legal & ethical debates on animal experimentation

3.2 Alternatives to animal experimentation, In-vitro models, organ-on-chip technology, and AI-based modeling

3.3 Species-Specific Laboratory Management & Husbandry: Mice and Rats - Anatomy, physiology, breeding, caging, health monitoring; Guinea Pigs and Rabbits - Handling, reproduction, and common diseases; Zebrafish and Xenopus - Water quality, feeding, spawning techniques

3.4 Environmental enrichment & behavioural well-being; Enrichment strategies for rodents, primates, and aquatic species; Impact of housing conditions on behavioural research

3.5 Biosafety and Laboratory Waste Management: Disposal of animal waste & biohazard containment; Disinfection protocols and sterility assurance.

UNIT IV: Applications of Laboratory Animals (15 Periods)

4.1 Animal Models in Biomedical Research; Importance and selection criteria; Models for cancer, diabetes, cardiovascular diseases, and neurodegenerative disorders

4.2 Types of Animal Models - Induced models (chemically, surgically); Spontaneous disease models; Transgenic and CRISPR-based models.

4.3 Applications in Biomedical Research: Studies on stem cells, regenerative medicine, and gene therapy; Immunological studies; Vaccine development

4.4 Behavioral Research Applications: Neurological and psychiatric models (Alzheimer's, Parkinson's, Autism); Cognitive and learning behaviour experiments

4.5 Toxicology and Pharmacological Applications: Safety testing of pharmaceuticals, pesticides, and cosmetics; Drug metabolism, LD_{50} studies, and bioavailability assessments

Suggested Readings

1. The Laboratory Rabbit, Guinea Pig, Hamster, and Other Rodents" by Murray E. Fowler and David M. Cubie
2. The Biology of Laboratory Animals" by S. F. B. O. Bakare
3. Laboratory Animal Medicine" by James G. Fox, Lynn C. Anderson, Franklin M. Loew, and Steven H. Mithun
4. The Ethics of Animal Experimentation: A Critical Analysis of the Arguments" by J.P. DeGrazia
5. Guide for the Care and Use of Laboratory Animals" by National Research Council (NRC)
6. Animal Experimentation: A Guide to the Issues" by M. O. Festing and R. M. W. Wilkinson
7. Principles of Laboratory Animal Science" by Helmut Greger, G. K. Zier, and D. L. Keil
8. Laboratory Animal Surgery" by C. R. MacDonald
9. Toxicology of Laboratory Animals" by Mark A. Suckow, Steven H. Weisbroth, and Craig L. Franklin
10. Biotechnology and the Ethics of Using Laboratory Animals" by Peter Singer

B.Sc. ZOOLOGY III YEAR
PRACTICAL SYLLABUS
SEMESTER-VI
DISCIPLINE SPECIFIC ELECTIVE I
LABORATORY ANIMALS MAINTENANCE AND APPLICATIONS

Instructions: 2 hrs per week
No. of credits: 1

1. Observation and identification of Laboratory Animals (Use of preserved specimens, models, or videos) to study of anatomy and physiology
2. Design a mock animal house facility and discuss about enrichment strategies
3. Analysis of sample diets, and comparison of animal diets and nutrient requirements.
4. Simulation of biosecurity protocols with emphasis on pathogen-free maintenance and zoonotic risks.
5. Behavioral observation and stress indicators through videos on behavioral observations to identify the stress indicators.
6. Case study analyses of the application of 3Rs (Replacement, Reduction, Refinement).
7. Use of computational tools to understand and find LD_{50}values.
8. Study of genetic modification techniques through simulation techniques.
9. Discuss the CPCSEA guidelines and risk assessment protocols.

• Laboratory record work shall be submitted at the time of practical examinations.
• Computer-aided techniques shall be adopted as per UGC guidelines.

B.Sc. ZOOLOGY III YEAR
SEMESTER-VI
DISCIPLINE SPECIFIC ELECTIVE I
FISHERIES AND LIMNOLOGY

Instructions: 4 hours per week
No. of period: 60
No. of credits: 4

UNIT-I: Introduction to Fisheries and Aquaculture Systems (15 periods)

1.1 Introduction to fisheries: Definition, history, and significance of fisheries; Present status and prospects of fisheries at global, national, and state levels.
1.2 Classification of Fisheries: Fin fisheries vs. Shell fisheries; Capture fisheries vs. Culture fisheries; Freshwater (inland), Brackish water, and Marine fisheries.
1.3 Aquaculture Systems, Overview of pond culture, pen culture, and cage culture, Monoculture, composite culture, and integrated culture systems
1.4 Recent trends in aquaculture: Recirculating Aquaculture Systems (RAS) and Biofloc.
1.5 Important cultivable species: Overview of Indian major and minor carps; Exotic carps, air-breathing fishes, and cold-water fishes; Freshwater prawns and mussels

UNIT-II: Breeding, Hatchery Management, and Fish Nutrition (15 periods)

2.1 Breeding Techniques, Bundh breeding: Concept, wet and dry bundhs, Collection and hatching of eggs
2.2 Induced Breeding, Environmental factors affecting spawning, Hypophysation technique: Fish pituitary gland extraction and injection methods, Role of synthetic hormones in breeding
2.3 Basic Management Practices: Nursery, rearing, and grow-out pond preparation; Liming, fertilization, and water quality management; Control of aquatic weeds and algal blooms
2.4 Hatchery Management: Types of hatcheries - Traditional, Chinese, Glass jar, and Modern controlled hatcheries; Breeding and hatchery management prawn rearing
2.5 Fish Nutrition: Natural vs. supplementary feeding; Forms of feeds - Wet, dry, pelleted, floating, and sinking feeds

UNIT-III: Introduction to Limnology (15 periods)

3.1 Basics of Limnology – Definition, scope and importance of limnology in water management.
3.2 Types of inland water bodies: Lentic and lotic ecosystems - Ponds, Lakes, Reservoirs, Streams, and Rivers
3.3 Physical and Chemical Properties of Water, Temperature, Light, pH, Turbidity, Dissolved Oxygen (DO), Alkalinity, Acidity, and Hardness, Importance of these parameters for aquatic organisms
3.4 Major Freshwater Bodies in India, Key rivers and lakes, Basic classification of lakes based on origin and morphology
3.5 Aquatic Organisms in Freshwater Systems, Plankton, Neuston, Nekton, Benthos, and Macrophytes, Adaptations of freshwater fauna

UNIT-IV: Productivity and Ecology of Aquatic Systems (15 periods)

4.1 Ecology of Ponds and Lakes, Structure and function of lentic and lotic ecosystems, Energy flow and food webs in aquatic systems
4.2 Productivity of Aquatic Systems, Concept of primary, secondary, and tertiary productivity, Factors affecting productivity

4.3 Types of water pollution, control and remediation.
4.4 Eutrophication and Its Impact: Causes and consequences; Control measures for eutrophication
4.5 Restoration of freshwater ecosystems – Lake and River restoration.

Reference Books:

1. Goldman C.R. and Horne A.J. (1983). Limnology. McGraw-Hill International.
2. Welch P.S. (1952). Limnology (2nd Ed.). McGraw-Hill, New York.
3. Cole G.A. (1983). Textbook of Limnology. C.V. Mosby, St. Louis.
4. Wetzel R.G. (1975). Limnology. W.B. Saunders, Philadelphia.

B.Sc. ZOOLOGY III YEAR
PRACTICAL SYLLABUS
SEMESTER-VI
DISCIPLINE SPECIFIC ELECTIVE I
FISHERIES AND LIMNOLOGY

Instructions: 2 hours per week
No. of credits: 1

1. Identification of Important Cultivable Freshwater Fishes – Indian major carps, exotic major carps, catfishes, murrels, and tilapias.
2. Morphometric and Meristic Studies of a Fish Species – Measurement of body proportions and counting of fin rays, scales, and vertebrae.
3. Study of Common Fish Feeding Habits – Observing gut contents and understanding feeding adaptations.
4. Observation of External Features of Freshwater Prawns & Mussels – Identifying key morphological structures.
5. Determination of Basic Water Quality Parameters – Measuring temperature, pH, dissolved oxygen, and turbidity in freshwater bodies.
6. Collection and Identification of Freshwater Plankton – Microscopic observation of phytoplankton and zooplankton.
7. Study of Fish Scales – Identification of scale types (cycloid, ctenoid, ganoid) and their significance in fish taxonomy and age determination.
8. Basic Hatchery Management Demonstration – Understanding induced breeding techniques (hypophysation) through a demonstration or video-based learning.
9. Fish Preservation Techniques – Simple methods of preservation using formalin and alcohol.
10. Field Visit to a Local Fisheries Unit or Freshwater Body – Observation of aquaculture practices, fish diversity, and limnological aspects; submission of a certified field note book.

References:

1. Ayyappan, S. (2011).Handbook of Fisheries and Aquaculture. ICAR Publications, New Delhi.
2. Rath, R.K. (2011). Freshwater Aquaculture. Scientific Publications.
3. Santhanam, R., Sukumaran, N., & Natarajan, P. (1987).A Manual of Aquaculture. Oxford-IBH, New Delhi.
4. Jhingran, V.G., &Pullin, R.S.V. (1997).A Hatchery Manual for the Common, Chinese, and Indian Major Carps. Asian Development Bank.

B.Sc. ZOOLOGY III YEAR
SEMESTER-VI
DISCIPLINE SPECIFIC ELECTIVE I
ECOLOGY, ZOOGEOGRAPHY AND EVOLUTION

Instructions: 4hr per week
No. of period: 60
No. of credits: 4

UNIT – I: Ecology - I (15 Periods)

1.1 Ecosystem structure and functions; Types of Ecosystems –Aquatic and Terrestrial.
1.2 Biogeochemical cycles - Nitrogen, Carbon, Phosphorus and Water.
1.3 Energy flow in ecosystem.
1.4 Food chain, food web and ecological pyramids.
1.5 Animal Associations - Mutualism, commensalism, parasitism, competition, predation

UNIT – II: Ecology - II (15 Periods)

2.1 Concept of Species; Population dynamics and Growth curves.
2.2 Community structure and dynamics; Ecological succession.
2.3 Ecological Adaptations – Terrestrial (aerial, arboreal, fossorial, cursorial, desert, & cave), aquatic (freshwater & marine).
2.4 Environmental Pollution – Sources, effect and control measures of air, water, Soil and Noise Pollution.
2.5 Wildlife legislation and conservation – Wild Life (Protection) Amendment Act 2022; National parks and sanctuaries of India; Endangered species.

UNIT – III: Zoogeography (15 Periods)

3.1 Zoogeographical regions 1 – Palearctic, Nearctic, and Neotropicalregions - their Climatic and faunal peculiarities
3.2 Zoogeographical regions 2 – Oriental, Australian and Ethiopian regions - their Climatic and faunal peculiarities
3.3 Wallace line; Weber line; Discontinuous distribution.
3.4 Continental Drift – Definition, its impact on shaping zoogeographical regions.
3.5 Biodiversity and hotspots of Biodiversity in India.

UNIT – IV: Evolution (15 Periods)

4.1 Theories of evolution – Lamarckism and Neo-Lamarckism, Darwinism and Neo-Darwinism.
4.2 Concept of Modern Synthetic Theory– mutation, gene flow, genetic drift, and natural selection; Hardy Weinberg Law
4.3 Evidenceof Evolution; Causes and Role of Extinction in Evolution.
4.4 Isolation: Types and mechanisms of isolation.
4.5 Speciation: Methods of speciation – Allopatric, parapatric, peripatric, and sympatric speciation.

Suggested Readings:

1. **M.P.Arora**, '*Ecology*' Himalaya Publishing company.
2. **P.D.Sharma**, *Environmental Biology'*.
3. **P.R.Trivedi and Gurdeep Raj**. '*Environmental Ecology'*

4. **BuddhadevSarma and Tej Kumar**, *Indian Wildlife Threats and Preservation*
5. **Chapman J.L. and Reiss M.J,** *Ecology Principles and Applications*, SecondEd., Cambridge University Press, London.
6. **Benny Joseph,** *Environmental Studies*, TATA McGraw Hill Com., New Delhi.
7. **Eugene P. Odum**, *Fundamentals of Ecology* Third Ed., Nataraj Publishers, Dehradun.
8. **Veer BalaRastogi**, "Ecology and Animal Distribution"
9. **P.K. Gupta,** "Text Book of Ecology and Environment"
10. **Bhatnagar and Bansal,** "Ecology and Wildlife biology
11. **Ridley, M. (2004).** *Evolution*. III Edition. Blackwell Publishing
12. **Douglas, J. Futuyma (1997).** *Evolutionary Biology*. Sinauer Associates.
13. **Minkoff, E. (1983).** *Evolutionary Biology*. Addison-Wesley.
14. **Jan M. Savage**. *Evolution*, 2nd ed, Oxford and IBH Publishing Co., New Delhi.

B.Sc. ZOOLOGY III YEAR
PRACTICAL SYLLABUS
SEMESTER-VI
DISCIPLINE SPECIFIC ELECTIVE I
ECOLOGY, ZOOGEOGRAPHY AND EVOLUTION

Instructions: 2hr per week
No. of credits: 2

1. Determination of pH of Soil and Water
2. Estimation of carbonates and bicarbonates in the given water samples.
3. Estimation of dissolved oxygen of pond water, sewage water and effluents.
4. Identification of zooplankton from a nearby water body.
5. Study of pond ecosystem **/**local polluted site - Report submission
6. Study of at least 3 endangered or threatened wild animals of India through photographs / specimens / models
7. Field visit to Zoo Park to study the management, behavior and enumeration of wild animals.
8. Identification of Zoogeographical realms from the Map and identify specific fauna of respective regions.
9. Museum Study: *Peripatus, Coelacanth Fish, Dipnoi fishes, Sphenodon, Archeopteryx*.
10. Study of homology and analogy from suitable specimens and pictures
11. Problems based on Hardy-Weinberg Law
12. Macroevolution using Darwin finches (pictures)

Laboratory Record work shall be submitted at the time of practical examination

Computer aided techniques should be adopted as per UGC guide lines.

Suggested manuals
1. **Robert Desharnais, Jeffrey Bell**, 'Ecology Student Lab Manual, Biology Labs'
2. **Darrell S Vodopich,** 'Ecology Lab Manual'

B.Sc. ZOOLOGY III YEAR
SEMESTER-VI
SKILL ENHANCEMENT COURSE – I
SERICULTURE

Instructions: 2 hours per week
No. of period: 30
No. of credits: 2

UNIT- I: Introduction to Sericulture and Mulberry Cultivation (15 Periods)

1.1 History and scope of sericulture in India, economic importance; Major types of silkworms (Mulberry and Non-Mulberry: Tasar, Eri, and Muga).
1.2 Silkworm Biology – Systematic position and life cycle of *Bombyxmori*; Structure and function of the silk gland.
1.3 Mulberry Cultivation – Importance of mulberry plants in sericulture; Environmental conditions required (soil, climate, land preparation).
1.4 Mulberry Plant Management – Pruning techniques, intercultivation, and harvesting methods.
1.5 Mulberry Pests and Diseases – Common pests and diseases of mulberry plants and their control methods.

UNIT- II: Silkworm Rearing and Silk Production (15 Periods)

2.1 Silkworm Rearing Principles – Essential conditions for successful silkworm rearing (temperature, humidity, hygiene).
2.2. Rearing Practices – Feeding of silkworms, bed cleaning, spacing, moulting process, and harvesting of cocoons.
2.3 Silkworm Pests and Diseases – Common diseases and pests affecting silkworms; preventive and control measures.
2.4 Silk Processing – Reeling process; types of reeling appliances and methods of reeling cocoons.
2.5 Sericulture as industry – Global and Indian perspectives.

References:

1. Ullal, S.R., &Narasimhanna, M.N. (1987). Handbook of Practical Sericulture. Central Silk Board, Bangalore.
2. Ganga, G., &Sulochana Chetty, J. An Introduction to Sericulture.
3. FAO Manuals on Sericulture, Vol. I-IV.
4. Krishnaswamy, S. (1986). Improved Method of Rearing Young Age Silkworms. CSB Publication, Bangalore.
5. Hanumappa, H.G. (1978). Sericulture for Rural Development. Himalaya Publishing.
6. Tazima, Y. (1978). The Silkworm: An Important Laboratory Tool. Kodansha Publications, Tokyo.

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B.Sc. ZOOLOGY III Year

SEMESTER-VI

SKILL ENHANCEMENT COURSE -I

ECOTOURISM

Instructions: 2hr per week
No. of period: 30
No. of credits: 2

UNIT-I: Introduction to Ecotourism (15 Periods)

1.1. Ecotourism: Concept and Scope - Definition of ecotourism; principles and objectives of ecotourism; Differentiation between ecotourism, sustainable tourism, and mass tourism; Overview of ecotourism's role in environmental conservation and community development.

1.2. Evolution and Historical Development of Ecotourism-Global evolution of ecotourism: origins, milestones, and trends; Ecotourism in India: emergence and significant developments; Role of key international organizations in promoting ecotourism (e.g., IUCN, UNWTO, and WWF).

1.3. Ecotourism and Biodiversity Conservation-Ecotourism's contribution to biodiversity conservation and habitat protection.; Case studies of ecotourism in biodiversity hotspots, such as the Western Ghats, Sundarbans, and the Himalayas.; Synergies between ecotourism and wildlife protection.

1.4. Ecotourism in Telangana-Overview of ecotourism hotspots in Telangana (Pocharam, Kawal Wildlife Sanctuary, Ananthagiri Hills, Kinnerasani Wildlife Sanctuary, Eturunagram Wildlife Sanctuary, Bogatha Waterfalls, Laknavaram Lake, Pakhala Lake & Wildlife Sanctuary,; Role of regional flora and fauna in promoting ecotourism.; Government initiatives for ecotourism development in the region.

1.5. Sustainable Tourism Principles-Minimizing environmental impact through responsible tourism practices.; Enhancing cultural sensitivity and local community involvement.; Economic benefits for local communities, focusing on capacity building and revenue sharing.

UNIT-II: Ecotourism and its Impacts (15 Periods)

2.1. Economic Significance of Ecotourism - Contribution of ecotourism to the local and national economies.; Revenue generation models: entry fees, guided tours, accommodation (e.g., homestays), and sustainable products.; Long-term economic sustainability through ecotourism.

2.2. Ecotourism as a Career Path -Career opportunities in the ecotourism industry (e.g., tour guides, wildlife photographers, ecotourism managers).;Required skills for ecotourism professionals (e.g., communication, environmental awareness, cultural sensitivity, and field expertise).; Professional development: certifications, training programs, and potential academic pathways.

2.3. Community-Based Ecotourism Development -The role of local communities in developing and sustaining ecotourism initiatives.; Case studies of successful community-based ecotourism projects in India, such as Thenmala (Kerala), and the role of community participation.; Benefits to local communities: economic empowerment, cultural preservation, and environmental stewardship.

2.4. Environmental Benefits of Ecotourism -Conservation of natural resources, ecosystems, and endangered species through ecotourism activities; Reduction of carbon footprint: promoting eco-friendly practices such as waste management, energy conservation, and low-impact travel.; Ecotourism's role in environmental education and raising awareness about climate change.

2.5. Challenges and the Future of Ecotourism -Key challenges in ecotourism development: infrastructure issues, over-tourism, environmental degradation, and commercialization.; Strategies for overcoming challenges: sustainable infrastructure, responsible marketing, and

government involvement.; Future trends in ecotourism: digital innovation (e.g., virtual ecotourism), ecotourism policy development, and the rise of eco-conscious travelers.; Strategies for promoting ecotourism in Telangana: government policies, private sector involvement, and eco-certification systems.

Suggested Readings:

1. Fennell, D.A. (2015). Ecotourism: An Introduction (4th ed.). Routledge.
2. Weaver, D.B. (2008). Ecotourism (2nd ed.). John Wiley & Sons.
3. Honey, M. (2008). Ecotourism and Sustainable Development: Who Owns Paradise? (2nd ed.). Island Press.
4. Kumar, S. (2012). Ecotourism in India: Opportunities and Challenges. Kanishka Publishers.
5. Telangana Tourism Development Corporation (TTDC). (2023). Ecotourism Potential in Telangana
6. Problems and Solutions. In: Brophy, S.C., (Ed), Ecotourism: Practices, Benefits and Environmental Impacts. Nova Science Publishers, pp. 119 – 134
7. Wearing, S. and Schweinsberg, S., 2019. Ecotourism: Transitioning to the 22ndcentury. Routledge
8. Government Reports and Articles on Ecotourism in Telangana from relevant state and national agencies.
9. Ballantyne, R. and Packer, J., 2013. International Handbook on Ecotourism. EdwardElgar Publishing Limited, UK
10. Pruthi R.K., Tourism Industry and Environmental Management, (New Delhi, 2006).
11. Kandari, O. P., Tourism, Biodiversity and Sustainable Development: Tourism and sustainability, Delhi: Isha, 2003

WEB SOURCES

- https://www.ecotourism.org/what-is-ecotourism
- www.nature.org › Green Living
- www.ecoindia.com/eco-tourism-in-india.html

B.Sc. ZOOLOGY III YEAR
SEMESTER-VI
SKILL ENHANCEMENT COURSE – I
PUBLIC HEALTH AND HYGIENE

Instructions: 2 hours per week
No. of period: 30
No. of credits: 2

UNIT – I: Nutrition, Environment, and Health (15 Periods)

1.1 Classification of Foods - Macronutrients: Carbohydrates, Proteins, Lipids, Micronutrients: Vitamins, Minerals, Role of dietary fiber and probiotics in health.

1.2 Nutritional Deficiencies and Disorders - Malnutrition: Under-nutrition and Over-nutrition. Deficiency disorders: Carbohydrates (ketosis), Proteins (kwashiorkor, marasmus), Lipids (essential fatty acid deficiency), Vitamins (A, B-complex, C, D, E, K), and Minerals (iron, iodine, calcium, zinc). Emerging concerns: Obesity, Metabolic syndrome, Gut microbiome imbalance

1.3 Environment and Health Impact Assessment (EHIA) - Concept, principles, steps, and applications. Climate change and its impact on public health, Role of One Health approach in environmental health

1.4 Occupational, Industrial, Agricultural, and Urban Health - Workplace hazards: Chemical, biological, physical, and ergonomic risks. Occupational diseases: Silicosis, Asbestosis, Noise-induced hearing loss. Agricultural health risks: Pesticide exposure, Zoonotic diseases. Urban health concerns: Air pollution, Vector-borne diseases, Mental health in urban settings

1.5 Environmental Pollution and Associated Health Hazards- Air pollution and respiratory diseases: Asthma, Lung cancer. Water pollution and health impacts: Fluorosis, Lead poisoning. Soil contamination and food safety concerns. Emerging contaminants: Microplastics, Endocrine disruptors

UNIT-II: Communicable and Non-Communicable Diseases (15 Periods)

2.1 Communicable Diseases: Causes, Symptoms, Treatment, and Prevention. Vector-borne diseases: Malaria, Dengue, Chikungunya, Zika virus. Bacterial infections: Tuberculosis, Leprosy, Plague, Cholera, Typhoid. Viral infections: Measles, Polio, Rabies, Influenza, COVID-19. Parasitic diseases: Filaria, Leishmaniasis, Schistosomiasis. Sexually transmitted infections: HIV/AIDS, Syphilis, Gonorrhea

2.2 Non-Communicable Diseases: Causes, Symptoms, Treatment, and Prevention. Cardiovascular diseases: Hypertension, Coronary artery disease, Stroke. Metabolic disorders: Diabetes, Obesity, Thyroid disorders. Neurological and mental health disorders: Depression, Anxiety, Alzheimer's disease. Cancer: Risk factors, Early detection, Screening, Lifestyle modifications

2.3 Waterborne Diseases: Causes, Symptoms, Treatment, and Prevention of Cholera, Hepatitis A & E, Leptospirosis, *E. coli* infections; Airborne Diseases: Causes, Symptoms, Treatment, and Prevention of Influenza, Chickenpox, Tuberculosis, Pneumonia.

2.4 Health Care Legislation and Policies in India. Legal frameworks: Medical Termination of Pregnancy (Amendment) Act, Surrogacy Regulation Act, Mental Healthcare Act, National Health Policy. Public health policies: Swachh Bharat Abhiyan, Ayushman Bharat, National Health Mission. Biomedical waste management and disposal regulations. Personal health records, digital health initiatives (e-health, telemedicine)

2.5 Global Health Initiatives and WHO Programs. Global health governance: WHO, CDC, UNDP; Sustainable Development Goals (SDG) and health targets

Suggested Readings:

1. Park, K. (2021) - Textbook of Preventive and Social Medicine – BanarsidasBhanot Publishers, India.
2. Beaglehole, R., & Bonita, R. (2019) - Public Health at the Crossroads: Achievements and Prospects – Cambridge University Press.
3. Wallace, R.B. (2019) - Maxcy-Rosenau-Last Public Health and Preventive Medicine, 15th Edition.
4. Sathe, P.V., & Sathe, A.P. (2018) - Epidemiology and Management for Health Care – Popular Prakashan, Mumbai.
5. Merson, M., Black, R.E., & Mills, A.J. (2020) - International Public Health: Diseases, Programs, Systems, and Policies – Jones and Bartlett Publishers.
6. World Health Organization (2022) - World Health Report & WHO Technical Reports on Global Health Priorities.

B.Sc. ZOOLOGY III YEAR
SEMESTER-VI
SKILL ENHANCEMENT COURSE – I
APICULTURE

Instructions: 2hr per week
No. of period: 30
No. of credits: 2

UNIT-I: Introduction to Apiculture (15 Periods)

1.1 History, classification, and current status of the apiculture industry in India; Global trends in apiculture and its economic significance; Role of apiculture in agriculture, biodiversity conservation, and pollination services.

1.2 Biology of Honey Bees and Bee Economy: Overview of the Apidae family, particularly *Apismellifera* and *Apiscerana*; Bee behaviour, reproduction, and lifespan; Economic importance of honey bees in crop pollination

1.3 Social Organization of the Bee Colony; Role of the queen, workers, and drones; Communication within the colony (e.g., waggle dance, pheromones); Colony division of labour and environmental cues influencing colony behaviour

1.4 Selection of Bee Species for Apiculture: Factors influencing species selection, (climate, productivity, disease resistance); Differences between native species and non-native species in Indian conditions; Pros and cons of different honey bee species for commercial production.

1.5 Bee Rearing Methods: Artificial Bee Rearing (Apiary); Types of beehives (Langstroth, Top-bar, and Warre hives); Innovations in hive design for increased productivity; Sustainable and organic beekeeping practices.

UNIT-II: Apiculture Industry and Their Uses (15 Periods)

2.1 Products of the Apiculture Industry and Their Uses: Honey - Varieties, composition, medicinal and nutritional benefits; Beeswax - Extraction methods, uses in cosmetics, pharmaceuticals, and candles; Propolis - Collection, properties, and medicinal uses; Royal jelly - Production and its role in colony development

2.2 Methods of Honey Extraction: Indigenous methods - Traditional techniques of honey harvesting; Modern methods - Mechanical honey extractors, centrifugation, and filtration; Best practices for maintaining honey quality during extraction

2.3 Beekeeping Equipment: Essential tools - Hive tools, smokers, bee brushes, and protective gear; Modern equipment for efficient beekeeping (e.g., automatic honey extractors); Innovations in hive management systems

2.4 Colony Inspection and Maintenance of Equipment: Regular inspection of hives - Identifying queen status, colony strength, and disease symptoms; Disease management practices (e.g., Varroa destructor, Nosema, etc.); Cleaning, sterilization, and maintenance of beekeeping equipment

2.5 Bee Diseases and Enemies: Control and preventive methods; Common bee diseases - Bacterial, fungal, and viral diseases; Pests and predators - Varroa mites, wax moths, hornets; Integrated pest management in beekeeping; Organic and natural methods for disease prevention and control

Suggested Reading:

1. Textbook of Applied Zoology, Telugu Academy
2. Apiculture, Prost P.J., Oxford & IBH Publishing, New Delhi
3. Apiculture, Bisht, ICAR Publication
4. Bee Health: Science, Philosophy, and Policy, Morse, R. A., & Flottum, K. (Editors), Wicwas Press
5. The Beekeeper's Bible, Hargreaves, R. S., & B. F. B. Oxford University Press

B.Sc. ZOOLOGY III YEAR
SEMESTER-VI
SKILL ENHANCEMENT COURSE – I
MEDICAL DIAGNOSTICS

Instructions: 2 hrs per week
No. of period: 30
No. of credits: 2

UNIT-I: Advanced Diagnostic Techniques (15 Periods)

1.1 Introduction to Medical Diagnostics and Its Importance, Evolution of medical diagnostics, importance in disease detection and treatment, Emerging trends: Point-of-care diagnostics, wearable biosensors, AI-assisted diagnostics.

1.2 Diagnostic Methods for Blood Analysis; Advanced smear preparation techniques, automated hematology analyzers; Complete Blood Count (CBC) with automated analysis: RBC, WBC, platelet count, ESR (Erythrocyte Sedimentation Rate), PCV (Packed Cell Volume), Hemoglobin estimation, Bleeding and clotting time, Coagulation disorders & tests (PT, APTT, INR),Blood grouping and Rh typing, cross-matching.

1.3 Hematological Disorders diagnostic techniques: Blood coagulation, thrombolytictherapy, Blood banking, storage techniques, and transfusion medicine; Platelet-rich plasma therapy and its applications.

1.4 Clinical Biochemistry and Biomarkers: Blood glucose monitoring - HbA1c, CGM (Continuous Glucose Monitoring), Serum proteins and electrophoresis; Advanced Liver Function Test (LFT) - SGPT, SGOT, ALP, Bilirubin, GGT; Kidney Function Tests (KFT) - Creatinine, BUN, eGFR; Lipid profile - LDL, HDL, VLDL, triglycerides; Cardiac markers - Troponins, CK-MB, NT-proBNP, Myoglobin; Enzymatic tests - Amylase, Lipase, Lactate Dehydrogenase (LDH).

1.5 Histopathology and Advanced Diagnostic Pathology: Tissue processing and staining techniques, Immunohistochemistry (IHC), Flow cytometry in cancer diagnostics, Autopsy and biopsy: AI-assisted digital pathology.

UNIT-II: Diagnostic Techniques for Diseases (15 Periods)

2.1 Urine and Body Fluid Analysis: Urine analysis - Physical, chemical, and microscopic examination; Renal biomarkers in urine (albuminuria, microalbuminuria); Dialysis techniques - Hemodialysis and peritoneal dialysis; CSF (Cerebrospinal Fluid) analysis for neurological conditions - Analysis of synovial, pleural, pericardial, peritoneal fluids; Sputum and faecal examination - Detection of infections, occult blood tests

2.2 Clinical Diagnosis of Infectious Diseases: Bacterial infections - Advanced diagnostics for Tuberculosis (GeneXpert, MGIT), Typhoid (Widal test, rapid antigen tests), Antibiotic resistance testing and antimicrobial stewardship; Viral infections - PCR-based and ELISA diagnostics for Hepatitis, HIV/AIDS, Polio, COVID-19; Protozoan infections - Rapid Malaria diagnostic tests, molecular methods for Amoebiasis; Helminthic infections - Serological tests for Ascaris, *Taeniasolium*, *Wuchereriabancrofti*.

2.3 Clinical Diagnosis of Non-Communicable Diseases (NCDs): Diabetes - Insulin resistance markers, CGM; Hypertension - Ambulatory Blood Pressure Monitoring (ABPM); Asthma - Pulmonary Function Tests (PFT), Fractional Exhaled Nitric Oxide (FeNO); Stroke - D-dimer test, CT perfusion scans, MRI diffusion; Arthritis - Rheumatoid factor, Anti-CCP antibodies; Cardiovascular diseases - ECG, echocardiography, cardiac CT/MRI; Cancer diagnostics - Tumor markers (CEA, AFP, PSA, CA-125, CA 19-9), Liquid biopsy, Next-Generation Sequencing (NGS).

2.4 Cellular and Molecular Pathophysiology: Concepts of Edema, Hyperemia, Hemorrhage, and Hemostasis, Thrombosis and embolism - Deep vein thrombosis (DVT) diagnostics; Cellular responses to stress: Hyperplasia, Hypertrophy, Metaplasia, Atrophy, Apoptosis and necrosis in disease mechanisms; Molecular pathology: CRISPR and gene-editing in diagnostics.

2.5 Medical Imaging and Technological Innovations: X-ray, Digital X-ray advancements, PET (Positron Emission Tomography) and hybrid PET-CT scans; MRI (Magnetic Resonance Imaging) - Functional MRI (fMRI), Diffusion Tensor Imaging (DTI); CT scan - 3D reconstruction, AI-assisted image analysis; ECG (Electrocardiogram) and new wearable cardiac monitors, EEG (Electroencephalogram) and neurodiagnostics; Echocardiography - Doppler and 3D echo, AI in medical imaging and deep learning in radiology.

Suggested Readings:

1. Cheesebrough, M. A Laboratory Manual for Rural Tropical Hospitals – Updated Edition
2. Mukherjee, K. Medical Laboratory Techniques Vol-I, II, III – Tata McGraw Hill
3. Sachdev, K. N. Clinical Pathology and Medical Microbiology – Jaypee Brothers
4. Sood, R. Medical Laboratory Techniques – Jaypee Brothers
5. Prakash, G. Lab Manual on Blood Analysis and Medical Diagnostics – S. Chand and Co. Ltd.
6. Robbins and Cotran Pathologic Basis of Disease, 10th Edition – Elsevier
7. Guyton A.C. and Hall J.E. Textbook of Medical Physiology – Saunders
8. Park, K. Preventive and Social Medicine, 27th Edition – B.B. Publishers
9. Bishop, M. L., Fody, E. P., Schoeff, L. E. Clinical Chemistry: Principles, Techniques, and Correlations – Wolters Kluwer
10. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry, 8th Edition – W.H. Freeman

B.Sc. ZOOLOGY III Year
SEMESTER-VI
SKILL ENHANCEMENT COURSE – I
ENVIRONMENTAL IMPACT ASSESSMENT

Instructions: 2hr per week
No. of period: 30
No. of credits: 2

UNIT-I: Introduction to Environmental Impact Assessment (EIA) (15 Periods)

1.1. History and Importance of EIA - Definition, objectives, and significance of Environmental Impact Assessment (EIA).; Historical development of EIA: Global trends and evolution in India.; The role of EIA in promoting sustainable development and environmental protection.

1.2. Legal and Regulatory Framework - Overview of key EIA laws and policies in India, such as the EIA Notification 2006 and subsequent amendments.; Role and functions of the Ministry of Environment, Forest and Climate Change (MoEFCC); Key institutions involved in the EIA process in India.

1.3. Stages of the EIA Process -Detailed discussion on the stages of EIA**:** screening, scoping, baseline data collection, impact prediction, mitigation measures, and monitoring.; The role of public participation and stakeholder consultation in the EIA process.

1.4. Tools and Techniques for EIA -Environmental indicators, checklists, matrices, and modeling tools used in EIA.; The application of Geographic Information Systems (GIS) and Remote Sensing in EIA for data collection and impact prediction.

1.5. Types of Environmental Impacts -Understanding direct, indirect, cumulative, and synergistic environmental impacts.; Case studies highlighting environmental impacts from industrial, mining, and infrastructure projects.

UNIT-II: Application and Challenges in EIA (15 Periods)

2.1. EIA in Development Projects - Role of EIA in ensuring sustainable development in sectors such as mining, dams, urban development, and industrial projects.; Case studies of EIA in various development sectors.

2.2. EIA in Telangana-Overview of EIA practices and procedures in Telangana.; Case studies of EIA for major projects such as the Kaleshwaram Lift Irrigation Scheme, Hyderabad Metro, and industrial zones in Telangana.

2.3. Challenges in EIA Implementation-Limitations and challenges in the EIA process, including lack of transparency, inadequate public participation, and insufficient data.; Strategies for improving the effectiveness of EIA, such as capacity building, better public engagement, and the use of advanced tools.

2.4. Socio-Economic Dimensions of EIA-Cost-benefit analysis of environmental impacts.; Integration of Social Impact Assessment (SIA) with EIA to consider social, economic, and cultural impacts.

2.5. The Future of EIA-Emerging trends in EIA, including Strategic Environmental Assessment (SEA) and the integration of climate change considerations.; Role of technology and innovation in enhancing EIA processes, such as digital tools, remote sensing, and big data analytics.

Suggested Readings:

1. Canter, L.W**.** (1996). *Environmental Impact Assessment* (2nd ed.). McGraw-Hill.
2. Glasson, J., Therivel, R., & Chadwick, A. (2012). *Introduction to Environmental Impact Assessment* (4th ed.). Routledge.

3. Ministry of Environment, Forest and Climate Change (MoEFCC). (2006). *Environmental Impact Assessment Notification*. Government of India.
4. Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Trivedi R.K., Enviro Media.
5. Environmental Protection and Laws, Jadhav, H &Bhosale, V.M., Himalaya Pub. House, Delhi.
6. Text Book on Environmental Impact Assessment, Barthwal, R. R., New Age International Private Limited.
7. Environmental Impact Assessment, Canter, L.W., McGraw Hill, New York. 11. Environmental Audit, Shrivastava, A. K., New Delhi, India.
8. Petts, J. (1999). *Handbook of Environmental Impact Assessment* (Vol. 1 & 2). Blackwell Publishing.
9. Reddy, M.S. (2018). *Environmental Impact Assessment: Theory and Practice*. PHI Learning.
10. Telangana State Pollution Control Board (TSPCB). (2023). *EIA Guidelines for Telangana*.

Suggestive Digital Platforms / Web Links

1. Environment, UGC-MOOCs SWAYAM; https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/228
2. Environmental Impact Assessment, Ministry of Environment & Forests: http://moef.gov.in/wp-content/uploads/report/0607/chap03.pdf; http://moef.gov.in/wp-content/uploads/2018/04/Introducation.pdf.

B.Sc. ZOOLOGY III YEAR
SEMESTER-VI
SKILL ENHANCEMENT COURSE – I
POULTRY AND ANIMAL HUSBANDRY

Instructions: 2 hrs per week
No. of period: 30
No. of credits: 2

UNIT - I: Poultry Science (15 Periods)

1.1 Poultry Industry: Present status and future prospects, Global and Indian poultry industry trends, economic importance of poultry farming; Technological advancements in poultry farming, Role of genetics and biotechnology in poultry improvement, Sustainable poultry farming and environmental impact: Nutritional value of egg and chicken meat.

1.2 Poultry Housing and Management, Housing systems: Deep litter, cage, slatted floor, and environment-controlled housing, Biosecurity measures and smart poultry farming (IoT-based monitoring, automated feeding, climate control), Free-range and organic poultry farming trends.

1.3 Poultry Nutrition and Feed Management, Advanced classification of feedstuffs: Energy feeds, protein feeds, minerals, vitamins, probiotics, and prebiotics, Feed formulation and optimization using precision nutrition, Role of omega-3 fatty acids, phytobiotics, and nutraceuticals in poultry feed, Water quality and its role in poultry health.

1.4 Poultry Diseases: Diagnosis, Prevention, and Control, Viral diseases: Newcastle disease (Ranikhet), Fowl pox, EDS-76 (Egg Drop Syndrome), Infectious Bursal Disease (Gambaro), Bacterial diseases: Colibacillosis, Salmonellosis, Mycoplasmosis, Fungal diseases: Aspergillosis, Mycotoxicosis, Parasitic diseases: Coccidiosis, Helminthiasis (Tapeworms), Ectoparasitic infestations (Mites, Lice), Advanced diagnostic tools: ELISA, PCR, and rapid antigen tests for poultry diseases, Strategies for antibiotic-free poultry farming

1.5 Poultry Health and Vaccination Programs, Updated vaccination schedule for broilers, broiler breeders, commercial layers, turkeys, ducks, Role of probiotics, immunomodulators, and herbal alternatives in poultry health, Heat stress, management and welfare considerations in poultry farming.

UNIT - II: Advanced Animal Husbandry (15 Periods)

2.1 Dairy Farming in India: Current trends and future prospects, Growth of dairy industry and livestock economy, Economical importance of dairy farming; Impact of genetics and selective breeding on milk production; Smart dairy farming - AI-based herd management, RFID tracking, precision feeding; Sustainable dairy farming and zero-waste models

2.2 Dairy Farm Infrastructure and Management, Hygienic housing: Modern ventilation, lighting, water supply, drainage; Waste management and biogas production from dairy farms; Nutritional value of milk, Automation in milking (robotic milking, automatic milking systems); Organic dairy farming and A2 milk production trends; Preservation of milk and milk products

2.3 General Animal Husbandry Practices: Grooming, hoof trimming, deworming, vaccination schedules, Heat stress management, disease prevention, and biosecurity in farms, Ethical concerns in animal husbandry: Welfare standards and humane handling

2.4 Cattle and Buffalo Management, Neonatal calf care and colostrum feeding, Management of pregnant, parturient, lactating, and dry cows and buffaloes, Summer stress management in

buffaloes, Advances in breeding technology: Artificial Insemination (AI), Embryo Transfer Technology (ETT), In Vitro Fertilization (IVF)

2.5 Sheep, Goat, and Swine Management, Early-life nutrition and management of lambs, kids, and piglets, Genetic improvement and crossbreeding strategies for enhanced meat and milk yield, Disease management: Foot and Mouth Disease (FMD), Peste des Petits Ruminants (PPR), Brucellosis, Sustainable pasture and fodder management for small ruminants.

Suggested Readings:

1. Ghosh, N. Poultry Science and Practice – CBS Publishers
2. Prasad, J. Poultry Production and Management – Kalyani Publishers
3. Banerjee, C.C. A Textbook of Animal Husbandry – Oxford & IBH Publishing
4. Kaushish, S.K. A Textbook of Animal Husbandry – Kalyani Publishers
5. FAO (Food and Agriculture Organization) Dairy and Poultry Industry Reports
6. Singh, R.A. Modern Poultry Management – International Book Distributors
7. Jain, N.C. Veterinary Hematology and Clinical Pathology – CBS Publishers
8. Tyagi, R. and Singh, J. Artificial Insemination and Livestock Improvement – CBS Publisher

B.Sc. ZOOLOGY III YEAR
SEMESTER-VI
SKILL ENHANCEMENT COURSE – I
AQUACULTURE

Instructions: 2 hrs per week
No. of period: 30
No. of credits: 2

UNIT - I: Aquaculture Systems and Management (15 Periods)

1.1 Introduction to Aquaculture: Concept, scope, and significance of aquaculture; Types of aquaculture - Freshwater aquaculture, Brackish water aquaculture, Mariculture
1.2 Composite Fish Culture, Definition, patterns, and techniques of composite culture in India, Polyculture strategies: Major carps, catfish, and other species.
1.3 Water quality management: Parameters, monitoring and treatment methods
1.4 Nutritional Management in Aquaculture, Natural fish food organisms and their production, Feed formulation: Live feed (zooplankton, phytoplankton), artificial feeds, probiotics, Role of biofertilizers in aquaculture.
1.5 Fish Seed Transport: Transportation of fish seed and broodstock: Methods (open/closed systems), water quality management, Use of anesthetics, antibiotics, and probiotics in live fish transport

UNIT - II: Fish Health, Breeding, and Advanced Aquaculture Practices (15 Periods)

2.1 Fish Diseases and Health Management; Common fish diseases, diagnosis and control measures.
2.2 Fish Breeding and Post-Harvest Technology, Natural and induced breeding techniques (Hypophysation, hormonal manipulation)Post-harvest handling and processing
2.3 Freshwater Prawn Culture, Breeding characteristics and lifecycle of *Macrobrachium* species, Juvenile prawn migration, seed identification, and controlled breeding, Role of water quality, feed, and pond fertilization in prawn culture
2.4 Pearl Culture and Molluscan Aquaculture, Pearl-producing mollusks and formation process, Techniques for collection, rearing, and nucleus implantation, Economic significance and quality grading of pearls
2.5 Emerging Technologies in Aquaculture, Recirculating Aquaculture Systems (RAS): Water conservation, biofiltration, and sustainability, Geographic Information System (GIS) & Remote Sensing: Site selection and resource mapping, Information and Communication Technology (ICT) in Fisheries: Precision aquaculture, market intelligence, and AI-driven monitoring systems

Suggested Readings:

1. Jingran, V.G. Fish and Fisheries of India, Hindustan Publishing Corp., New Delhi.
2. Hute, M. and Kahn, H. Textbook of Fish Culture, Blackwell Scientific Publications, Australia.
3. Srinivasulu, M., Reddy, K.R.S., Rao, S. Textbook of Aquaculture, Discovery Publishing House, New Delhi.
4. Mehta, Y. Fisheries & Aquaculture Biotechnology, Campus Books International, New Delhi.
5. FAO & WHO Reports on Sustainable Aquaculture Practices
6. Timmons, M.B., &Ebeling, J.M. Recirculating Aquaculture Systems, NRAC Publication.
7. Silva, S.S. &Desilva, S. Aquaculture in the 21st Century, Springer.
8. Beveridge, M.C.M. Cage Aquaculture, Fishing News Books.

B.Sc. ZOOLOGY III YEAR
SEMESTER-VI
SKILL ENHANCEMENT COURSE – I
VECTOR BIOLOGY

Instructions: 2 hrs per week
No. of period: 30
No. of credits: 2

UNIT - I: Vector Biology of Public Health Importance (15 Periods)

1.1 Introduction to Vector Biology: Definition and classification of vectors, Medical and veterinary importance of vectors; Role of vectors in disease transmission - Mechanical vs. biological transmission, Emerging and re-emerging vector-borne diseases in the context of climate change

1.2 Mosquito Vectors of Public Health Importance: Updated taxonomy, morphology, and life cycle of *Anopheles*, *Aedes*, *Culex*, and *Mansonia*; Host-seeking behavior, blood-feeding, and vector competence; Molecular aspects of mosquito-pathogen interactions

1.3 Other Dipteran Vectors of Public Health Importance: Sandflies (*Phlebotomus*) - Leishmaniasis transmission, vector-parasite interactions; Blackflies (*Simulium*) - Role in Onchocerciasis transmission; Houseflies (*Musca domestica*) - Mechanical transmission of pathogens; Myiasis-causing flies (Cochliomyia, Dermatobia) - medical and veterinary significance.

1.4 Fleas and Lice as Disease Vectors: Life cycle, morphology, and disease transmission potential; Role of fleas (*Xenopsyllacheopis*) in plague (*Yersinia pestis*)transmission; Role of lice (*Pediculushumanus* and *Pthirus pubis*) in epidemic typhus, trench fever, and relapsing fever.

1.5 Ticks and Mites of Public Health Importance: Ticks (Ixodes) - Role in tick-borne encephalitis; Mites (*Sarcoptesscabiei*) - Role in scabies and scrub typhus; Vector competence and pathogen transmission mechanisms

UNIT - II: Vector-borne disease Control, Sanitation, and Public Health (15 Periods)

2.1 Sanitation and vector control; Hygiene and personal protection against vector-borne diseases; Safe disposal of human waste and its impact on vector populations; Solid waste and wastewater management - Role in mosquito and fly control

2.2 Human Malarial Parasites and Host-Parasite Interactions: Morphological and genetic differences among *Plasmodium vivax*, *P. falciparum*, *P. malariae*, *P. ovale*, and *P. knowlesi*.

2.3 Human Filarial Parasites and Host-Parasite Interactions: Morphological and genetic diversity of *Wuchereriabancrofti*, *Brugiamalayi*, *B. timori*; Microfilariae periodicity and transmission dynamics

2.4 Arboviral Diseases and Transmission Dynamics: Epidemiology and transmission of dengue, chikungunya, Zika, yellow fever, West Nile virus, and Japanese encephalitis; Mechanisms of viral adaptation in vectors; Influence of climate change and urbanization on arbovirus transmission

2.5 Modern Vector Control Strategies: Source Reduction - Environmental management and habitat modification; Chemical Control - Use of insecticides, resistance management, and novel formulations (IGRs, neonicotinoids); Biological Control - Role of *Bacillus thuringiensis israelensis* (BTI), larvivorous fish; Genetic Control - Sterile Insect Technique (SIT).

Suggested Readings:

1. Clements, A. N. The Biology of Mosquitoes – CABI Publishing
2. Marquardt, W.C. et al. Biology of Disease Vectors – Elsevier
3. Service, M.W. Medical Entomology for Students – Cambridge University Press
4. Gillespie, S.H., Smith, G.L. et al. Principles and Practice of Clinical Parasitology – Wiley
5. WHO Reports on Vector-Borne Diseases and Control Strategies
6. Gubler, D.J. et al. Dengue and Dengue Hemorrhagic Fever – CABI
7. Rueda, L.M. Global Identification of Mosquito Vectors – The American Entomological Institute