Systematics and Diversity of Life Protists to Chordates

Semester I — Hours of instruction / week : 4

23BZOC01 — No of credit: 4

Objectives

1. To study the biosystematics classification of animals.
2. To learn the salient features and diversity of invertebrates and vertebrates
3. To understand the evolutionary significance of chordates

Unit 1: **Products of evolutionary process** — 12 hrs

Multicellularity: from simple collections of poorly differentiated cells to complex body plans. Biological diversity- Types and measurements. Systematics and taxonomy. Species concept, clades. Nomenclature and utility of scientific names. Classification based on morphology and evolution (molecular). Relationship of taxa: phylogenetics and cladistics with special reference to paraphyly, monophyly, apomorphy, plesiomorphy and phenoplasticity.

Unit 2: **Diversity in Protists and acoelomate Metazoa** — 12 hrs

Structure and diversity in Protists. Origin of Metazoans: Diploblastic and triploblastic organization; symmetry, body cavities, protostomes and deuterostomes, Special features and structural diversity in sponges. Cnidarians: Special features; transition of third germ layer; polymorphism and division of labour; coral reef forming Cnidarians. The Bilateria: Basic characteristics. The acoelomates: Basic organization and adaptive radiations in flatworms.

Unit 3: **Diversity in pseudocoelomate and coelomate Nonchordates** — 12 hrs

The Ecdysozoa: Characteristics of the representative taxa. Pseudo coelomates; Basic organization and adaptive radiations in roundworms. The coelomates: Basic organization and adaptive radiations in Arthropods. Ancestors/ fossil arthropods. Adaptive radiations in Crustaceans, Myriapods, Chelicerates, Insects, etc. Basic organization and diversity in Annelids, Basic organization and diversity in Molluscs. Disruption of bilateral symmetry and its significance. Basic organization of Echinodermy, their affinity to Chordates.

Unit 4: **Diversity in Protochordates and Chordates** — 12 hrs

Chordates – Primitive Chordates and their affinities. Hemichordates, Urochordates and Cephalochordates. Advent of vertebrates: Cyclostomes, their evolutionary status and affinities. Basic organization and diversity of fishes, their evolutionary transitions. From Water to Land invasion - Early Tetrapodes. Amphibians diversity and adaptability to dual mode of life.

Unit 5: Amniotes: the amniotic egg, adaptive radiations in reptiles; Poisonous and non poisonous snakes of South India, identification of poisonous snakes, poison apparatus and bitting mechanisms. The avian ancestors. Birds**:** Adaptation from terrestrial to aerial mode of life. Origin of Mammals Special features of Monotremes and Marsupials. Characteristics of other mammalian groups with special reference to primates — 12 hrs

Total – 60 hrs

Text Books:

1. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
3. Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W; Spicer, J. I. (2002). The Invertebrates: a Synthesis, Blackwell Publishing.
4. Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition), McGraw-Hill.
5. Kotpal, R.L. 2015. Modern Text Book of Zoology – Vertebrates. Meerut: Rastogi Publications.

Reference Books:

1. **Liem, Karel F., William E. Bemis, Warren F. Walker, Lance Grande,** 2001. Functional Anatomy of the Vertebrates: An Evolutionary Perspective. Brooks Cole; 784 pages.
2. Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.
3. Eisenhour, David, Allan Larson, Susan Keen, Larry Roberts, Cleveland Hickman Jr. 2014. Animal Diversity. Boston: McGraw-Hill International.
4. Kotpal, R.L. 2017. A Text Book of Animal Diversity. Meerut: Rastogi Publications.
5. Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.

Course Outcomes:

1. Develop understanding on the diversity of protists, non chordates and chordates.
2. Understanding the concepts of how animals changed from a primitive cell to simple cells.
3. Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
4. Understand the role of morphological changes in bringing out the evolution over a long period of time.
5. Acquire skill in identification of invertebrate and vertebrates in their habitats.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L	H	M	-	M	H	-	H	H	H	-	H
CO 2	-	-	M	H	-	-	H	-	L	-	-	-	H
CO 3	H	M	H	M	-	L	H	M	H	L	H	-	H
CO 4	M	L	-	-	-	-	M	M	H	M	H	-	M
CO 5	H	-	H	H	H	H	H	H	H	H	H	-	H

Practicals I- Systematics and Diversity of Life Protists to Chordates

Semester I — Hours of instruction / week : 4

23BZOC01P — No of credit : 2

Objectives:

1. To identify and classify museum specimens and to study their salient features.
2. To develop skills in stimulated dissections.
3. To observe and compare the diversity of animals in their natural habitat.

1. Studyofanimalsthroughslidesandmuseumspecimensinthelaboratory withdetailsontheirclassification, biogeography and diagnostic features (record book).

Invertebrate Simulated animal dissections available on invertebrates — 12 hrs

Representative organisms for each phylum

I. Amoeba, Paramecium
II. Leucosolenia, Gemmule of Sponge
III. Hydra, Obelia colony and medusa
IV. Fasciola, Ascaris,
V. Neries, Megascolex
VI. Daphnia, Naupilus
VII. Fresh water mussel, Pila
VIII. Starfish, Sea urchin,

Vertebrates Simulated animal dissections of shark and frog — 8 hrs

Representative organisms for each Phylum

I. Amphioxus, Scoliodon
II. Ranahexadactyla, Icthyophis
III. Calotes, Cobra
IV. Pigeon, Woodpecker
V. Bat, Loris

2. Study of animals in nature during a survey of a National Park or Forest area. — 8 hrs
   Visit to Gass Museum
   Visit to Anamalai Tiger Reserve
   Visit to Zoological Park/ National Park
3. Collection of five species (preferably invertebrates, insects) belonging to a clade. A project work on 2 their generic identification, description and illustration with a note on their locality. Also the assessment of their relationship by constructing a cladogram using characters and characterstates- Insect box preparation — 8 hrs
4. Comparison of two species of birds belonging to same genus (Inter specific difference) — 8 hrs
5. Comparison and weighting of characters of two birds belonging to same family but dissimilar genera. — 8hrs

6. Group discussion or Seminar presentation on one or two related topics from the list 8 hrs

    1. Molecular systematic Vs Traditional Taxonomy
    2. Instinctive behavior invertebrates
    3. Parental care of animals

Total - 60

Course Outcome:

1. Study the behaviours of invertebrate through simulated animal dissections.
2. Providing with the ability to recognize the major groups of invertebrates and vertebrates
3. Record the fauna of different phylum and families through the visit to National park and forest area.
4. Collection and contribution of animal specimens to department museum through field visit.
5. Learn the keys for the identification of bird watching through field visits.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	L	L	H	H	H	-	H	M	L
CO 2	H	H	H	H	M	H	H	H	H	-	H	M	L
CO 3	H	H	H	M	H	M	M	M	L	-	H	M	L
CO 4	H	H	H	M	M	H	M	H	M	-	M	M	L
CO 5	H	H	H	M	H	H	M	M	L	-	M	M	M

Developmental Biology & Evolution

Semester I — Hours of instruction / week: 4
23BZOC02 — No of credit: 4

Objectives:

1. To learn the basic principles of growth and development
2. To understand the role and application of developmental biology
3. To know about the evolutionary history of transitions

Unit 1. **Process of reproduction in living system** 13hrs

Reproduction: a basis of species sustenance. Asexual and sexual reproduction and their relevance in corresponding environments. Gamete formation, external and internal fertilization; causes of Infertility. Structural and biochemical changes in gametes during and after fertilization, block to polyspermy. Establishment of the major embryonic axes, polarity, morphogen gradients and their interpretation. Fate maps, their relevance. *In vitro* fertilization; Amniocentesis; Artificial insemination (AI); Gamete intra-fallopian transfer (GIFT). Intra-cytoplasmic sperm injection (ICSI); Test tube baby.

Unit 2. **Role of development in organization of phenotypes and their variations** 12hrs

Direct and indirect development. Cleavage: types and patterns. Body plan and symmetries. Germ layer differentiation Tubulation. Morphogenesis: Epiboly, emboly/ invagination, involution and ingression. Cell-cell interactions (cell signaling, cell adhesion etc.) during tissue organization, lateral inhibition, induction, and recruitment. Organogenesis: formation of gut, heart, kidney and muscles. Concept of competence, determination and differentiation and growth, molecular mechanism involved. Pleuropotency. Stem cell biology and tissue repair.

Unit 3. **Tracing the evolutionary biology of development** 12 hrs

Role of extra embryonic membranes in development, Placenta: types, structure and functions. Metamorphosis in insect and frog. Regeneration: epimorphosis, morphollaxis and compensatory regeneration. Development, ageing and apoptosis. Developmental biology in understanding of disorders. Teratogenesis; wound healing, birth defects, developmental brain disorders.

Unit 4. **Understanding evolution through natural selection.** 12hrs

Early life on Earth and its indirect evidences, direct evidence of early life; great oxygenation and its relationship with life. Evolution and radiation of metazoans, major

evolutionary transitions, Mass extinctions, Anthropocene and its uniqueness. Evidences of evolution: Hardy-Weinberg Equilibrium, Selection, Migration. Nonrandom mating, Cost/ benefit of sex, Sexual conflict, Evolution in asexual systems Life-history adaptations, Trade-offs, Number and size of offspring; Parent-offspring conflict.

Unit 5. Knowledge on adaptation and optimal model stradeoffs. 11 hrs

Genetic drift, Neutral evolution; Theories of evolution. Linkage disequilibrium; Epistasis. Heritability; Breeding value. Sources of variation: mutation, recombination, epigenetic variation. Evolution of mutation rates. Phenotypic plasticity, Genome evolution: Mobile genetic elements; gene duplication. Evolution and Health: Evolution of antibiotic Resistance, Virulence, Evolutionary medicine.

Total - 60

Text Books

1. VishramSing, 2020.Text book of Clinical Embryology, 2nd Updated edition, Elsevier India, Elsevier Health Science.
2. Morgan. TH. 2010.Embryology and Genetics. Agro House Behind Nasrani Cinema. 4th edition, Jodhpur
3. Verma, P.S and Agarwal, V.K. 2016 Chordate Embryology (Developmental biology).Generic (1).

Reference Books

1. Gerhart, J. *et al*. 1997. Cells, Embryos and Evolution. Blackwell Science
2. Baressi,M.J.F and Gilbert, S.F. 2019. Developmental Biology (12th edition).Sinauer Associates is an imprint of Oxford University Press.
3. Wolpert, L. 2015.Principles of Developmental Biology (5th edition). Oxford University Press
4. Campbell, N. and Reece, J. 2014 Biology (10th edition). Benjamin Cummings
5. Charles Darwin, 2021. The Origin of Species. (1 may Deluxe Hard bound 2021edition finger print publishing.
6. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H.2007. *Evolution*. Cold Spring, Harbour Laboratory Press.
7. Hall, B. K. and Hallgrimsson, B. 2008. *Evolution*. IV Edition. Jones and Bartlett Publishers

Course outcome:

1. Understand the development from an egg to embryo and adult through cell division, cell differentiation and morphogenesis.
2. Realize the expressions and functions of gene networks in controlling the molecular changes and brings out the variation.
3. Explore the relevance of developmental biology in medicine and related disorders
4. Know the past and present scenario of research in developmental biology and evolution
5. Examine the evolutionary history of the taxa based on developmental affinities

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO 1	H	H	H	H	-	M	H	-	H	-	H	H	H
CO 2	H	H	H	H	-	M	H	-	H	-	H	H	H
CO 3	H	H	H	H	-	M	H	-	H	-	H	H	H
CO 4	H	H	H	H	-	M	H	-	H	-	H	H	H
CO 5	H	H	H	H	-	M	H	-	H	-	H	H	H

Practicals II - Developmental Biology & Evolution

Semester I — Hours of instruction / week:4

23BZOC02P — No of credit: 2

Objectives:

1. To understand the developmental stages of animal
2. To develop the skill in dissecting and learn the anatomy of internal structure
3. To know the phylogenetic relationship of animal phyla

1.	Types of eggs based on quantity and distribution of yolk: Sea urchin, Insect, Frog, Chick.	6hrs
2.	Comparative study of cleavage patterns in Frog and Amphioxus models.	6hrs
3.	Morphogenetic movements - Blastulation, Gastrulation in Amphioxus, Frog, Chick- Slides	6hrs
4.	Mounting of chick embryo developmental stages up to 96 h .	4hrs
5.	Extra embryonic membranes of chick through (virtual aid).	4hrs
6.	Understanding the process of development (videos)	4hrs
7.	Study of adaptive radiations in feet and beak of birds and mouth parts of insects. (TNAU insect Museum and bird watching in their localty)	6hrs
8.	Understanding embryological evidence of evolution (through charts and videos).	4hrs
9.	Study of types of fossils. Nautilus, Peripatus & limulus (through charts and videos and Ariyalur field visit)	6hrs
10.	Analogy and homology (wings of birds and insects, forelimbs of bat and rabbit)	4hrs
11.	Serial homology in appendages of *Palaemon*.	4hrs
12.	Group discussion or Seminar presentation on one or two related topics from the list 1. Latest trends in developmental biology 2. Metamorphosis of frog 3. Relevance of Palaentology in current scenario	6hrs

Total - 60hrs

Course outcome

1. Know the different stages in the development of animals.
2. Pursue fundamental concept of embryological stages of animals
3. Identify the factors influencing the cleavage patterns and gastrulation in animals
4. Understand the adaptive radiation of animals.
5. Study the evidences of evolution and fossil.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	-	M	H	M	H	-	H	H	M
CO 2	H	H	H	H	-	M	H	M	H	-	H	H	M
CO 3	H	H	H	H	L	M	H	M	H	L	H	H	M
CO 4	H	H	H	H	-	M	H	M	H	-	H	H	M
CO 5	H	H	H	M	-	H	M	H	H	-	H	H	M

Comparative Anatomy & Physiology of Nonchordates

Semester II — Hours of instruction / week: 4
23BZOC03 — No of credit: 4

Objectives:

1. To learn the diversity of various system in Nonchordates
2. To study about the evolutionary importance of Nonchordate taxa
3. To know the parasitic adaptations to different taxa

Unit 1: **Diversity of Tegument and Digestive system** — 12 hrs

Basic affinities and differences between prokaryotes and eukaryotes; protists and the non-chordate animals. Symmetry, Coelom development and diversity. Cell membrane in protists and its derivatives. Tegument in non-chordates and its derivatives. Nutrition and feeding modes in protists. Digestive system & feeding mechanism in non-chordates): Process of digestion from food vacuoles to complex digestive organs.

Unit 2: **Diversity of Locomotory, Respiratory and Circulatory systems** — 12 hrs

Locomotion and diversity of locomotory organs in protists and non-chordates, muscle and locomotion, Structure and diversity of skeletal elements in protists and non-chordates. Respiration: diversity of respiratory organs, modes of respiration. Respiratory pigments and oxygen consumption rates of different organisms. Circulation and the diversity of circulatory system.

Unit 3: **Diversity of Excretory, Nervous system and sense organs** — 12 hrs

Excretion (protists): endocytosis, exocytosis; Excretion and diversity of excretory organs in non chordates. Nervous system with special reference to diversity in brain and nerve chord. Neuroendocrine systems, pheromones. Sense organs: Mechanoreceptors and their diversity in different taxa. Sense organs: photoreceptors, chemoreceptors, thigmoreceptors, rheoreceptors and proprioceptors in different taxa. olfaction and sound perception in insects, etc.

Unit 4: **Evolution and characteristics of important Non Chordate taxa** — 12 hrs

Diversity of the reproductive organs and accessory sex organs; modes of reproduction- asexual and sexual reproduction. Metamorphosis. Diversity of larval forms in non-chordates. Organization and affinities in fossils (such as trilobites). Affinities of living fossils, *Limulus* and *Peripatus*. Polymorphism and colony formation. in echinoderms. Taxa with special characteristics: Types of canal systems in sponges and their significance. Torsion and detorsion in Mollusca. Components of water vascular system.

Unit 5: **Parasitic adaptation** — 12 hrs

Parasitic adaptations and life cycle patterns in parasites belonging to different taxa and The parasites listed by World Health Organization under preventive programmes - *Ascaris lumbricoides, Ancylostoma duodenale, Necator americanus, Trichuris trichiura, Strongylodesstercoralis, Taenia solium, Hymenolepis nana, Entamoeba histolytica, Giardia intestinalis and Cryptosporidium.* Structure and diversity of the pest organisms- Paddy pest –*Tryporyza*a, Sugarcane pest – *Chilo* and Stored grain pest – *Sitophilus oryzae.* Invertebrate model organisms and their importance - *Drosophila*

melanogaster and *Caenorhabditis elegans*.- morphological structure and significance.

Total - 60hrs

Text Books:

1. Marshall,A.J and Williams,W.D.1995.Textbook of Zoology-Invertebrates.VIIEd.,Vol.I,A.L.T.B.S. Publishers.
2. Boradale, L.A. and Potts, E.A.1961.Invertebrates: A Manual for the use of Students. Asia Publishing Home.
3. Barrington, EJ W. (1967) Invertebrate structure and function, Nelson, London.
4. Barnes,R.S.K.,Calow,P.,Olive,P.J.W.,Golding,D.W.andSpicer,J.I.(2002.The Invertebrates: A NewSynthesis.III Edition. Blackwell Science.
5. Rastogi V. B. 2015: Invertebrate Zoology. Publisher- Kedar Nath Ram Nath.

Reference Books:

1. **G.J.Tortora& N.P. Anagnostakos,** 1984. Principles of anatomy and physiology. (Harper & Row Publ., N.Y.). 838 pages.
2. Ruppert and Barnes, R.D. 2006. Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
3. Boston: McGraw-Hill. Jordan, E.L. and P.S. Verma.2010. Invertebrate Zoology. New Delhi: S. Chand & Co Ltd.
4. Margulis L and Capman MJ. 2010. Kingdoms and Domains: An Illustrated Guide to the Phyla of Life on Earth. (IV Ed.). W.H. Freeman and Company, USA.
5. Kapoor VC. 2019. Theory and Practice of Animal Taxonomy and Biodiversity. (VIII Ed.). Oxford and IBH Publishing
6. Barrington EJW. 2021. Invertebrate Structure and Function (II Ed.). Affiliated East-West Press Pvt Ltd.

Course outcomes

1. Able to understand the fundamental principles of systematic.
2. Elucidate the functional significance of associated morphology and behaviour.
3. Understand the physiological mechanisms in diverse organisms.
4. Understand and communicate the evolutionary significance in invertebrates.
5. Explicate research in any aspects of animal physiology in future.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L	-	M	-	H	H	-	H	M	H	-	H
CO 2	M	-	-	-	-	M	H	-	H	-	M	M	H
CO 3	-	-	-	-	-	L	H	-	H	-	-	-	H
CO 4	H	H	H	M	-	M	H	-	H	L	H	-	H
CO 5	H	H	H	H	M	H	H	H	H	H	H	-	H

Practicals III- Comparative Anatomy & Physiology of Nonchordates

Semester II — Hours of instruction / week: 4

23BZOC03P — No of credit: 2

Objectives:

1. To learn computer aided simulated animal dissection
2. To study the economic importance of invertebrates and model organism.
3. To observe and record the animal behavior in their natural habitats

1.	Slides and specimens	
	i) Protozoans of agricultural importance-Euglena and Vorticella	6hrs
	ii) Coral-reef forming Cnidarians- *lcyonium glomeratum* and *Diploria labyrinthiformi* (Visit to CMFRI-Central Marine Fisheries Research Institute)	6hrs
	iii) Plant parasitic nematodes- *Meloidogyne incognita* and *Globodera rostochiensis*	6hrs
2.	Nematodes used as models in experimental biological research- *Caenorhabditis elegans*	4hrs
3.	Virtual Dissection of *Pheretima* to expose circumpharyngeal ganglia	4hrs
4.	Dissection of *Periplaneta* to expose the digestive system and mouth parts	6hrs
5.	Dissection of *Palaemon* to expose nervous system.	6hrs
6.	Study of larval forms: *Planula, Trochophore, Pluteus*, Zoea, Metazoea, Bipinnaria	4hrs
7.	Videos to develop understanding on the animals of different taxa.	6hrs
8.	GroupdiscussionorSeminarpresentationononeortworelatedtopicsfromthelist	12hrs

i. Helminth infection in humans

ii. Molluscs of industrial value

iii. Prawn culture, a good source of revenue generation

Total 60 hrs

Course outcome:

1. Be familiar with the external morphology of animals through observation of preserved specimens.
2. Acquire basic skills in animal dissections.
3. Able to dissect and examine various organ systems.
4. To understand evolutionary significance through larval forms.
5. Disseminate knowledge through group discussions.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	M	L	H	H	H	L	H	H	H
CO 2	H	H	H	H	L	-	H	H	H	-	H	H	M
CO 3	H	H	H	H	L	-	H	H	H	-	H	H	M
CO 4	H	H	H	H	L	-	H	L	H	-	H	H	M
CO 5	H	H	H	H	L	L	H	L	H	L	H	H	M

Cell Biology and Histology

Semester II — Hours of instruction / week: 4
23BZOC04 — No of credit: 4

Objectives:

1. To provide a detailed insight into basic concepts of cellular structure and function.
2. To explore the complex regulatory mechanisms that control cell function.
3. To understand the structural and functional significance of animal tissues

Unit 1. **Structure and functions prokaryotic and eukaryotic cells** — 15 hrs

Introduction: Cell biology, its scope in modern perspective. Cell theory and its modern version and interpretation.

General structure of prokaryotes and eukaryotes: Extra nuclear cell organelles: Ultrastructure and functions of endoplasmic reticulum, ribosome, Golgi apparatus, lysosome, peroxisomes, Mitochondria, microtubules and microfilaments. Nucleus: size, shape, structure and functions of interphase nucleus. Ultrastructure of nuclear membrane and pore complex. Nucleolus: general organization, chemical composition and functions, nuclear sap/ nuclear matrix

Unit 2. **Cell membrane and transport mechanism** — 13 hrs

Cell membrane organization: cell membrane: origin, structure, composition and functions. Fluid mosaic model: Lipid Composition, inner and outer leaflets. Structure and functions of membrane proteins: Integral, peripheral and lipid-anchored membrane proteins.

Modifications of cell membrane and membrane transport: Junctional complexes, membrane receptor modifications: microvilli, desmosomes and plasmodesmata. Cell receptor function - cellular trafficking. Transport across membrane: diffusion and osmosis. Active and passive transport, endocytosis and exocytosis.

Unit 3. **Cell cycle and cell signaling** — 10 hrs

Cell cycle, cell division- mitosis and meiosis. Cell division check points and their regulation. Mutations in the genes that regulate cell cycle and division and their role in causing cancer. Programmed cell death (Apoptosis). Cell regulation and Cell signaling: Signaling molecules and their receptors. Functions of cell surface receptors. Regulation of signaling pathways.

Unit 4. **Cell culturing techniques** — 10 hrs

Cell culture: Types of cell culture- monolayer and suspension culture. Types of culture media. Sterilization methods for culture wares and culture media. Maintenance of a cell line and storage of cells. Subcellular fractionation by differential centrifugation. Somatic cell hybridization. Basic characteristics of tissue culture media. Tissue culture and engineering.

Unit 5. **Structural and functional significance of animal tissues** — 12 hrs

Introduction to tissues: Epithelial tissue: types, structure and characteristics. Basement membrane: structure and characteristics. Connective tissue cells.

Structure and function of loose, dense and adipose tissue. Cartilage and bone: classification, and fine structure. Muscular tissue: ultrastructure of smooth, skeletal and cardiac muscles. Types of supporting (glial) cells and their function. Myelin sheath and its formation.

Total - 60hrs

Text Books:

1. Rastogi, S.C. 2021.Cell and Molecular Biology (Fourth Edition).New Age International Publishers, New Delhi.
2. Vijayakumaran Nair, K. and Jayaprakash, M.2007.Cell Biology, Genetics and Molecular Biology. Fourth Edition. Academica, Thiruvananthapuram.
3. Ajoy Paul, 2011.Textbook of Cell and Molecular Biology. Third Edition. Books and Allied (P) Ltd, Kolkata.

References Books:

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Karp, G., Iwasa, J., Marshall, W. 2015. Cell and Molecular Biology: Concepts and Experiments, 8th Edition. John Wiley & Sons Inc.
3. Darnell, Lodish and Baltimore. 2000. Molecular Cell Biology, Scientific American Publishing Inc.
4. De Robertis, E.D.P. and De Robertis, E.M.F. 2006.Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
5. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.

Course Outcomes:

1. Have comprehensive knowledge on the functioning of nucleus, extra nuclear organelles and intricate cellular mechanisms.
2. Acquire knowledge of different pathways related to cell signaling and apoptosis.
3. Gain knowledge of how cells function in both healthy and pathological states.
4. Find new avenues of joining research in areas such as genetic engineering of cells, cloning, vaccines development, human fertility programme and organ transplant
5. Understand how tissues are produced from cells in a normal course and malfunctioning which may lead to benign or malignant tumor.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO 1	H	H	H	H	-	H	L	-	H	-	M	H	L
CO 2	H	M	M	M	-	L	-	-	M	-	M	H	M
CO 3	H	M	L	H	-	M	-	-	M	-	-	H	H
CO 4	M	M	M	H	-	M	L	L	M	L	L	H	H
CO 5	H	L	M	M	-	M	L	-	M	-	-	H	M

Practicals IV- Cell Biology and Histology

Semester II — Hours of instruction / week:4

23BZOC04P — No of credit: 2

Objectives:

1. To be able to perform experiments using the common tools of cell biology, including light microscopy and cellular fractioning
2. To list the fundamental features of prokaryotic and eukaryotic cells and methods used to examine them
3. To learn histological techniques for the preparation of permanent stained slides

1.	Study of prokaryotic and eukaryotic cell types with the help of chart, slide and video	4hrs
2.	Principles of light microscope	2hrs
3.	Separation and identification of sub cellualr organelles using ultracentrifugation-online video demo	4 hrs
4.	Homogenization and centrifugation of tissues	4 hrs
5.	Haemolysis	4 hrs
6.	Buccal smear test	4 hrs
7.	Examination of live Paramecium to study streaming movement of cytoplasm	4 hrs
8.	Squash preparation of onion root tip to observe chromosome segregation in mitosis	6hrs
9.	Preparation of chromosome squashes from cockroach testes for the observation of stages of meiosis.	6hrs
10.	Study of types of tissue through permanent slides: epithelial, connective, nervous and muscular tissues	6hrs
11.	Study of histology of tissues by preparing permanent stained slides through microtome.	6hrs
12.	Isolation and estimation of DNA from onion	6hrs

13. Group discussion or Seminar presentation on one or two related topics from the list 4hrs
    1. Popular cell lines and their importance
    2. Apoptosis
    3. Blood groups and their importance

60 hrs

Course Outcomes:

1. Attain knowledge in the identification of different types of cells
2. Acquire practical skills in cytological experiments that mimic those undertaken in diagnostic and research laboratories
3. Gain knowledge in documentation of appropriate diseases
4. Understand the principle and operation of relevant laboratory equipments
5. Perform experiments using microtome techniques to aid immunohistochemistry

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO 1	H	L	L	M	-	L	-	L	M	-	-	H	H
CO 2	H	L	L	M	-	M	-	-	M	-	L	H	H
CO 3	L	M	L	L	-	M	M	L	L	-	L	L	M
CO 4	M	-	M	M	-	H	L	-	L	-	L	L	H
CO 5	M	L	M	M	-	H	-	L	M	-	L	H	M

Annexure-II

Avinashilingam Institute for Home Science and Higher Education for Women
(Deemed to be University under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956)
Re - accredited with A++ Grade by NAAC. Recognised by UGC Under Section 12B
Coimbatore – 641043, Tamil Nadu, India
B.Sc. Zoology
(With Language & English for 4 Semesters)

Programme Outcome:

1. Attain strong fundamental knowledge on practical background in basic concepts of Zoology.
2. Capability to express theories and concepts to propose ideas to address the community.
3. Apply accurate identification of the problem and suggest appropriate mitigation strategies.
4. Develop interrogative capacity to analyse the problems and suggest solutions to counteract issues.
5. Work as an individual or as team to observe the variety of animal species, characteristics and organization, behavior and evolution.
6. Acquire skills for identification of appropriate resources for managing a specific task.
7. Ability to access digital technology for the creation of biological database
8. Imbibe ethical values recognize the need for research ethics and implementation
9. Implementation of acquired knowledge in life sciences for lifelong learning
10. Promote the individual's entrepreneurial skills in life sciences.

Programme Specific Outcome:

1. Have a comprehensive knowledge of Zoology, able to identify and classify major groups of organisms
2. Understand the cellular and genomic level of organization in organisms.
3. Explain the origin, ancestory and ecological adaptation of animals.
4. Have a wide knowledge on the embryonic development, cellular differentiation and reproduction in organisms.
5. Promote the individual's ability and skills to pursue entrepreneurship.

Scheme of instruction and examinations
(For students admitted from 2021-2022 onwards)

Part	*Subject Code*	*Name of paper/component*	*Hours of instructions/week*		*Scheme of Examination*				
			Theory	*Practical*	*Duration of Exam*	*CIA*	*CE*	*Total*	*Credit*
First Semester									
I	21BLT001/ 21BLH001 21BLF001	Tamil- IlakkiamI-IlakkanamIlakkiyaVaralaru / Hindi–Prose & Non detailed Texts/French I	5	-	3	50	50	100	4
II	21BLE001	English Language for Communication – I	5	-	3	50	50	100	4
III		**Core Course**							
	21BZOC01	Invertebrata I	4	-	3	50	50	100	3
	21BZOC02	Invertebrata II	5	-	3	50	50	100	3
	21BZOC03	Practicals I- Invertebrates	-	3	3	50	50	100	2
III		**Discipline Specific Elective (DSE) Course**							
	21BZOI01	DSE I –Chemistry theory for Zoology	4	-	3	50	50	100	3
	21BZOI02	DSE I – Chemistry Practicals for Zoology	-	3	3	50	50	100	2
		Games	-	1		-	-	-	-
Second Semester									
I	21BLT002/ 21BLH002/ 21BLF002	Tamil- IlakkiamII-IlakkanamIlakkiyaVaralaru / Hindi-Grammar, Translation & General Essay/ French II	5	-	3	50	50	100	4
II	21BLE002	English Language for Communication – II	5	-	3	50	50	100	4
III		**Core Course**							
	21BZOC04	Chordata I	4	-	3	50	50	100	3
	21BZOC05	Chordata II	5	-	3	50	50	100	3
	21BZOC06	Practicals II-Chordates	-	5	3	50	50	100	2
		Discipline Specific Elective (DSE)Course							
	21BZOI03	DSE II- Computer Applications in Zoology	2	3	3	50	50	100	4
		Games	-	1	-	-	-	-	-

Third Semester									
I	21BLT003/ 21BLH003/ 21BLF003	Tamil- Ilakkiam III - IlakkanamIlakkiyaVaralaru / Hindi-Ancient & Modern Poetry/ French III	5	-	3	50	50	100	4
II	21BLE003	English Language for Communication – III	5	-	3	50	50	100	4
III		**Core Course**							
	21BZOC07	Cell Biology	4	-	3	50	50	100	3
	21BZOC08	Molecular Biology	4	-	3	50	50	100	3
	21BZOC09	Practicals III- Cell and Molecular Biology	-	5	3	50	50	100	2
		Discipline Specific Elective (DSE)Course							
	21BZOI04	DSE III Diversification of Plants (Botany)	4	-	3	50	50	100	3
	21BZOI05	DSE III Practicals I - Diversification of Plants (Botany)	-	3	3	50	50	100	2
Fourth Semester									
I	21BLT004/ 21BLH004/ 21BLF004	Tamil- Ilakkiam IV- IlakkanamIlakkiyaVaralaru / Hindi-Introduction to Functional Hindi & Journalism/ French IV	5	-	3	50	50	100	4
II	21BLE004	English Language for Communication – IV	5	-	3	50	50	100	4
III		**Core Course**							
	21BZOC10	Genetics	4	-	3	50	50	100	3
	21BZOC11	Evolution	4	-	3	50	50	100	3
	21BZOC12	General Entomology	3	-	3	50	50	100	3
	21BZOC13	Practicals IV-General Entomology	-	2	3	50	50	100	2
		Discipline Specific Elective (DSE)Course							
	21BZOI06	DSE IV –Diversity of Angiosperms(Botany)	4	-	3	50	50	100	3
	21BZOI07	DSE IV –Practicals II - Diversity of Angiosperms (Botany)	-	3	3	50	50	100	2

Fifth Semester									
III		**Core Course**							
	21BZOC14	Biochemistry	5	-	3	50	50	100	3
	21BZOC15	Animal Physiology	5	-	3	50	50	100	3
	21BZOC16	Biostatistics	5	-	3	50	50	100	3
	21BZOC17	Aquaculture	4	-	3	50	50	100	3
	21BZOC18	Practicals V - Biochemistry and Animal Physiology	-	5	3	50	50	100	2
	21BZOC19	Sericulture and Apiculture (Self study course)	1	-	-	100	-	100	4
	21BZOC20	Zoology (Computer based test)	-	-	1	-	100	100	2
	21BZOC21	Project	-	3	-	100	-	100	4
		Generic Elective (GE) Course	2	-	3	100	-	100	2
Sixth Semester									
III		**Core Course**							
	21BZOC22	Microbiology	5	-	3	50	50	100	3
	21BZOC23	Immunology	5	-	3	50	50	100	3
	21BZOC24	Developmental Biology	5	-	3	50	50	100	3
	21BZOC25	Environmental Biology	5	-	3	50	50	100	3
	21BZOC26	Practicals VI– Microbiology and Immunology	-	5	3	50	50	100	2
	21BZOC27	Practicals VII– Developmental and Environmental Biology	-	5	3	50	50	100	2
Total Credits									**128**

Semester	*Subject code*	*Name of paper/component*	*Hours of instruction/ week/Course*	*Credit/ Course*	*Total Credits*
PART IV Components					
	A. Ability Enhancement Courses				
I	21BAES01	Environmental Studies (Foundation Course)	4		4
II	21BAFU01	Fundamentals of Research	2		2
V	21BSCS01	Communication Skills	3	Remarks	2
VI	21BSSS01	Soft Skills	3	Remarks	2
	II. Skill Enhancement Courses (SEC)				
III		**Value added course (from a basket of choice offered)**	40 hrs. Duration	Remarks	2
IV		**Co-curricular Course** Add on Certificate/ Quantitative Aptitude/ Certificate Courses- Gandhian Studies/ Women's Studies/ Ambedkar Studies/ Verbal and Non-verbal Reasoning / General Awareness/others as per list	Varied duration	Remarks	2
	B. Extra- curricular Course				
I-VI	21BXNC01-06	**NCC/**	- -	Remarks	24 Credits*
	21BXNS01-06	**NSS/**			6 Credits
	21BXSP01-06	**Sports/**			6 Credits
				Total credits	**20**

For NCC Students alone 38 credits for Part IV Components.
Total credits to earn the degree

1. Part I, II and III components - 128
2. Part IV components - 20

Total credits - 148credits

Other courses offered by the Department

❖ **Discipline Specific Elective**	DSE I -21BBOI01 Nonchordates and Chordates- Semester I
(For Botany Students)	DSE I- 21BBOI02 Practicals I - Nonchordates and Chordates - Semester I
	DSE II -21BBOI03 Developmental Zoology and Animal Physiology – Semester II
	DSE II -21BBOI04 Practicals II -Developmental Zoology and Animal Physiology - Semester II
Generic Elective Course	21BZOO01 Ornamental fish culture
Value added Course	21BZOV01 Vermicomposting

Invertebrata I

Semester I **Hours of Instruction/week: 4**
21BZOC01 **No. of credits: 3**

Objectives:

1. To study the principles of animal classification
2. To learn the salient features of invertebrates
3. To know the economic importance of various invertebrates.

Unit 1. **Introduction to Invertebrates and Phylum Protozoa** 12 hrs

Introduction - Principles of classification, outline classification of animal kingdom, Protozoa - General characters and major classes of Phylum Protozoa with examples, Type study - Paramecium, locomotion, nutrition and reproduction in protozoa, protozoan parasites.

Unit 2. **Phylum Porifera** 12 hrs

General characters and major classes of Phylum Porifera with examples, Type study - Leucosolenia, origin of metazoa, canal system and economic importance of sponges.

Unit 3. **Phylum Coelenterata** 12 hrs

General characters and major classes of Phylum Coelenterata with examples, Type study - Obelia, polymorphism in hydrozoa, symmetry in metazoans, corals and coral reefs.

Unit 4. **Phylum Platyhelminthes** 12 hrs

General characters and major classes of phylum Platyhelminthes with examples, Type study –*Fasciola hepatica*

Unit 5. **Phylum Aschelminthes** 12 hrs

General characters of Phylum Aschelminthes with examples

Type study – Ascaris, nematode parasites of man, parasitic adaptations of helminth parasites

Total hours : 60

Text Books :

1. Kotpal, R.L., (2014).Modern text book of Zoology- Invertebrates, Eleventh edition, Rastogi Publications, Meerut, India.
2. M. EkambaranathaAyyar and T.N. Ananthakrishnan (2016).A Manual of Zoology, Volume 1 Part I(Invertebrata), Sixth Edition, S. Viswanathan (Printers and Publishers) Pvt.Ltd., Chennai.
3. Jordan, A.L and Verma, P.S. (2014). Invertebrate Zoology, Fifth Edition, S. Chand & Publishing company Pvt. Ltd., New Delhi.

Reference Books :

1. Kohli, K. S., Trigunayat,M. M and KavithaSahani. (2008).Invertebrates (Structure & function),First Edition, Ramesh Book Depot Publishers, Jaipur, India.
2. Edward E.Ruppert., Richard S.Fox. and Robert D. Barnes.(2003). Invertebrate Zoology: A Functional Evolutionary Approach, First edition, Brooks Cole, USA.
3. R.P. Karyakarte and A. S. Damle(2003).Medical Parasitology, First edition, Books and Allied (P) Ltd., Kolkatta, India.

Course Outcomes:

1. Understand common and distinctive features of invertebrate organisms including protozoan.
2. Explain specific characteristics of the phyla
3. Recognize and describe salient features of invertebrates
4. Describe important biological processes in invertebrates
5. Discuss the parasitic, ecological adaptation and economic importance of invertebrates

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	L	H	H	H	M	H	H	H	L
CO 2	H	H	H	H	H	M	H	H	H	H
CO 3	H	H	L	H	H	L	H	H	H	M
CO 4	H	H	H	H	M	M	H	H	H	L
CO 5	H	H	H	H	H	M	H	H	H	L

Invertebrata II

Semester I **Hours of Instruction/week : 5**

21BZOC02 **No. of credits : 3**

Objectives :

1. To learn the salient features of invertebrates
2. To know the economic importance of various invertebrates.
3. To study the larval forms of invertebrates

Unit 1. **Phylum Annelida I** 15hrs

General characters and major classes of Phylum Annelida with examples, Type study- Megascolex

Unit 2. **Phylum Annelida II** 15hrs

Type study- Hirudinaria, metamerism, coelom and excretory systems in annelids, tube dwelling polychaetes

Unit 3. **Phylum Arthropoda** 15 hrs

General characters and major classes of Phylum Arthropoda with examples, Type study- Penaeus, larval forms of crustacean, Peripatus and its affinities, Limulus as living fossil, respiratory organs in arthropoda, economic importance of arthropods.

Unit 4. **Phylum Mollusca** 15hrs

General characters and major classes of Phylum Mollusca with examples, Type study- Pila, torsion and detorsion in gastropods, economic importance of Mollusca.

Unit 5. **Phylum Echinodermata** 15hrs

General characters and major classes of Phylum Echinodermata with examples, Type study- Star fish, larval forms in Echinodermata.

Total hours : 75

Text Books :

1. Kotpal, R.L., (2014). Modern text book of Zoology- Invertebrates, Eleventh edition, Rastogi Publications, Meerut, India.
2. M. EkambaranathaAyyar and T.N. Ananthakrishnan (2016). A Manual of Zoology, Volume 2 Part II (Invertebrata), Sixth Edition, S. Viswanathan (Printers and Publishers) Pvt. Ltd., Chennai

3. Jordan, A.L and Verma, P.S (2014). Invertebrate Zoology, Fifth edition, S. Chand & Publishing company Pvt. Ltd., New Delhi

Reference Books :

1. K. S. Kohli, M. M.Trigunayat and KavithaSahani.(2008).Invertebrates (Structure & function), First Edition, Ramesh Book Depot, Jaipur.
2. Edward E.Ruppert, Richard S.Fox. and Robert D. Barnes (2006). Invertebrate Zoology: A Functional Evolutionary approach, First edition, Brooks Cole Publishers, USA.
3. Barnes, R.S.K., Calow, P. Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, Third Edition, Blackwell Science Publishers, USA.

Course Outcomes:

1. Gain knowledge on the basic organization of annelids
2. Recognize the structure and function of invertebrates
3. Understand the functional morphology of various groups of invertebrates
4. Understand the ecological adaptations and economic importance of invertebrates
5. Compare the structural organization of invertebrates and their larval forms

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	M	H	H	H	M	H	H	H	L
CO 2	H	H	H	H	H	M	H	H	H	H
CO 3	H	H	L	H	H	L	H	H	H	M
CO 4	H	H	H	H	M	M	H	H	H	L
CO 5	H	H	H	H	H	M	H	H	H	L

Practicals I - Invertebrates

Semester I **Hours of Instruction/week : 3**
21BZOC03 **No. of credits : 2**
Objectives :

1. To identify museum specimen
2. To develop skills in animal dissections
3. To give exposure to virtual dissections

Dissections

Prawn	Mounting of appendages	12 Hrs
	Nervous system	

Salient features and biosystematics, adaptive features and biological significance of the following

	Amoeba, Paramecium, Plasmodium, Euglena	21 Hrs
	Leucosolenia, Spicules and Gemmule of Sponges	
	Hydra, Obelia colony and medusa, Sea anemone, Madrepora, Favia,Tubifora, Fasciola, Ascaris, Neries, Megascolex, Arenicola,Hirudinaria Naupilus, Cyclops, Daphnia, Centipede, Millipede, Peripatus Freshwater mussel, Mytilus, Octopus, Sepia , Pearl oyster, Pila Starfish, Sea Urchin	

Anatomy of Earthworm

	Earth worm dissection (CD); Sources: http://neosci.com	6 Hrs
Live Zoology	Paramecium culture	3 Hrs
	Examination of zooplankton from a pond	3 Hrs

Total hours : 45

Course Outcomes:

1. Able to dissect and examine various organ systems in situ.
2. Acquire basic skills in animal dissections.
3. Be familiar with the external morphology of animals by observing the preserved specimens.
4. Know how to culture some protozoans
5. Gain knowledge on virtual dissections

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	M	M	M	H	H	H	L
CO 2	H	H	M	H	H	M	H	H	M	H
CO 3	H	H	L	H	H	L	H	H	H	M
CO 4	H	H	H	H	M	M	H	H	H	L
CO 5	H	H	M	H	H	M	H	L	H	M

Chordata I

Semester II **Hours of Instruction/week: 4**

21BZOC04 **No. of credits : 3**

Objectives

1. To learn the salient features, biosystematics and biological significance of chordates
2. To study the anatomy of higher organisms
3. To understand the economic importance of higher animals

Unit 1.	**Introduction to Chordata** General characters and outline classification of chordates, origin and ancestry of chordates	12 hrs
Unit 2.	**Prochordata** General characters and classification of prochordates with examples, Amphioxus, Ascidia and Balanoglossus as type study	12 hrs
Unit 3.	**Pisces I** General characters and outline classification with examples, Type study - Scoliodon	12 hrs
Unit 4.	**Pisces II** Accessory respiratory organs, parental care, migration and economic importance of fishes, Dipnoi and affinities	12 hrs
Unit 5.	**Amphibia** General characters and outline classification with examples, Frog as type study, origin of amphibians, metamorphosis in frog, parental care in amphibians	12 hrs

Total hours : 60

Text Books :

1. M. EkambaranathaAyyar and T.N. Ananthakrishnan (2016). A Manual of Zoology, Volume 1 – Part I (Chordata), Sixth Edition, S. Viswanathan (Printers and Publishers) Pvt. Ltd., Chennai
2. Kotpal, R.L. (2002). Modern text book of Zoology Vertebrates (Animal Diversity -II), Fourth Edition, Rastogi Publication, Meerut, India.
3. Jordan, E.J and Verma, P.S. (2014). Chordate Zoology, Second Edition, S. Chand & Company Ltd, New Delhi.

Reference Books :

1. Singh, B.D. (2018). An introduction to Chordata, First Edition, KedarNath Ram Nath Publishers, Meerut (U.P).
2. H.V. Bhaskar (2010). Chordates (Volume 2), First edition, Campus book international, New Delhi.
3. Philip, P.T. and George, T.V. (2005). Text Book of Zoology Animal Diversity – II, | First edition, Leo Publications, Thiruvananthapuram

Course Outcomes:

1. Portray comprehensive knowledge on origin, ancestry and basic principles of chordate classification
2. Gain knowledge on fundamentals of chordate characters
3. Understand interrelationship of primitive pro-chordates with invertebrates and vertebrates
4. Gain knowledge on significance and economic importance of higher animals
5. Understand the patterns of migration and parental care among animals

CO / PO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	H	H	H	H	H	H	L
CO 2	H	H	H	H	H	H	H	H	H	L
CO 3	H	H	H	H	L	H	H	H	H	L
CO 4	H	H	H	H	H	H	H	H	H	H
CO 5	H	H	L	H	H	L	H	H	H	H

Chordata II

Semester II **Hours of Instruction/week : 5**

21BZOC05 **No. of credits: 3**

Objectives:

1. To learn the salient features, biosystematics and biological significance of chordates
2. To study the anatomy of higher organisms
3. To understand the economic importance of higher animals

Unit 1. Reptiles 15hrs

General characters and outline classification with examples, Type study - Calotes, Poisonous and non poisonous snakes of South India, key to identification of poisonous snakes, poison apparatus and bitting mechanisms, snake venom and first aid.

Unit 2. Aves I 15 hrs

General characters and outline classification with examples, Pigeon - Type study.

Unit 3. Aves II 15hrs

Archaeopteryx, Ratitae, bird migration, flight adaptations in birds, Types of beaks and feets in birds, Economic Importance of birds

Unit 4. Mammals I 15 hrs

General characters and outline classification with examples, Rabbit - Type study

Unit 5. Mammals II 15hrs

Origin of mammals, aquatic mammals, flying mammals, adaptive radiation in mammals, economic importance of mammals.

Total hours : 75

Text Books :

1. M. EkambaranathaAyyar and T.N. Ananthakrishnan (2016). A Manual of Zoology, Volume 1 – Part I (Chordata), Sixth Edition, S. Viswanathan (Printers and Publishers) Pvt. Ltd., Chennai
2. Kotpal, R.L. (2016). Modern text book of Zoology Vertebrates (Animal Diversity -II),Fourth Edition,Rastogi Publication, Meerut, India.
3. H.S.Bhamrah and KavithaJuneja (2001). An introduction to birds, First edition, Anmol Publications Private Ltd., New Delhi.

Reference Books :

1. H.S.Bhamrah and KavithaJuneja (2001). An introduction to reptiles, First edition, Anmol Publications Private Ltd., New Delhi.
2. Jordan, E.J and Verma, P.S. (2014). Chordate Zoology, Second Edition, S. Chand & Company Ltd, New Delhi.
3. H.V. Bhaskar (2010). Chordates (Volume 2), First edition, Campus book international, New Delhi.

Course Outcomes:

1. Knowledge on mechanism of adaptation of animals to environment
2. Understand the salient features of major groups within phylum chordata
3. Understand the anatomical features of chordates
4. Differential knowledge on the anatomy of chordates
5. Illustrate the economic significance of reptiles, birds and mammals

CO / PO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	H	H	H	H	H	H	L
CO 2	H	H	H	H	H	H	H	H	H	L
CO 3	H	L	H	H	M	H	H	H	H	L
CO 4	H	L	H	H	H	H	H	H	H	L
CO 5	H	H	M	H	H	L	H	H	H	H

Practicals II - Chordates

Semester II **Hours of Instruction/week : 5**

21BZOC06 **No. of credits : 2**

Objectives:

1. To identify and classify museum specimens and to study their salient features.
2. To observe animals in their natural habitat
3. To get trained in virtual dissections

A. Dissections (Demonstration only) 10hrs

Teleost fish – Digestive system
Reproductive system

B. Study of the following specimens by observing its salient features and biological significance 15hrs

a. Amphioxus and Salpa
b. Scoliodon, Mugil, Arius, Hippocampus and Electric ray
c. Frog, Alytes and Icthyophis15
d. Calotes, Chelone, Chameleon, Crocodile,Viper and Cobra
e. Pigeon, Woodpecker and Kingfisher
f. Rat , Anteater and Porcupine

C. 15 hrs

a. Identification of locally available fishes
b. Study of ornamental fishes
c. Study of scales of fishes
d. Study of different types of feathers of birds
e. Study of different types of beaks and feets of birds

D. Osteology

Frog : Pectoral girdle, pelvic girdle, fore limb, hind limb and typical vertebrae 10 hrs

E. Supplementary sources for laboratory exercise 10 hrs

Anatomy of frog

a. The dissection works(CD)
Source: http://www.scienceclass.com 10
b. Prodissector – Frog (CD)
Source: http://www.prodissector.com

F. Field work

a. Report on visit to Gauss museum
b. Report on visit to SACON 15 hrs
c. Report on visit to National park / Zoological park/ Sanctuary

Total hours : 75

Course Outcomes:

1. Identify visceral organs of fishes in situ
2. Able to identify marine and fresh water, food and ornamental fishes
3. Gain basic training in virtual dissections
4. Know about museum specimens and their salient features
5. Assess the adaptive features of beak and feet of bird

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	M	H	M	H	M	H	M	H	L
CO 2	H	H	H	M	H	M	H	H	H	H
CO 3	H	M	L	H	H	L	H	H	H	M
CO 4	H	H	H	H	M	M	H	H	H	L
CO 5	H	H	H	L	H	M	M	H	H	L

Cell Biology

Semester III **Hours of instruction / week : 4**

21BZOC07 **No of credit: 3**

Objectives:

1. To learn various cytological techniques to understand ultra structure of cellular organelles
2. To understand the structure and function of cellular organelles
3. To understand the principles of membrane transport

Unit 1. **Introduction to cell and cytological techniques** 12 hrs

Concepts of a modern cell, cell theory, prokaryotic and eukaryotic organization. Light, transmission and scanning electron microscopes, preparation of materials for light and electron microscopes, cell fractionation methods, homogenization and centrifugation.

Unit 2. **Plasma membrane** 12 hrs

Chemical composition, structure, fluid mosaic model, membrane transport, cell adhesion, cell junction

Unit 3. **Cell organelles** 12 hrs

Morphology, ultrastructure and functions of mitochondria, golgi complex, endoplasmic reticulum, ribosomes, lysosomes, centrosomes

Unit 4. **Nucleus** 12 hrs

Nuclear envelope, nucleolus, organization and functions of nucleus, morphology and ultrastructure of chromosome, euchromatin, heterochromatin, polytene and lamp brush chromosomes

Unit 5. **Cytology of cancer** 12 hrs

Difference between normal and cancer cells, membrane and biochemical changes, nuclear and chromosomal changes, tumour viruses, oncogenes, environmental factors inducing cancer, hormones in relation to cancer cells

Total hours : 60

Text Books:

1. Verma, P.S. and Agarwal, V.K. (2014). Cytology, Third edition, S.Chand& Company Ltd., New Delhi.
2. Prakash S. L. (2007). Cell and Molecular Biology, First edition, MJP Publishers, Chennai.
3. Ajoy Paul (2007). Text book of Cell and Molecular Biology, Second edition, Books and Allied (P) Ltd, Kolkata

References Books:

1. Veer BalaRastogi (2010). Introduction to Cytology, Revised edition, Kedarnath Ram Nath Publishers, Meerut (UP)
2. Verma, P.S. and Agarwal, V.K. (2006). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S.Chand& Company Ltd. Publishers, New Delhi.
3. Cooper, G.M. (2007). The cell – A Molecular Approach. Second edition. ASM press, The American Society for Microbiology, USA.

Course Outcomes:

1. Evaluate and apply knowledge of modern scientific techniques in cellular biology functions
2. Describe the structure and functions of the plasma membrane, transport across cell and cell-cell communication
3. Portray the intricate relationship between various cellular structures and their corresponding
4. Be able to describe the structure and functions of nucleus with special reference to chromosomes
5. Describe the intricate relationship between the normal and the pathological state of tumor cell

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	M	H	H	H	H	H	H	H	H
CO 2	H	H	M	M	M	H	H	H	H	L
CO 3	H	M	M	M	H	M	H	M	H	H
CO 4	H	H	H	H	H	H	M	M	H	H
CO 5	H	H	H	M	L	H	H	H	H	M

Molecular Biology

Semester III **Hours of instruction / week: 4**
21BZOC08 **No of credit: 3**

Objectives:

1. To elucidate central dogma of molecular biology
2. To know the types and structure of nucleic acids
3. To understand synthesis and processing of RNA, DNA and protein

Unit 1. **Introduction to molecular biology** 12 hrs

Nature of genetic material,evidences for DNA as genetic material, bacterial transformation, bacterial conjugation, bacteriophage infection, transduction evidences for RNA as genetic material

Unit 2. **Molecular structure of DNA** 12 hrs

Constituents of nucleic acid, structure of DNA , types of DNA, alternative forms of DNA, supercoiling of DNA, repeated and unusual structures of DNA sequence, properties of DNA

Unit 3. **Replication of DNA** 12 hrs

Basic requirements for DNA synthesis, semi conservative mode of DNA replication, enzymology and proteins associated with DNA replication, mechanism of DNA replication in prokaryotes

Unit 4. **Ribonucleic acid and transcription** 12 hrs

Structure of RNA, types of RNA, basic features of RNA synthesis , steps in the synthesis of RNA, post transcriptional modifications of RNA

Unit 5. **Genetic code and translation** 12 hrs

Features and deciphering of genetic code, requirements and steps involved in protein biosynthesis, post translational modifications

Text Books:

1. Verma, P.S. and Agarwal, V.K. 2009. Molecular Biology. Fourth Edition, S.Chand and Company Ltd., New Delhi.
2. VeerBalaRastogi .2007. Molecular Biology. Second Edition, KedarNath Ram Nath Publishers, Meerut (UP)
3. Jeyanthi, G.P. 2009. Molecular Biology. First Edition, MJP Publishers, Chennai.

References Books:

1. Watson. J. D, Baker. T. A, Bell. S. P, Gann. A, Levine. M, Losick. R. 2008.Molecular Biology of Gene. 6th Edition; The Benjamin / Cummings Pub. Co. Inc,
2. Karp, G., Iwasa, J., Marshall,W.2015. Cell and Molecular Biology: Concepts and Experiments, 8th Edition.John Wiley & Sons, Inc.,
3. Darnell, Lodish and Baltimore. 2000. Molecular Cell Biology, Scientific American Publishing Inc,

Course Outcomes:

1. Be able to explain how DNA provides a mechanism for heredity
2. Understand structure of nucleic acids and basic concepts of protein synthesis
3. Describe the molecular mechanisms behind DNA replication in prokaryotes and eukaryotes
4. Comprehend RNA synthesis and processing, and protein synthesis
5. Understand and apply general concepts of cell and molecular biology to relevant, specific problems.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	M	M	H	L	H	M	M	M
CO 2	H	M	H	M	M	L	H	L	H	L
CO 3	M	M	H	M	H	L	H	M	M	L
CO 4	H	H	M	H	M	L	H	L	H	L
CO 5	H	H	M	H	H	L	H	L	H	M

Practicals III - Cell and Molecular Biology

Semester III **Hours of instruction / week: 5**

21BZOC09 **No of credit: 2**

Objectives:

1. To be able to perform experiments using the common tools of cell and molecular biology, including light microscopy, cellular fractioning and leucocyte culture
2. To list the fundamental features of prokaryotic and eukaryotic cells and methods used to examine them
3. To learn techniques for the isolation and separation of biomolecules

	Cell Biology	
1.	Principles of light microscope	2 hrs
2.	Homogenization and centrifugation of tissue samples	3 hrs
3.	Haemolysis	5 hrs
4.	Cell division in grass hopper / cockroach testis	5 hrs
5.	Squash preparation of onion root tip	5 hrs
6.	Buccal smear test	5 hrs
7.	Examination of live Paramecium to study streaming movement of cytoplasm	5 hrs
8.	Measurement of cell size using micrometer	5 hrs
9.	Mounting of polytene chromosome	5 hrs
10.	Human peripheral leucocyte culture	5 hrs
	Molecular Biology	
11.	Isolation and estimation of DNA from onion	5 hrs
12.	Isolation and estimation of DNA from goat liver	5 hrs
13.	Isolation of DNA from Bacteria	5 hrs
14.	Plasmid DNA isolation	5 hrs
15.	Separation of DNA by agarose gel electrophoresis	5 hrs
16.	Preparation of competent cells	5 hrs
	Total hours :	75

Course Outcomes:

1. Acquire practical skills in undertaking simple immunological experiments that mimic those undertaken in diagnostic and research laboratories.
2. Coherently report in a written document using the appropriate language of the field
3. Understand the principle and operation of relevant laboratory equipment.
4. Evaluate laboratory test outcomes and determine the validity of the test results obtained.
5. Perform experiments using techniques for isolation and separation of biomolecules

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	H	H	H	L	H	H	H
CO 2	L	H	M	M	M	M	L	M	M	H
CO 3	H	H	H	H	H	M	L	H	H	M
CO 4	H	H	H	H	H	H	M	H	H	H
CO 5	H	H	H	H	H	H	M	H	H	H

Genetics

Semester IV **Hours of Instruction / week : 4**

21BZOC10 **No. of credits : 3**

Objectives :

1. To learn the genetic principles in animals.
2. To understand the inheritance of genetic disorders in man.
3. To know about the applied aspects of genetics

Unit 1: Introduction

Mendelism, Mendels's work, mono hybrid, dihybrid, back cross, test cross. Mendels's laws- Law of dominance, segregation and independent assortment, Incomplete dominance. 12 hrs

Unit 2: Gene interactions 12 hrs

Complementary, supplementary, epistatic, lethal and cumulative genes, Characters of multiple alleles with examples, ABO blood groups, Rh factor.

Unit 3: Linkage and crossing over 12 hrs

Definition, types of linkages in drosophila, definition, types of crossing over, mechanism of crossing over, cytological evidence for crossing over, factors affecting crossing over, chromosome mapping.

Unit 4: Sex linked inherentance and Sex determination 12 hrs

Definition, X and Y linked inherentance, haemophilia and colour blindness in man, sex influenced and sex limited genes in man, chromosomal theory, quantitative theory (Lyons hypothesis and dosage compensation), environmental theory, hormonal theory of sex determination, primary and secondary chromosomal non disjunction

Unit 5: Human genetics 12 hrs

Pedigree analysis, Mendelian traits, human karyotype, autosomal and sex chromosomal abnormalities, inbreeding, out breeding and hybrid vigour, genetic counseling

Total hours : 60

Text Books:

1. Verma, P.S. and Agarwal, V.K. (2007), Genetics S. Chand and Company Ltd., New Delhi.
2. Veer BalaRastogi (2008), Elements of Genetics, Eleventh edition, KedarNath Ram Nath Publishers, Meerut (U.P).
3. Miglani. G.S. (2011). Advanced Genetics. N.K. Mehra for Narosa publishing House, 2nd edition, Delhi, Chennai, Mumbai, Kolkata.

Reference Books:

1. S.V. Sawardekar., S.S. Sawant., S.G. Bhave(2010). Principles of Genetics. International Book House Pvt. Ltd. 1st edition, Mumbai, India.
2. G.S. Miglani. 2011. Advanced Genetics. N.K. Mehra for Narosa publishing House, 2nd edition, Delhi, Chennai, Mumbai, Kolkata.
3. Alice Marcus. 2010. Human Genetics. Narosa publishing House, 1st edition, Delhi, Chennai, Mumbai, Kolkata.

Course Outcomes:

1. Understand and describe the mechanism that underpins biological inheritance
2. The knowledge required to design, execute and analyze the results of genetic experimentation in animal and plant model systems
3. Insights into the inheritance of linked genes and the contribution of recombination of genes in evolution
4. Assess the role of chromosomes in sex determination and inheritance of X and Y linked genes
5. Construct personal and family pedigrees and integrate genetic testing options in genetic counseling practices

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	H	H	L	H	H	H	-
CO 2	H	H	H	H	H	H	H	H	H	H
CO 3	H	H	H	H	H	H	H	H	H	L
CO 4	H	H	H	H	H	M	H	H	H	M
CO 5	H	H	H	H	H	H	H	H	H	H

Evolution

Semester IV **Hours of Instruction / week : 4**
21BZOC11 **No. of credits : 3**

Objectives:

1. To learn the origin of life.
2. To understand the principles and mechanism of evolution.
3. To know the types of fossil and its significance.

Unit 1. **Introduction** 12 hrs

History, theories of evolution, origin of life, Evidences for evolution – morphological, anatomical, embryological, physiological, taxonomical and paleontological evidences

Unit 2. **Mechanism of Evolution** 12 hrs

Lamarckism, Neo-Lamarckism, Darwinism, Neo-Darwinism and Mutation theory

Unit 3. **Isolation and speciation** 12 hrs

Isolation - Premating and postmating isolation mechanism and their significance, Speciation - modes of speciation- allopatric, sympatric and parapatric speciation

Unit 4. **Fossils** 12 hrs

Fossil formation, types of fossils, dating of fossils, significance of fossil record, Indian fossils, living fossils and geological time scale.

Unit 5. **Evolution of man** 12 hrs

Evolution of man, biological aspects (with fossils record) and cultural evolution of man.

Total hours : 60

Text Books:

1. MeenakshiChakraborty (2012).A Text book of Organic Evolution. Wisdom press,India
2. Verma, P.S. and Agarwal, V.K. (2010). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Ltd., New Delhi
3. Veer BalaRastogi (2000). Evolution, KedarNath Ram Nath, Meerut.

Reference Books:

1. Monroe W. Strickberger (2005). Evolution, Fourth edition, Jones and Bartlett Publications, Massachusetts.
2. Mark Ridley (2004). Evolution, Third edition, Blackwell Science Ltd and Publishing company, UK.
3. Franklin, S.A (2000). Evolution, J V Publishing House, Jodhpur

Course Outcomes:

1. Understand the history and development of evolutionary thoughts.
2. Able to trace the evidence of evolution and its required corollaries
3. Elucidate the mechanism and significance of evolution
4. Knowledge about the evolutionary information of the fossils
5. Investigate the evolutionary basis of behavior in primates and man.

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	M	H	M	H	L	M	L
CO 2	H	H	H	L	H	M	H	L	H	L
CO 3	H	H	H	H	H	M	M	L	L	L
CO 4	H	H	H	L	H	M	H	L	M	L
CO 5	H	H	H	M	H	M	H	L	M	L

General Entomology

Semester IV **Hours of Instruction/week: 3**
21BZOC12 **No. of credits: 3**

Objectives:

1. To enable the students to know about the various types of insects,
2. To know about the types of pests and their control.
3. To understand the social life of insects

Unit 1. **Classification of insects-Introduction**

Introduction, principles underlying classification, classification up to orders with examples. 8 hrs

Unit 2. **Structure and functions of insects** 9 hrs

External characters, integument, head, mouth parts, thorax, wings and legs, andabdomen

Unit 3. **Physiology of insects** 10 hrs

Digestion, respiration, circulation, excretion, nervous, sensory, and reproductive systems – Hormones in metamorphosis

Unit 4. **Insect pests** 10 hrs

Pests of major crops - Paddy – *Tryporyza*and*Spodoptera*

Sugarcane – *Chilo and Pyrilla*

Stored grain pests – *Sitophilusoryzae, Triboliumcastaneum, Callosobruchusmaculatus*and*Sitotrogacereallela*

Pests of medical importance - Mosquitoes – Culex, Anopheles and Aedesspecies,Housefly

Unit 5. **Pest Control Measures** 8 hrs

Primary control measures – physical, cultural, chemical control – insecticides – Classification of a mode of action - Biological control – Integrated Pest Management (IPM)

Total hours : 45

Text Books :

1. Tembhare, D.B. (2015). Modern Entomology, Second Edition, Himalaya Publishing House Pvt. Ltd., Chennai
2. Vasanthara David, B., and Kumaraswamy, T. (1982). Element of Economic Entomology. Popular Book Depot, Madras.
3. Anand Prakash, Jagadiswari Rao, Sahoo B.K. and Asangla Jamir, I. T (2016). Pests of stored grains and their management Applied Zoologists Research Association (AZRA), Bhubaneswar, Odisha.

Reference Books :

1. Choudhary, V. (2008). Entomology and Part Management. Navayag Publishers, New Delhi.
2. *Larry*P.*Pedigo*, Marlin E. Rice. (2009) Entomology and Pest Management, 6th edition. Prentice-Hall, New Jersey.
3. Vincent H. Resh. and Ring T. Carde (2009). EncyCOpedia of Insects, 2nd edition. Elsevier Science, Munksgaard, Copenhagen

Course Outcomes:

1. **Attain a solid foundation of** the various types of insects
2. Knowledge of the structure and functions of insect anatomy
3. Explicate the functioning of the organ system of insects
4. Identification of pests of agricultural and medical importance
5. Attain skills in the various types of pest control practices

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	M	M	L	M	M	H	M	H	L
CO 2	H	M	M	L	M	H	H	L	M	M
CO 3	H	H	M	M	H	H	H	M	M	M
CO 4	H	H	H	H	H	H	H	M	H	L
CO 5	H	H	H	H	H	H	H	L	H	M

Practicals IV - General Entomology

Semester IV **Hours of Instruction/week : 2**
21BZOC13 **No. of credits : 2**

Objectives:

1. To enable the students to dissect out an invertebrate
2. To know about the insect research institutions.
3. To identify the insects of agricultural and medical importance

I Dissections

Cockroach – Mouth parts
Digestive system
Nervous system
Reproductive system — 14 hrs

II Visits to — 6 hrs

Sugar cane Breeding Institute for survey of sugar cane pests
Tamilnadu Agricultural University for survey of agricultural pests
Institute of Forest Genetics and Tree Breeding

III Identification of stored grain pests from house hold — 4 hrs

IV Male and female identification in cockroach, drosophila and mosquito — 6 hrs

Total hours : 30

Course Outcomes:

1. Understand the internal and external features of cockroach
2. Knowledge on the structure and functions of insect body parts
3. Acquiring information on research institutions through field visits
4. Identification of pests of agricultural and medical importance
5. Develop the keys for the identification of different types of insects

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	M	H	H	H	L	L	H	M	L
CO 2	H	M	M	H	H	M	L	H	H	L
CO 3	H	H	H	H	H	H	M	H	H	H
CO 4	H	M	H	H	H	H	H	H	H	H
CO 5	H	M	H	H	H	H	H	H	H	H

Biochemistry

Semester V **Hours of instruction / week : 5**

21BZOC14 **No of credit : 3**

Objectives :

1. To facilitate the students to understand the key principles of biochemistry
2. To enable the students to know about the structure of the biomolecules
3. To understand the metabolism of biological molecules

Unit 1. **Introduction to Biochemistry** 15 hrs

Atoms, chemical bonds, acids and bases, hydrogen ion concentration, concept of pH, maintenance of blood pH, bicarbonate, phosphate and protein buffers

Unit 2. **Carbohydrates** 15 hrs

Classification, structure and function of carbohydrates

Metabolism - Glycolysis, TCA cycle, Glycogenesis and Glycogenolysis

Unit 3. **Amino acids and Proteins** 15 hrs

Structure, classification and properties of amino acids and proteins

Metabolism - Transamination and Deamination of amino acids

Unit 4. **Lipids** 15 hrs

Classification, structure of fatty acids, triacylglycerol, phospholipids, steroids and properties of lipids

Metabolism - β-oxidation of palmitic acid and valeric acid

Unit 5. **Enzymes** 15 hrs

Types, general properties, classification, active site, mechanism of enzyme action, factors affecting enzyme activity, enzyme inhibition

Total hours : 75

Text Books:

1. Satyanarayana, U. and Chakrapani, U. (2013). Biochemistry, Seventh Edition, Books and Allied Pvt. Ltd., Kolkatta and Elsevier, New Delhi.
2. Jain, J.L., Sunjay Jain, Nithin Jain (2005). Fundamentals of Biochemistry, Sixth Edition, S. Chand Publishing Company, New Delhi.
3. Albert L. Lehninger, David L. Nelson, Micheal M. Cox (2008). Principles of Biochemistry, Fifth edition, CBS Publishers and Distributors, New Delhi.

Reference Books

1. Victor W. Rodwell, David A. Bender, Peter J. Kennelly, Kathleen M. Botham (2012). Harper's Illustrated Biochemistry, 29th edition. Lange Medical Publications, Maruzen, Asia.
2. Donald J. Voet, Judith G.Voet (2010). Biochemistry, Fourth edition, John Wiley and Sons Inc., United States
3. Rodney Boyer (2006). Concepts in Biochemistry, Third Edition, John Wiley and Sons Inc., United States

Course Outcomes:

1. Gain knowledge on the basic principles of chemistry to biological systems
2. Comprehend the chemical nature and functions of biomolecules
3. Ability to relate various interrelated physiological and metabolic events.
4. Firm foundation in the fundamentals and application of biomolecules
5. Acquire fundamental knowledge on enzymes and their importance in biological reactions.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	M	L	M	M	M	M	M
CO 2	H	H	H	H	H	H	M	H	H	M
CO 3	H	H	H	H	H	H	M	H	H	M
CO 4	H	H	H	H	H	H	M	H	H	M
CO 5	H	H	H	H	H	H	M	H	H	M

Animal Physiology

Semester V **Hours of instruction/week : 5**

21BZOC15 **No of credits : 3**

Objectives:

1. To enable the students to understand the physiological aspects of life.
2. To apply the knowledge in day to day life.
3. To know the anatomy of different organ system and their specific functions.

Unit 1. Introduction 15 hrs

Scope of physiology, nutrition, types of nutrition, digestion and absorption in a mammal.

Unit 2. Respiration and Circulation 15 hrs

Respiration - Organs of respiration, respiratory pigments, transport of gases Circulation - Heart types, structure of mammalian heart, properties of heart muscle, origin and conduction of heart beat, composition and functions of blood

Unit 3. Excretion and Nervous system 15 hrs

Excretion:Excretory organs and excretory products of animals, structure of mammalian kidney, urine formation, composition of urine

Nervous system: Structure of neuron, conduction of nerve impulses, synapses, reflexes, autonomic nervous system

Unit 4. Receptors and Effectors 15 hrs

Receptors - Photoreceptors, mechanoreceptors and chemoreceptors of a mammal.

Effectors - Structure and physico-chemical properties of skeletal muscles, theories, physiology and muscle contraction

Unit 5. Reproduction 15 hrs

Reproductive organs and physiology of reproduction in a mammal, Sexual cycles, Pregnancy, Menopause, Hormones in reproduction.

Endocrine Glands of a mammal, Pituitary, Thyroid, Parathyroid, Adrenal, Islets of Langerhans

Total hours : 75

Text Books:

1. Verma,P.S., Tyagi,B.S., Agarwal,V.K.(2015). Animal Physiology, Chand Publishing, India
2. Goel, K.A and Sastry, K.V.(2014). Animal Physiology, 6th edition, Rastogi Publication, Meerut.
3. Agarwal, R.A., Anil K. Srivastava, Kumar, K. (2007). Animal Physiology and Biochemistry, S. Chand and Company Ltd., New Delhi

Reference Books:

1. Richard Hill, Gordon, Wyse, A. and Margaret Anderson(2016). Animal Physiology, Fourth edition, Sinauer Associates
2. Sobti, R.C., (2008). Animal Physiology, Narosa Publishing House Pvt. Ltd., New Delhi.
3. Bhaskar, H.V., (2008). Animal Physiology, Campus Books International, New Delhi.

Course Outcomes:

1. Understand the physiological processes that regulate body function and their regulation.
2. Know about the structure and functions of respiratory and circulatory organs
3. Gain knowledge on the anatomy of different physiological system and their functions.
4. Able to describe the different types of receptors and muscle contraction.
5. Comprehend the physiology of reproduction and hormonal regulation

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	M	H	M	H	H	H	L
CO 2	H	H	H	M	H	M	H	H	H	L
CO 3	H	H	H	L	H	L	H	H	H	L
CO 4	H	M	L	L	H	M	H	H	H	L
CO 5	H	H	H	M	H	M	H	H	H	L

Biostatistics

Semester V **Hours of instruction/week : 5**
21BZOC16 **No of credits : 3**

Objectives:

1. To study the fundamentals of biostatistics
2. To study the application of biostatistics for testing hypothesis
3. To communicate the results of statistical analysis accurately and effectively.

Unit 1. **Introduction to biostatistics** 15 hrs

Introduction, collection, types, methods of collection of data, sources of data, census and sampling, laws of sampling, probability and nonprobability, sampling methods, sampling and non-sampling errors.

Unit 2. **Presentation of data** 15 hrs

Classification, types of classification, tabulation, parts of a table, types of tables, diagrammatic and graphic presentation, bar, pie diagram, line graph, graph of frequency distribution

Unit 3. **Measures of central tendency** 15 hrs

Objectives, mean, medium, mode, merits and demerits, geometric mean and harmonic mean

Unit 4. **Measures of dispersion** 15 hrs

Objectives mean deviation and standard deviation, merits and demerits, variance, standard error, coefficient of variation.

Unit 5. **Correlation and regression analysis** 15 hrs

Objectives, types of correlation, Karl Pearson's coefficient of correlation, regression types, regression line, regression equations, regression coefficients

Total hours : 75

Text Books:

1. Annadurai. B (2007). A text book of Biostatistics, New age International publications, Fifth edition, New Delhi.
2. Sharma, A.K.,(2005).Text book of Biostatistics, First edition, Discovery Publishers, New Delhi.
3. Naren K R. Dutta (2004).Fundamentals of Biostatistics: Practical approach, First edition, Kanishka publications and Distributors, New Delhi.

Reference Books:

1. Rajeev Goswami (2009).Biostatistics and computer applications, First edition, MD publications (P)Ltd, New Delhi
2. Wayne W, Daniel (2007). Biostatistics: A foundation for analysis in the health sciences, Seventh edition, Wiley India (P) Ltd, New Delhi.
3. Gupta,S.P.(1979). Statistical methods, Third edition, Sultan Chand & Sons, New Delhi.

Course Outcomes:

1. Understand the basic concept of data collection and techniques of sampling.
2. Describe the process of classification, tabulation and diagrammatic and graphic presentation of data
3. Acquire the knowledge to calculate the different measures of central tendency
4. Illustrate the properties of variance and standard deviation.
5. Choose the best logistic model that describes the relationship between variables

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	M	M	H	H	H	M	M
CO 2	H	H	H	M	L	H	H	H	L	L
CO 3	H	H	M	L	M	H	H	H	M	L
CO 4	H	H	M	L	M	H	H	H	L	L
CO 5	H	H	H	M	L	H	H	H	M	M

Aquaculture

Semester V **Hours of instruction / week: 4**

21BZOC17 **No of credit: 3**

Objectives:

1. To enable the students to understand the importance and applications of aquaculture.
2. To know the commercially important species and its culture practice.
3. To demonstrate the design, construction and maintenance of aquaria.

Unit 1. **Introduction to fisheries and aquaculture** 9hrs

History of aquaculture. Fishing gear and conventional fishing methods, Different types of nets (Seines, trawls, gill nets, trap nets, dip nets, casting net and blankets net), Hook and line gear

Unit 2. **Construction and management of fish farms** 15 hrs

Structure of fish ponds (bundhs, slope, berm), types of fish ponds, nursery ponds, Rearing ponds, Production pond. Fish culture in fresh water, Objectives of fish culture, Types of cultivable fishes, Breeding habits of cultivable fishes.

Practical 1: Analysis of morphometric and meristic characters of fish

Practical 2: Gut content analysis

Unit 3. **Composite fish culture** 12hrs

Sewage fed fisheries in carp culture, Brackish water fish culture, Integrated fish farming. Hormonal and genetic approach to fisheries, Cryopreservation of gametes, Hybridization, Transgenic fish, Inbreeding cross breeding and selective breeding.

Practical 3: Fish feed formulation using probiotics, fish waste and vegetable waste

Unit 4. **Setting and fabrication of aquarium tanks** 15 hrs

Accessories used in aquarium tank (aerators, filters, nets, gravels and ornamental objects), common ornamental fishes, and aquarium plants.

Practical 4: Setting up of an aquarium

Unit 5. **Taxonomy and biology of some popular ornamental fishes** 9 hrs

Live bearers (ovoviviparous), red sword tail, platy, guppy and molly. Egg layers (oviparous), Gold fish, Siamese fighting fish, gourami, angel fish, Oscar, breeding and spawning of liver bearers and egg layers.

Practical 5: Identification of ornamental fishes

Total hours : 60

Text Books:

1. Parker, R.O. (2012), Aquaculture Science, 2nd edition, Delmar Thomson Learning Publishers, Australia.
2. Chakrabaty, N.M., Chakrabaty P.P. and Mondal, S.C. (2010). Biology, breeding and farming of important food fishes, 1st edition, Narendra pub. House, Delhi.
3. Agarwal,S.C. (2007). A handbook of fish farming. 2ndedition.,Narendra publishing House, Delhi.

Reference Books:

1. Ranga and Shammi, (2003). Fish Biotechnology, Agrobios, India.
2. Gupta S. K. And Gupta P. C (2006). General and applied Ichthyology (Fish and Fisheries),S. Chand & Company, India.
3. Parker.R.O (2002). Aquaculture industry, 2nd edition, Delmar Thomson Learning Publishers, Australia.

Course Outcomes:

1. Identify significant operational and management practices in aquaculture systems.
2. Conceptualize, design, develop and manage commercial aquaculture farm units.
3. Acquire technical knowledge in applied genetics in aquaculture and composite fish culture systems.
4. Fundamental insights to start-up an ornamental fish culture unit
   Identify the different types of ornamental fishes.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	H	H	M	M	H	H	H
CO 2	H	M	H	H	H	M	H	M	H	H
CO 3	H	M	H	H	H	M	M	L		H
CO 4	H	H	H	H	H	H	H	L	M	H
CO 5	H	H	H	H	H	L	H	M	L	H

Practicals V – Biochemistry and Animal Physiology

Semester V **Hours of instruction/week: 5**
21BZOC18 **No of credits : 2**

Biochemistry

1.	Quantitative estimation of carbohydrates	5
2.	Quantitative estimation of lipids	5
3.	Quantitative estimation of proteins	5
4.	Effect of enzyme activity at different pH	5

Animal Physiology

5.	Human Blood smear preparation	5
6.	Erythrocyte and Leucocyte count using Haemocytometer	5
7.	Estimation of Haemoglobin	5
8.	Estimation of excretory products of animals	5
9.	Analysis of digestive enzymes in cockroach	5
10.	Ciliary activity of fresh water mussel in relation to temperature	5
11.	Estimation of Oxygen consumption in an aquatic animal	5
12.	Slides – Striped, Unstriped and Cardiac muscle	5
13.	Human Anatomy - Integument, digestive, respiratory circulatory, excretory system (from models)	15

Total hours : 75

Course outcomes:

1. Demonstrate the common laboratory techniques used in biochemistry.
2. Infer the biochemical constituents in food samples.
3. Knowledge on the fundamental of tissue and blood.
4. Know the structure and function of human anatomy.
5. Ability to identify the models and slides.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	H	H	H	H	H	H	H
CO 2	H	H	H	H	M	M	H	M	M	H
CO 3	H	H	H	H	M	M	H	M	M	H
CO 4	H	H	H	H	H	M	M	H	H	M
CO 5	H	M	M	M	M	M	L	L	L	H

Sericulture and Apiculture (Self Study course)

Semester V **Hours of instruction / week : 1**

21BZOC19 **No of credit : 4**

Objectives :

1. To enable the students to learn the basics of silk worm rearing techniques
2. To understand the economic importance of sericulture and apiculture
3. To obtain knowledge on the basic facts about bees and bee keeping

Unit 1.	**Introduction**	3hrs
	History of sericulture , economic importance of sericulture , varieties of silk worms, mulberry, tassar, eri and muga silkworms, life cycle of *Bombyxmori*	
Unit 2.	**Silk worm rearing**	3 hrs
	Rearing house, facilities, rearing equipments, optimum environmental conditions, spacing, chawki, shelf-floor and shoot rearing , mounting and harvesting, cocoon marketing	
Unit 3.	**Silkworm diseases**	3 hrs
	Pebrine, flacherie, grasserie, muscardine, methods of prevention, pests of silkworms	
Unit 4.	**Types of honey bees and Bee colony**	3 hrs
	Rock bee, Indian bee, European bee, Little bee, Dammer bee and their identification, bee colony, its members, life cycle of honey bee	
Unit 5.	**Apiary**	3 hrs
	Types of bee hives, accessories of apiculture, enemies of bees Honey - extraction, properties, chemical composition, preservation and storage, nutritive and medicinal value	
	Total hours :	15

Text Books:

1. Pradip, J. V., (2005). Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture and their controls, First Edition, Discovery Publishers, New *Delhi*.
2. Ahsan, J. and Sinha, S.P. (2010). A Handbook of Economic Zoology, Fifth Edition, S.Chand Publishing Company, New Delhi.
3. Bhargav, B K. (2016). Text Book of Economic Zoology, Omega Publications, Fifth Edition, New Delhi.

Reference Books:

1. Singh, T., Bhat, M.M., Khan, M.A. (2009). Sericulture Extension – Principles and Management, MotilalBanarsidas Publishers Private Limited.
2. Philips, E.F. (2003). Bee keeping, International Books & Periodicals Supply Services, New Delhi.
3. Chakravorty, D. and Pandey P.N. (2005). Silkworm Crops, APH Publishing Corporation, New Delhi.

Course Outcomes:

1. Acquire the fundamental knowledge of silkworm and honey bee
2. Comprehend the methodologies involved in silkworm rearing
3. Asses self employment in sericulture and apiculture
4. Apply different strategy of bee keeping techniques and its byproducts
5. Understand the control of pests of silkworm and honey bee

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	H	H	H	H	M	H	H
CO 2	H	H	H	H	H	H	H	M	H	H
CO 3	H	H	H	H	H	H	L	M	H	H
CO 4	H	H	H	H	H	H	H	M	H	H
CO 5	H	H	H	H	M	H	H	M	H	M

Ornamental fish culture (Generic Elective Course)

Semester V **Hours of instruction/week: 2**

21BZOO01 **No. of credits: 2**

Objectives:

1. To demonstrate to design, construct and maintain home aquaria.
2. To provide self-employment
3. To educate the students on the importance and relevance of recreational fisheries in the society

Unit 1. Fresh water aquarium 6 hrs

Introduction, definition, origin, history of aquarium, types of aquarium, nature of aquaria, space and setting of aquarium tank.

Unit 2. Taxonomy and biology of some popular ornamental fishes 6 hrs

Live bearers (ovoviviparous),red swordtail, platy, guppy and molly.

Egg layer (oviparous), gold fish, siamese fighting fish, gourami, angel fish, koi carp, oscar and neon tetra. Breeding and spawning of live bearers and egg layers.

Unit 3. Accessories used in aquarium tank and its maintenance 6 hrs

Accessories used in aquarium tank (aerator, filters, nets, gravel, ornamental objects). Maintenance of water quality, (temperature, ammonia, pH, O_2 / CO_2) control of snail and algal growth.

Unit 4. Nutritional requirements of ornamental fish 6 hrs

Different kinds of feeds- Live feed, culture of live feed organisms, infusoria, chironomous, tubifex, rotifers cladocerans and brine shrimp. Artificial feed, feed formulations, uses of natural and synthetic feed additives, balanced diet.

Unit 5. Marine ornamental fishes and diseases 6 hrs

Important marine ornamental fishes, purchase and transport of ornamental fishes, other ornamental organisms.

Common diseases- protozoan, fungal, bacterial and nutritional diseases, their diagnosis and treatment.

Total hours : 30

Text Books:

1. Jagtap, H.S., Mukherjee, S.N. and Garad, V.K., (2009). A Text Book of Pisiculture and Aquarium Keeping, Daya Publishing House, New Delhi.
2. AmitaSaxena (2003). Aquarium management. Daya publishing House, New Delhi.
3. Pandey and Shukla (2005). Fish and Fisheries, 1st edition, Rastogi Publication.

Reference Books:

1. Venkataramani, V.K., (2004), Biodiversity and Stock Assessment of Marine Ornamental Fishes, Department of Fisheries Biology and Capture Fisheries, Fisheries College and Research Institute, TNAUVAS, Tuticorin.
2. S.C.Agarwal (2007). A handbook of fish farming. Narendra pub. House, Second edition, New Delhi.
3. Srivastava.B.B.L. (1999) A Text book of fishery science and Indian Fisheries, Allahabad.

Course Outcomes:

1. Acquire knowledge on the importance of aquaculture.
2. Assess the systematic and importance of ornamental fishes.
3. Develop the construction techniques of aquarium and its maintenance
4. Gain capability to design novel formulated feeds for ornamental fishes.
5. Identify the fish diseases, diagnosis and treatment

Microbiology

Semester VI **Hours of instruction / week : 5**
21BZOC22 **No of credit : 3**

Objectives :

1. To enable the students to know about the aspects of microorganisms
2. To know the pathogenesis of microorganisms
3. To gain knowledge on the applications of microbes and its significance in various fields.

Unit 1. **Introduction** 15hrs

History and scope of microbiology, Classification of bacteria, fungi and virus

Unit 2. **Microbial culture and growth** 15 hrs

Sterilization, media types and preparation, sample collection, isolation, maintenance of microbes, bacterial growth pattern, factors affecting growth, measurements of growth.

Unit 3. **Food Microbiology** 15 hrs

Food spoilage, Food borne diseases - Food borne infections - Salmonellosis, Bacillary dysentery, Q fever, Food borne intoxications– Botulism, Staphylococcal poisoning, Aflatoxins, Food preservation

Unit 4. **Industrial and Environmental Microbiology** 15hrs

Fermentor design, microbial selection, ethanol and penicillin production, water analysis, sewage treatment.

Unit 5. **Medical Microbiology** 15 hrs

Bacterial Diseases – Tuberculosis, Leprosy, Syphilis, Cholera.

Fungal Diseases – Cutaneous and systemic mycoses.

Viral Diseases – Chicken pox, Influenza, Rabies, Hepatitis, Poliomyelitis, AIDS.

Total hours : 75

Text Books:

1. Dubey, R.C. and Maheswari, D.K. (2000). A text book of Microbiology. Fourth Edition, S. Chand and Company Ltd, New Delhi.
2. Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton (2014). Prescott's Microbiology, 9th edition, McGraw Hill Education, New York.
3. Anthanthanarayanan, R. and JayaramPaniker (2009). Text book of Microbiology, Eighth Edition, Universities Press (India) Private Ltd., Hyderabad.

Reference Books:

1. Powar, C.B. and Daginawala, H.F. (2001). General Microbiology. Fourth Edition, Himalaya publishing house, New Delhi.
2. Jeffrey Pommerville (2014). Alcamo's Fundamentals of Microbiology, First Edition, Jones and Bartlett India Pvt. Ltd., New Delhi.
3. Talaro, K.P and Talaro, A. (2002). Foundations in Microbiology, Fourth Edition, McGraw Hill Education, New York.

Course Outcomes:

1. Describe the importance of microbial groups
2. Apply microbial techniques to solve scientific problems
3. Assess the importance of microbes in food and industrial sector
4. Suggest the strategy for pollutant decontamination
5. Communicate the roles of microbes in ecosystem and health-related issues

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	M	M	H	M	H	H	H	H	H	L
CO 2	M	M	M	H	M	M	H	M	M	H
CO 3	H	H	H	H	M	M	M	M	M	M
CO 4	H	H	H	H	H	H	M	M	H	M
CO 5	H	H	H	H	H	H	M	H	H	H

Immunology

Semester VI **Hours of instruction / week: 5**

21BZOC23 **No of credit: 3**

Objectives:

1. To identify major components of the immune system at organ, cellular and molecular levels.
2. To discuss normal functions of these components during immune responses.
3. To learn principles of transplantation immunology

Unit 1	**Introduction to Immunology** History of immunology, immunity, types of immunity, lymphoid organs, primary, thymus, bursa of fabricius, bone marrow, secondary, lymph nodes, spleen.	15 hrs
Unit 2	**Antigen and Antibody** Factors for antigenicity, epitope and paratope, major classes of antigens, Immunoglobulins, structure, classes, properties and functions. Antigen – antibody interaction, primary interaction, secondary interaction. Application of antigen - antibody interactions.	15 hrs
Unit 3	**Cells of immune system** Lymphocytes and its types, macrophages, eosinophils, basophils, neutrophils, mast cells antigen presenting cells, platelets. Immune response, types, humoral immune responses, B cell activation, cell mediated immune response.	15 hrs
Unit 4	**Complement** Complement activation, classical, alternate pathway, biological functions. Major histocompatability complex , histocompatable molecules , human leucocyte antigen, functions	15 hrs
Unit 5	**Hypersensitivity** Types, mechanism of type 1 hypersensitivity. Transplantation immunology, types of graft, graft acceptance and rejection, mechanism of allograft rejection, prevention of graft rejection.	15 hrs

Text Books:

1. Kuby, J. 2007. Immunology. 6th edition, W.H.Freeman and Co, New York.
2. Banarjee, A. and Nirmala, B.2006. Fundamentals of Microbiology and Immunology. New Book Agency, Kolkata.
3. Roitt, I.M., Brostoff, J. 2002. Immunology. Mosby Publishers, London

References Books:

1. Murphy, K., Travers, P. and Walport, M. 2008. Immunology. Garland Science, UK.
2. Benjamini, E.,Coico, R. 2000. Immunology. A short course, John Willey Inc., New York.
3. David, K. M., Jonathan, David,B.R and Ivan,M.R. 2013. Immunology, 8th Edition, Elsevier-Saunders publications

Course Outcomes:

1. Describe the basic mechanisms, distinctions and functional interplay of innate and adaptive immunity
2. Apply immunologic techniques to solve certain clinical and research problems
3. Identify the role of antigen presenting cells, lymphocytes, and phagocytic cells in immune responses
4. Elucidate the relationship between major cellular and molecular components of the immune system.
5. Describe the basic structure of the cellular receptors and discuss their interactions during an immune response.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	M	H	H	L	L	M	L	H	L
CO 2	H	M	H	H	L	M	M	M	H	M
CO 3	M	M	M	M	L	L	L	L	H	L
CO 4	M	M	H	H	L	L	L	M	H	L
CO 5	H	H	M	H	L	M	M	L	H	L

Developmental Biology

Semester VI **Hours of instruction/week: 5**
21BZOC24 **No of credits: 3**

Objectives :

1. To enable the students to understand the basic principles of growth and development
2. To understand the general concept of ontogenic development
3. To understand the application of developmental biology

Unit 1. Introduction 15 Hrs

Historical reviews, scope of embryology, gametogenesis, spermatogenesis, structure of a typical sperm, significance, oogenesis, egg types, egg membranes

Unit 2. Fertilization 15 Hrs

Mechanism and significance of fertilization, cleavage, features, planes and patterns of cleavage, morula, blastula, cleavage in frog, chick and rabbit, fate maps, construction of fate maps, fate map of frog and chick.

Unit 3. Gastrulation 15 Hrs

Features of gastrulation, morphogenetic movements, gastrulation of frog and chick, significance

Unit 4. Organogenesis 15 Hrs

Ectodermal derivatives, development of brain and eye, endodermal derivatives, development of alimentary canal and associated glands. mesodermal derivatives, development of heart and kidney, development of foetal membranes in chick

Unit 5. Embryology of the mammal 15 Hrs

Human embryo development during trimester, implantation, tubal pregnancy. placentation in mammals, structure, types, functions

Total hours : 75

Text books:

1. Gilbert, (2006), Developmental Biology, Tamil Nadu Book House Publishers, Chennai
2. Verma, P. S. and Agarwal, V. K. (2012). Chordate embryology, S Chand & Company Ltd, New Delhi.
3. Veer BalaRastogi. (2011). Chordate Embryology (Developmental biology) Edition 2011, KedarNath Ram Nath Publishers, Meerut (U.P).

Reference books:

1. Banerjee, S., (2001), A Textbook of Developmental Biology, Dominant Publishers and Distributors, New Delhi.
2. Khana, D.R., (2004), Advanced Embryology, Discovery Publishing House, New Delhi.
3. Mathur, R. and Mehta, M., (2002), Embryology, Anmol Publications Private Limited, New Delhi.

Course Outcomes:

1. Familiarize the events in process of fertilization and embryogenesis
2. Knowledge on cytological background of animal development;
3. Compare development and homeostasis in different animals models
4. Insights on the complex developmental process of organs
5. Awareness on the human foetal development and child birth.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	M	M	H	H	H	M	M
CO 2	H	H	H	M	L	H	H	H	L	L
CO 3	H	H	M	L	M	H	H	H	M	L
CO 4	H	H	M	L	M	H	H	H	L	L
CO 5	H	H	H	M	L	H	H	H	M	M

Environmental Biology

Semester VI **Hours of instruction/week : 5**
21BZOC25 **No of credits : 3**

Objectives :

1. To enable the students to understand the various factors of environment
2. To know about the interaction between organizations of environment
3. To know the effects of population and its control measures

Unit 1.	**Introduction to Ecology** Segments of earth- Environment, atmosphere, hydrosphere, lithosphere. Abiotic factors - light, temperature, humidity, Biogeochemical cycles- oxygen, nitrogen, phosphorus and sulphur cycles	15Hrs
Unit 2.	**Population ecology** Definition, density, natality, mortality, population growth, population equilibrium, population fluctuations, biotic potential, dispersal, dispersion, regulation of population.	15 hrs
Unit 3.	**Community ecology** Definition, types of community, characteristics of community- community diversity, structure, community dominants, stratification, community periodicity, ecotone and edge effect, ecological niche, ecological equivalents, concepts of community, ecological succession.	15 hrs
Unit 4.	**Animal adaptations** Aquatic adaptation- primary and secondary,cursorial adaptation, desert adaptation- desert fauna and its characters,cave adaptation- origin, zonation, characters, cave fauna and flora, burrowing adaptations, arboreal adaptations, flight adaptations-passive and true flight.	15 hrs
Unit 5.	**Environment impact assessment** Steps in EIA, problems and potential solutions, methods of EIA, prospects for the future, EIS, environmental awareness, RIO summit and agenda, social forestry, Chipko movement, environmental auditing - types, methods, reporting	15 hrs

Total hours : 75

Text books:

1. Verma, P.S. and Agarwal, V.K. (2006), Cell biology, Genetics, Molecular Biology, Evolution and Ecology, Second edition, S. Chand and Company Ltd., New Delhi.
2. Kapoor, M. (2009), Disaster Management, First edition, MotilalBanarsidass Publishers Private Ltd., New Delhi
3. Odum, E.P. (1996). Fundamentals of Ecology Third edition, NatarajPublishers, Dehradun

Reference books:

1. Subrahmanyam, N.S. and Sambamurthy, A.V.S.S. (2006), Ecology, Second Edition, Narosa Publishing House Pvt. Ltd., New Delhi.
2. Rana, S.V.S., (2006), Environmental Pollution, Second Edition, Narosa Publishing House Pvt. Ltd., New Delhi
3. GaganMatta(2018) A text book of Environmental Science, first edition, KedarNath Ram Nath publishers , Meerut, U. P, India.

Course Outcomes:

1. Ability to express the mechanisms of interactions between different spheres of environment.
2. Knowledge on population parameters related to demography and population growth.
3. Imbibe the types and characteristics of community associated to ecosystem functions.
4. Gain knowledge on adaptations among animals for specific habitat.
5. Ability to critically observe the developmental actions with the fundamentals understanding of EIA.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	H	H	H	H	H	H	M
CO 2	H	H	H	H	M	M	H	M	H	L
CO 3	H	H	M	M	H	H	H	M	H	L
CO 4	H	H	H	M	H	M	H	L	H	L
CO 5	H	H	H	H	M	M	H	L	H	L

Practicals VI - Microbiology and Immunology

Semester VI **Hours of instruction / week : 5**

21BZOC26 **No of credit : 2**

Objectives :

1. To enable the students to isolate and identify the microorganisms using aseptic technique
2. To understand the factors that influence microbial growth.
3. To know the functions and usage of immunologic testing.

I. Microbiology

1	Isolation of microbes from soil by pour plate method	5 Hrs
2	Isolation of microbes from water by spread plate method	5 Hrs
3	Maintenance of microbial cultures by streaking methods	5 Hrs
4	Identification of bacteria by Gram staining	5 Hrs
5	Identification of bacteria by negative staining	5 Hrs
6	Identification of fungi by lacto phenol cotton blue staining	5 Hrs
7	Estimation of amylase isolated from microbial source	5 Hrs
8	Methylene blue reductase test for milk	5 Hrs
9	Bacterial growth curve	5 Hrs
10	Antibiotic sensitivity test	5 Hrs
11	Isolation of Coliforms from sewage	5 Hrs

II. Immunology

12	Demonstration of Ag – Ab interaction	5 Hrs
13	Isolation of lymphocytes on histopaque	5 Hrs
14	Precipitating ring test	5 Hrs
15	Single radial immunodiffusion	5 Hrs

Total hours : 75

Course Outcomes:

1. Identify the unknown microbes using staining techniques
2. Recognize and explain the use of common culture media
3. Assess the microbes in food samples
4. Detect possible drug resistance in common pathogens
5. Apply the immunological techniques in clinical diagnosis

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	H	H	H	L	H	M	M	M	H
CO 2	H	M	H	H	L	M	H	L	M	H
CO 3	H	H	H	H	L	H	H	M	M	H
CO 4	H	H	H	H	L	H	M	L	M	M
CO 5	H	H	H	H	L	H	M	L	M	M

Practicals VII - Developmental and Environmental Biology

Semester VI **Hours of instruction/week : 5**

21BZOC27 **No of credits : 2**

Objectives:

- Understand the developmental stages of frog and chick
- Learn the structure of embryo of various animals
- Learn the methods to estimate the physiochemical parameters of water samples

Developmental Biology

Microscopic examination of slides of frog

1. V.S of ovary of frog
2. Egg of frog (2,4,8 and 32 celled stage)
3. T.S of gastrula with yolk plug
4. Frog early gastrula
5. T.S of neural plate 15 hrs
6. T.S of neural fold
7. T.S of neural tube
8. Tadpole larva 4mm
9. Tadpole larva 7mm
10. Tadpole larva 10 mm

Microscopic examination of slides of chick embryo 15 hrs

1. Hen's egg
2. 18h chick embryo
3. 24h chick embryo
4. 36h chick embryo
5. 48h chick embryo
6. 72h chick embryo
7. 96h chick embryo

Spotters – Embryos of animals

1. Embryo of Rat
2. Embryo of Rabbit 5 hrs
3. Embryo of Pig
4. Embryo of Sheep

Environmental Biology

1. Estimation of pH of different water samples using pH meter
2. Estimation of salinity of different water samples
3. Estimation of dissolved oxygen in water samples
4. Estimation of dissolved carbon dioxide in different water samples
5. Determination of total alkalinity in different water samples
6. Estimation of TDS,TSS and TS in the given water sample
7. Estimation of chloride in water samples
8. Estimation of nitrates in water samples

40 hrs

Total hours : 75

Course Outcomes:

1. Maintain accurate records of laboratory experiments.
2. Know the differentstages of development of frog and chick
3. Describe the variations of embryos of mammals
4. Identify strategies for asking good questions in biological research
5. Apply the scientific method and quantitative techniques to describe, monitor and understand environmental systems.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	L	L	M	L	M	H	L	M	H
CO 2	H	M	M	M	M	M	M	M	M	M
CO 3	H	M	M	M	M	M	M	M	M	M
CO 4	H	M	M	M	M	M	M	M	M	M
CO 5	H	M	M	M	M	M	M	M	M	M

DSE-I Nonchordates and Chordates
(for B.Sc. Botany students)

Semester I **Hours of instruction / week : 4**
21BBOI01 **No of credit : 3**

Objectives:

1. To identify the salient features of non-chordates
2. To develop skills and acquire knowledge about the biology of non-chordates and chordates
3. Learn the importance of non-chordates and chordates

Unit 1.	**Introduction to Non-chordates**	12hrs
	General characters and outline classification of non-chordates with examples,	
	Type study - Paramecium.	
	Type study - Earthworm.	
Unit 2.	**Arthropoda and Mollusca**	12 hrs
	Type study - Cockroach.	
	Type study – *Pila globosa*.	
Unit 3.	**Introduction to Chordates**	12 hrs
	General characters and outline classification of chordates,	
	Type study - Scoliodon (Endoskeleton excluded).	
Unit 4.	**Amphibia**	12 hrs
	Type study - Frog (Endoskeleton excluded) parental care in Amphibia	
Unit 5.	**Mammals**	12 hrs
	Type study - Rabbit (Endoskeleton excluded), monotremes and marsupials.	
	Total hours :	60

Text books:

1. Ekambaranatha Ayyar, (2016). Manual of Zoology, Invertebrates, Fifth edition (revised edition) Vol. I, S.Viswanathan, (Printers and publishers) Pvt. Ltd., Chennai.
2. Ekambaranatha Ayyar, (2002). Manual of Zoology, Chordates, Fourth edition (revised edition) Vol. II, S.Viswanathan (Printers and publishers) Pvt. Ltd., Chennai.
3. Jordan, A.L and Verma, P.S (2014). Invertebrate Zoology, Second edition,S. Chand Publishing company Pvt. Ltd., New Delhi

Reference books:

1. Dr. K. S. Kohli, Dr. M. M.Trigunayat and Dr.KavithaSahani., 2008,Invertebrates (Structure & function), Ramesh Book Depot, Jaipur - New Delhi.
2. Edward E.Ruppert., Richard S.Fox. and Robert D.Barnes, 2006, Invertebrates Zoology, Seventh edition, Thomson Brooks/cole, USA.
3. H.V. Bhaskar (2010), Chordates (Volume 2), First edition, Campus book international, New Delhi.

Course Outcomes:

1. Acquire knowledge about fundamental non-chordate and chordate characters and basic principles of classification.
2. Describe the distinctive features selected invertebrate organisms.
3. Discuss the characteristics and outline classification of chordates and general organization of vertebrates
4. Identification of morphological and anatomical structure of selected vertebrates.
5. Illustrate the mammalian characteristic features with its diversification.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	M	M	M	H	H	H	M	H	H
CO 2	H	H	L	M	H	H	H	M	H	H
CO 3	H	M	L	M	H	H	H	L	H	H
CO 4	H	M	M	M	H	H	H	M	H	H
CO 5	H	M	L	M	H	H	H	M	H	H

DSE I Practicals I - Nonchordates and Chordates

Semester I **Hours of instruction / week : 3**

21BBOI02 **No of credit : 2**

Objectives:

1. To make students to understand slides of non-chordates
2. To make students to identify museum specimen
3. To develop skills in animal dissections

Dissections	Cockroach - Digestive system	12hrs
	Cockroach - Nervous system	12 hrs
Spotters	Ameoba, Euglena, Paramecium, Leucosolenia, Obelia colony, Madrepora, Planaria, Ascaris, Nereies, Peripatus, Prawn, *Pila globosa*, Sea star and sea cucumber	12 hrs
Dissection	**Chordates** Fish - Visceral organs	12 hrs
Spotters	Scoliodon, Ophiocephalus, *Rana hexadactyla*, Ichthyophis, Rabbit	12 hrs
	Total hours :	60

Course Outcomes:

1. Study the external as well as internal characters of non-chordates.
2. Ability to identify external morphology of animals by observing the slides.
3. Understand and study various systems in chordates.
4. Discuss the fundamental characters and identify the groups of chordates by observing the preserved specimens.
5. Maintain accurate records of laboratory experiments

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	M	M	M	H	L	H	M	H	H
CO 2	H	H	L	M	H	H	L	M	H	H
CO 3	H	M	L	M	M	H	H	L	H	H
CO 4	H	M	M	M	H	M	H	M	H	H
CO 5	H	M	L	M	L	H	H	M	H	H

DSE-II - Developmental Zoology and Animal Physiology

Semester - II **Hours of instruction / week : 4**
21BBOI03 **No of credit : 3**

Objectives :

1. To enable the students to understand the basic principles of growth and development
2. To understand the application of developmental biology.
3. To enable the students to understand the physiological aspects of life, apply the knowledge in day to day life.

Unit 1.	**Gametogenesis** Spermatogenesis, structure of a typical sperm, spermatogenesis, oogenesis - multiplication, growth phase, maturation phase	12 hrs
Unit 2.	**Fertilization** Fertilization, mechanism and significance of fertilization, cleavage, planes and patterns, blastulation and gastrulation in frog, test tube baby, twins	12 hrs
Unit 3.	**Digestion and Respiration** Nutrition, types of nutrition, digestion and absorption in a mammal. respiration, organs of respiration, respiratory pigments, transport of gases	12 hrs
Unit 4.	**Circulation** Heart types, structure of mammalian heart, origin and conduction of heart beat, composition and functions of blood, blood pressure	12 hrs
Unit 5.	**Excretion** Excretory organs and excretory products of animals, structure of mammalian kidney, urine formation, composition of urine, sexual cycles, pregnancy, menopause, hormones in reproduction	12 hrs
	Total hours :	60

Textbooks:

1. Gilbert, (2006). Developmental Biology, Sixth edition, Tamil Nadu Book House, Chennai.
2. Agarwal, R.A., Anil K. Srivastava, Kumar, K., (2007). Animal Physiology and Biochemistry, S. Chand and Company Ltd., New Delhi.
3. Veer Bala Rastogi. (2011). Chordate Embryology (Developmental biology) Edition , KedarNath Ram Nath Publishers, Meerut (U.P).

Reference books:

1. Khana, D.R., (2004), Advanced Embryology, Discovery Publishing House, New Delhi.
2. Bhaskar, H.V., (2008), Animal Physiology, Campus Books International, New Delhi.
3. Verma, P.S., Thyagi, B.S and Agarwal, V.K(2000), Animal Physiology, Sixth edition, S. Chand Publishing company Pvt. Ltd., New Delhi

Course Outcomes:

1. Ability to describe the processes of gametogenesis and fertilization
2. Understand the embryonic development of frog and significance of test tube baby and twins in human
3. Understand the biological process of digestion and respiration in higher animals
4. Evaluate the interdependence of circulation and excretion
5. Study the coordination of physiological process in a systematic way

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	M	M	H	M	L	H	M	H	H
CO 2	H	H	M	H	H	M	H	H	H	H
CO 3	H	M	M	H	H	L	H	H	H	H
CO 4	H	M	H	H	H	M	H	H	H	H
CO 5	H	M	M	H	H	M	H	H	H	H

DSE-II Practicals II - Developmental Zoology and Animal Physiology

Semester II **Hours of Instruction/week : 3**
21BBOI04 **No. of credits : 2**

Objectives:

1. To study the developmental stages of frog.
2. To know the metamorphosis of frog.
3. To learn the experiments in animal physiology.

Developmental Zoology

1. Microscopic examination of slides on frog embryology 10 hrs
2. T.S.of ovary
3. Early blastula
4. Gastrula with yolk plug
5. T.S of neural fold
6. T.S of neural plate
7. T.S of neural tube
8. Tadpole larva 4mm
9. Tadpole larva 7mm
10. Tadpole larva 10 mm

Animal physiology

Human blood smear preparation	10 hrs
Estimation of excretory products of animals	5 hrs
Analysis of digestive enzymes in cockroach	5 hrs
Estimation of oxygen consumption in an aquatic animal	5 hrs
Estimation of hemoglobin	5 hrs
Enumeration of RBC by hemocytometer	5 hrs

Total hours : 45

Course Outcomes:

1. Maintain accurate records of laboratory experiments.
2. Know the different stages of developmental of frog
3. Describe the variations in different stages of metamorphosis of frog
4. Able to estimate the hemoglobin count and RBC count in man
5. Develop skills to carry experiment in physiology

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	H	M	M	H	M	L	H	M	H	H
CO 2	H	H	M	H	H	M	H	H	H	H
CO 3	H	M	M	M	L	L	H	H	L	H
CO 4	H	M	H	H	M	M	H	H	M	H
CO 5	H	M	M	H	H	M	H	H	H	H

Ornamental fish culture (Generic Elective Course)

Semester V **Hours of instruction/week: 2**

21BZOO01 **No. of credits: 2**

Objectives:

1. To demonstrate to design, construct and maintain home aquaria.
2. To provide self-employment
3. To educate the students on the importance and relevance of recreational fisheries in the society

Unit 1. **Fresh water aquarium** 6 hrs

Introduction, definition, origin, history of aquarium, types of aquarium, nature of aquaria, space and setting of aquarium tank.

Unit 2. **Taxonomy and biology of some popular ornamental fishes** 6 hrs

Live bearers (ovoviviparous),red swordtail, platy, guppy and molly.

Egg layer (oviparous), gold fish, siamese fighting fish, gourami, angel fish, koi carp, oscar and neon tetra. Breeding and spawning of live bearers and egg layers.

Unit 3. **Accessories used in aquarium tank and its maintenance** 6 hrs

Accessories used in aquarium tank (aerator, filters, nets, gravel, ornamental objects). Maintenance of water quality, (temperature, ammonia, pH, O_2 / CO_2) control of snail and algal growth.

Unit 4. **Nutritional requirements of ornamental fish** 6 hrs

Different kinds of feeds- Live feed, culture of live feed organisms, infusoria, chironomous, tubifex, rotifers cladocerans and brine shrimp.Artificial feed, feed formulations, uses of natural and synthetic feed additives, balanced diet.

Unit 5. **Marine ornamental fishes and diseases** 6 hrs

Important marine ornamental fishes, purchase and transport of ornamental fishes, other ornamental organisms.

Common diseases- protozoan, fungal, bacterial and nutritional diseases, their diagnosis and treatment.

Total hours : 30

Course Outcomes:

1. Construct a fish aquarium
2. Identify the aquarium fishes suitable for home aquarium
3. Understand the culture and breeding techniques of aquarium fishes
4. Understand the various types of fish feed and feed formulation
5. Know various fish diseases, diagnosis and treatment

Text Books:

1. Jagtap, H.S., Mukherjee, S.N. and Garad, V.K., (2009). A Text Book of Pisiculture and Aquarium Keeping, Daya Publishing House, New Delhi.
2. AmitaSaxena (2003). Aquarium management. Daya publishing House, New Delhi.
3. Pandey and Shukla (2005). Fish and Fisheries, 1st edition,Rastogi Publication.

Reference Books:

1. Venkataramani, V.K., (2004), Biodiversity and Stock Assessment of Marine Ornamental Fishes, Department of Fisheries Biology and Capture Fisheries, Fisheries College and Research Institute, TNAUVAS, Tuticorin.
2. S.C.Agarwal (2007). A handbook of fish farming. Narendra pub. House, Second edition, New Delhi.
3. Srivastava.B.B.L. (1999) A Text book of fishery science and Indian Fisheries, Allahabad.

Avinashilingam Institute for Home Science and Higher Education for Women
(Deemed to be University under Category A by MHRD, Estd. u/s 3 of UGC Act 1956)
Re - accredited with A^{++} Grade by NAAC. Recognised by UGC Under Section 12B
Coimbatore – 641043, Tamil Nadu, India
Department of Zoology
M.Sc., Zoology

Programme Outcomes:

1. Acquire in-depth knowledge in science, gain technical and experimental skills in Zoology
2. Ability to express complex ideas in projects and research by enhancing the communicative skills
3. Enhance critical thinking by utilizing existing infrastructure to identify the problem and to discover solutions.
4. Building inquisitive skills to combat problems faced in the field of zoology by potential solutions
5. Impart team work skills to achieve shared goals in an effective manner
6. Capacity to identify resources required for a project and execute the project to completion by appropriate rules and regulations
7. Successful cope up with modern scientific trends through digital literacy to handle biological data.
8. Strengthen the ethical values to develop personal, professional and research ethics.
9. Imbibe a self-paced and self-directed learning ability to carry out independent research.
10. Identify the individual's entrepreneurial skills in life sciences.

Programme Specific Outcomes:

1. Understand the fundamentals and application oriented knowledge in zoology.
2. Create graduates in the fields of zoological sciences to develop innovative products for societal approaches.
3. Expand entrepreneurial opportunities in zoological sciences and train students to clear competitive exams at national level.

Scheme of instruction and examinations
(For students admitted from 2023 onwards)

Part	*Subject Code*	*Name of paper/component*	*Hours of instruction/week*		*Scheme of examination*				
			Theory	*Practical*	*Duration of exam*	*CIA*	*CE*	*Total*	*Credit*
First Semester									
I	23MZOC01	Functional Morphology of Invertebrates	5	-	3	40	60	100	4
	23MZOC02	Functional Morphology of Vertebrates	5	-	3	40	60	100	4

	23MZOC03	Cell and Molecular Biology	5	-	3	40	60	100	4
	23MZOC04	Genetics	5	-	3	40	60	100	4
	23MZOC05	Practicals I – Invertebrates and Vertebrates	-	3	3	40	60	100	4
	23MZOC06	Practicals II – Cell and Molecular Biology and Genetics	-	5	3	40	60	100	4
II	23MXCSS1/ 23MXAED1/ 23MXCSR1	**CSS/ Adult Education / Community Engagement and Social Responsibility**	2	-	-	-	-	-	-
	Second Semester								
I	23MZOC07	Biochemistry	4	-	3	40	60	100	4
	23MZOC08	Animal Physiology and Endocrinology	5	-	3	40	60	100	4
	23MZOC09	Developmental Zoology	5	-	3	40	60	100	4
	23MZOC10	Bioinformatics	4	-	3	40	60	100	4
	23MZOC11	Practicals III –Biochemistry, Animal Physiology, Endocrinology, Developmental Biology and Bioinformatics	-	5	5	40	60	100	4
	23MZOC12	Mini Project	-	1	-	100	-	100	2
		Interdisciplinary Course	4	-	3	40	60	100	4
II	23MXCSS1/ 23MXAED1/ 23MXCSR1	**CSS/ Adult Education / Community Engagement and Social Responsibility**	2	-	-	-	-	100	2
		Professional Certification course	-	-	-	-	-	-	2
Internship during summer vacation for one month									
Third Semester									
I	23MZOC13	Environmental Biology and Toxicology (Open Book)	4	-	3	100	-	100	4
	23MZOC14	Microbiology	4	-	3	40	60	100	4
	23MZOC15	Immunology	4	-	3	40	60	100	4
	23MZOC16	Biotechnology	4	-	3	40	60	100	4
	23MZOC17	Evolution	4	-	3	40	60	100	4
	23MZOC18	Practicals IV –Microbiology, Immunology and Biotechnology	-	3	5	40	60	100	4
	23MZOC19	Economic Zoology (Self Study)	1	-	3	40	60	100	4
		Multidisciplinary Course	2	-	-	100	-	100	2
II	23MZOC20	Internship	-	-	-	100	-	100	2

Fourth Semester									
I	23MZOC21	Biostatistics and Thesis Writing	4	-	3	40	60	100	4
	23MZOC22	Research Project	-	26	-	100	100	200	8

Total credits –98

Other course to be undergone by the students

MOOC course - 2 to 4 credits

Minimum 98 + 2 credits to earn the degree

Other courses offered by the department

Interdisciplinary Course - 23MZOI01 – Entrepreneurial Avenues in Zoology

Multidisciplinary Course -23MZOM01 – Conservation of Fauna

Professional Certification Course - 23MZOPC1- Conservation Biology

Functional Morphology of Invertebrates

Semester I — Hours of Instruction / week: 5
23MZOC01 — No. of credits: 5

Course Objectives:

1. To make students to understand
2. The systems of classification and morphology of invertebrates
3. The symmetry and coelom of the invertebrates and their significance

Unit 1.	**General principles of Animal Taxonomy** Definition of taxonomy, Biological classification (artificial, natural and phylogenetic)–Nomenclature-Rules of Binomial nomenclature- Hierarchy of categories-Systematics-Numerical taxonomy- New trends in taxonomy-Species concept-Typological, Nominalistic and Biological species concept-Ecospecies, Coenospecies and super species-Grade of organization - *Symmetry-Coelom-Metamerism.	20hrs
Unit 2.	**Locomotion and feeding** Locomotion by Pseudopodia, Flagella, Cilia, Undulation, Buoyancy -Hydrostatic movement in hydra and star fish. * Feeding: Patterns of feeding-Filter feeding in Polychaetes, Molluscs and Echinoderms, Deposit Feeding, Ram Feeding.	15 hrs
Unit 3.	**Respiration and circulation** Organs of respiration: Gills (Crustacea), lungs (Pila), and trachea (Insecta)– respiratory pigments - Mechanism of respiration;Circulation – Cyclosis (Paramecium), Diffusion (Sponge) *Open circulatory system (Cockroach) and closed circulatory system (Neries).	10 hrs
Unit 4.	**Nervous system and sense organs** Primitive nervous system in Coelenterata and Echinodermata; Advanced nervous system in Annelida, Arthropoda (Crustacea and Insecta) and Molluca (Cephalopoda)- Trends in neural evolution. *****Sense organs: Simple and Compound eye, statocyst and osphradium, nuchal organs, tactile and olfactory receptors	15 hrs
Unit 5.	**Excretion and Reproduction** Organs of excretion - coelom, coelomoducts, nephridia, green glands and Malphigian tubules - Mechanisms of excretion and Osmoregulation. Reproduction: Asexual (Paramecium), Alternation of generation (Obelia), sexual (Fasciola and Nereis). *****Larval forms of free living invertebrates and parasites-Strategies and evolution significance of larval forms.	15 hrs

***Self study** **Total Hours: 75**

Text Books:

1. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.

3. Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W; Spicer, J. I. (2002). The Invertebrates: a Synthesis, Blackwell Publishing
4. Ekambaranatha Ayyar.(2002) Manual of Zoology, Vol (I).Invertebrates, S.Viswanathan Printers and Publishers Pvt. Ltd., Chennai.
5. Jordan E L.(2010).Text book of Invertrabrate Zoology. S Chand and Company Ltd,New Delhi.
6. Kotpal RL.(2014). Modern Text Book of Zoology, Invertebrates (9th Edition) Rastogi Publications, Meerut.

Reference Books:

1. Barnes RSK, Calow P, Olive PJW, Golding DW, Spicer JI.(2002). The Invertebrates: A New Synthesis. 3rd Edition. Blackwell Science, USA.
2. Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.
3. Eisenhour, David, Allan Larson, Susan Keen, Larry Roberts, Cleveland Hickman Jr. 2014. Animal Diversity. Boston: McGraw-Hill International.
4. Ruppert, Fox and Barness. (2015).Invertebrate Zoology: A Functional Evolutionary Approach, 7 th Edition, Cengage India.
5. Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.

Course Outcomes:

1. Able to understand the fundamental principles of systematics.
2. Compare and understand the specific characteristics within each phyla.
3. Understand and communicate the major evolutionary significance in invertebrates.
4. Elucidate the functional significance of associated morphologies and behaviour.
5. Explicate economic importance of invertebrates.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	L	H	H	L	H	L	H	H	H
CO 2	H	H	H	H	L	H	H	H	L	M	H	H	H
CO 3	H	H	H	H	H	M	H	L	H	H	H	M	H
CO 4	H	H	H	H	M	H	H	L	L	L	H	H	H
CO 5	H	H	H	H	L	L	H	M	L	H	H	H	H

Functional Morphology of Vertebrates

Semester I — Hours of instruction / week: 5

23MZOC02 — No of credits: 4

Course Objectives:

1. To know the principles of vertebrate classification
2. To understand the evolution of organ systems
3. To understand the distinctive characteristics of major vertebrate groups,

Unit 1. **Outline classification of Vertebrates upto orders with examples** — 10hrs

Taxonomy- Principles of Taxonomy*Super class Pisces and super class Tetrapoda - Comparative anatomy of Vertebrates

Unit 2. **Vertebrate integument and its derivatives** — 15 hrs

General structure and functions of skin and *its derivatives - Glands, Scales, Horns, Claws, nails, hoofs, feathers and hairs, Economic importance of vertebrates

Unit 3. **Circulatory and Respiratory systems in Vertebrates** — 20 hrs

Composition and functions of blood, lymph, coagulation, cardiac cycle and its regulation in Vertebrates – Evolution of heart and aortic arches and portal systems *Respiration – Internal and external respiration, Respiratory organs and Types of respiration, accessory respiratory organs – Gill, Cutaneous, Buccal, Pulmonary and Diaphragmatic.

Unit 4. **Nervous system** — 15 hrs

Comparative anatomy of the brain in relation to its functions; Nerves– cranial and peripheral nerves - *Autonomous nervous system,neuromuscular junction in vertebrates

Unit 5. **Urinogenital system in Vertebrate** — 15hrs

Types and Functions of Kidneys- Pro, Meso and Meta nephric kidneys

Reproductive system, *Male and Female Gonads and Gono ducts - accessory reproductive glands, parental care of vertebrates

***Self Study**

Total Hours: 75

Text Books:

1. Kotpal RL. (2005).Modern text book of Zoology- Vertebrates, Rastogi publications, Meerut.
2. David Randall and Kathleen French (2001). Eckert Animal Physiology. W.H.Freeman & Co Ltd; 5th Edition
3. EkambaranathaAyyar. (2005). Manual of Zoology, Vol. II, Vertebrates, S.Viswanathan (Printers and Publishers) Pvt. Ltd., Chennai
4. Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition), McGraw-Hill.
5. Kotpal, R.L. 2015. Modern Text Book of Zoology – Vertebrates. Meerut: Rastogi Publications

Reference books:

1. Kingsley JS. (2010). Text book of vertebrate Zoology, New York, H.Holt.
2. Kim B, Susan B, Jason Y , Heddwen B (2019). Ganong's Review of Medical Physiology, McGraw-Hill Education / Medical; 26th edition
3. Kotpal RL. (2020 – 21). Modern Text Book of Zoology, Vertebrates (5^{th} Edition) Rastogi Publications, Meerut,
4. Liem, Karel F., William E. Bemis, Warren F. Walker, Lance Grande**,** 2001. Functional Anatomy of the Vertebrates: An Evolutionary Perspective. Brooks Cole; 784 pages
5. Kotpal, R.L. 2017. A Text Book of Animal Diversity. Meerut: Rastogi Publications.

Course Outcomes:

1. Understand the unique features, taxonomy and functional morphology of different classes of vertebrates.
2. Explore the role of integument and its derivatives in major vertebrates groups.
3. Knowledge of evolution of heart and lungs of vertebrates.
4. Compare the anatomy of vertebrate nervous system in perception to phylogenetic evolution.
5. Explore the structure and function of specific organization of vertebrates.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	M	H	H	H	M	H	H	H	H	H
CO 2	H	M	H	M	H	H	H	M	H	H	H	H	H
CO 3	H	M	H	M	H	H	H	M	H	L	H	M	H
CO 4	H	L	L	L	H	H	H	M	H	L	H	H	H
CO 5	H	M	H	M	H	H	H	M	H	H	H	H	H

Cell and Molecular Biology

Semester I | Hours of Instruction/week : 5
23MZOC03 | No. of credits : 5

Course Objectives:

1. To understand structural and functional components of the cell
2. To elucidate molecular mechanism of cell functioning
3. To Illustrate process of proteins synthesis and regulation of gene expression

Unit 1. **Membrane structure and cell signalling** — 15 hrs

Structure of model membrane- lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Cell surface receptors- signaling through G-protein coupled receptors, signal transduction pathways, second messengers and regulation of signaling pathways.

Unit 2. **Cell division and structural organization** — 15 hrs

Strategies of cell division- Mitosis and meiosis, central cell cycle control system- cell cycle check points- cyclin and cyclin dependent kinases –control of cell cycle.

Structural organization and function of intracellular organelles-Nucleus, mitochondria, Golgi bodies, endoplasmic reticulum, Protein sorting & targeting. cytoskeleton and its role.

Unit 3. **Cancer cells and DNA replication, repair and recombination** — 15 hrs

Cancer and the cell cycle- interaction of cancer cells with normal cells, apoptosis and therapeutic interventions of uncontrolled cell growth.

Replication- enzymes involved, replication origin and replication fork, fidelity of replication, extra chromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.

Unit 4. **RNA synthesis and processing** — 15 hrs

Transcription factors and machinery- formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, poly adenylation, structure and function of different types of RNA, RNA transport.

Unit 5. **Regulation of gene expression** — 15 hrs

Regulation of gene expression in prokaryotes – Operon model in prokaryotes – Lac operon hypothesis – types of control of Operons, *Regulation of gene expression in Eukaryotes-Genomic level-Transcription level-Processing of RNA transcript-Transport of RNA out of nucleus-Translation of mRNA. Post-translational modification of proteins.

*** Self study**

Total Hours: 75

Text Books:

1. Petter JR (2016). Genetics- A Molecular Approach, Third edition, Pearson Education, New Delhi.
2. Channarayappa. (2010). Cell biology, First edition, Orient Black Swan/ University Press, New Delhi.
3. Janet I, Wallace M. Karp.(2018). Cell and Molecular Biology-Concepts and Experiments, Eighth Edn. John Wiley & sons Inc., USA.

Reference Books:

1. David C, Nanette P, Michelle M (2019). Molecular Biology, Third Edn, Academic cell, Elsevier.
2. Veer Bala Rastogi (2007). Molecular Biology, Kedarnath Ram Nath publishers, Meerut (UP),India.
3. Ajoy Paul (2009).Text book of Cell and Molecular Biology, Second Edn, Books and Allied (P) Ltd, Kolkata, India.
4. Veer Bala Rastogi (2010). Introduction to cytology, revised edition, Kedarnath Ram Nath publishers, Meerut (UP), India.
5. Verma PS, Agarwal VK.. (2006). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Ltd., New Delhi.
6. Cooper GM. (2007).The cell – A molecular approach, Second Edn, ASM press, The American Society for Microbiology, USA.

Course Outcomes:

1. Able to describe transport across cell, cell-cell communication and mechanisms of signal transduction.
2. Outline the processes that control eukaryotic cell cycle.
3. Conceptualize and describe vesicular trafficking of secretory proteins and cell secretions.
4. Represent and illustrate the structural organization of genes and the control of gene expression.
5. Understand and apply general concepts of cell and molecular biology to relevant, specific problems.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	M	L	M	H	H	H	M	H	M	H
CO 2	H	M	H	M	L	M	H	H	H	M	H	M	H
CO 3	H	M	H	H	M	M	H	H	H	H	H	L	H
CO 4	M	M	H	M	M	M	H	H	H	M	H	H	H
CO 5	M	M	H	M	L	M	H	H	H	H	H	H	H

Genetics

Semester I — Hours of Instruction/week : 5
23MZOC04 — No. of credits : 4

Course Objectives:

To facilitate the students

1. To understand the basic principles of Genetics
2. To know about the applied aspects of Genetics
3. To learn and apply concepts of modern transmission and molecular genetics

Unit 1.	**Mendelianprinciples** : Dominance, segregation, independent assortment*Mendelian traits in man. **ModificationsofMendelianprinciples** :Codominance, incomplete dominance, gene interactions, pleiotropy, Complemetary, Supplementary, Epistatic, Lethal and cumulative genes- genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.	20 hrs
Unit 2.	**Concept of gene** :Allele, multiple alleles, ABO blood group and Rh factor, isoalleleandpseudoallele, **Gene mapping methods**: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. **Organelle inheritance**: Extra nuclear inheritance – Shell coiling in snails, inheritance of kappa particles in Paramecium, Sigma particles in Drosophila. Extra chromosomal inheritance : Inheritance of Mitochondrial and chloroplast genes, maternal inheritance*	20 hrs
Unit 3.	**Sex determination**and**Human Genetics** Genetic, hormonal, metabolic and environmentally controlled sex determining mechanism Human chromosomes- Classification and Identification – Lyons hypothesis – Barr body and heterochromatin- Autosomal and sex chromosomal abnormalities in man – Amniocentesis- Chromosomal aberrations - Pedigree charts – lod score for linkage testing, Eugenics and genetic counselling - Human genome project*	15 hrs
Unit 4.	**Population and Applied Genetics** Gene pool and gene frequencies – equilibrium of gene frequencies – Hardy- Weinberg equilibrium – Rate of changes in gene frequencies through natural selection Animal Breeding – History, Aims, Methods – Inbreeding, Outbreeding and hybrid vigour*	10 hrs
Unit 5.	**Regulation of gene expression and Microbial Genetics** Concept of operon of bacteria and bacteriophages.Utility of the model organisms: *Escherichia coli, Arabidopsis thaliana, Caenorhabditiselegans, Drosophila melanogaster* &*Musmusculus.* **Methods of genetic transfers**- Transformation - Transductionandsexduction, - Specialized and generalized- Conjugation –F^+ X F^- mating, HFr conjugation, F^1 conjugation, Transposons-Discovery, Characteristics, types of transposable elements - Ac and Dc elements, Retrotransposans, IS Elements*. ***Self Study**	10 hrs

Total Hours: 75

Text books

1. StrickbergerMW. (2012).Genetics (Macmillam). Prentice Hall of India Pvt Ltd. New Delhi.
2. Verma PS. Agarwal VK. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand Company, 2nd edition, New Delhi.

References

1. Gardner EJ. Simmons MJ. Snustad DP. Principles of Genetics. VIII Edition. Wiley India 2008.
2. Snustad DP. Simmons MJ. Principles of Genetics. V Edition. John Wiley and Sons Inc 2009.
3. Klug WS. Cummings MR. Spencer CA.Concepts of Genetics. X Edition. Benjamin Cummings 2012.
4. Russell PJ. Genetics- A Molecular Approach.III Edition. Benjamin Cummings 2009.
5. Griffiths AJF. WesslerSR.Lewontin RC. Carroll SB. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co 2007.
6. Fletcher H. Hickey I. Genetics. IV Edition. GS, Taylor and Francis Group, New York and London 2015.

Course Outcomes:

1. Comprehensive, detailed understanding of the chemical basis of heredity
2. Understand and describe the mechanisms that underpin biological inheritance
3. Acquire the knowledgetodesign, execute, and analyze the results of genetic experimentation in animal, plant model systems and human being.
4. Understanding of how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc.
5. Construct relevant, targeted and comprehensive personal and family histories and pedigrees and integrate genetic testing options in genetic counselling practice

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3
CO 1	H	H	L	M	L	-	H	M	H	-	H	H	H
CO 2	H	H	H	H	M	H	H	H	H	M	H	H	H
CO 3	H	H	H	H	H	H	H	H	H	H	H	H	H
CO 4	H	H	H	H	H	H	H	H	H	H	H	H	H
CO 5	H	H	H	H	H	H	H	H	H	H	H	H	H

Practicals I-Invertebrates and Vertebrates

Semester I — Hours of instruction / week: 3

23MZOC05 — No of credits: 3

Course Objectives:

1. To learn computer aided Simulated animal dissection
2. To study the representative organisms of each phylum of both invertebrates and vertebrates
3. To observe the birds and other animals from their natural habitats through field visits

Invertebrate Simulated animal dissections available on invertebrates 3 Hrs

Five representative organisms for each phylum 8 Hrs

I. Amoeba, Paramecium, Plasmodium, Euglena and Balantidium
II. Leucosolenia, Hyalonema, Euplectela, Spicules and Gemmule of Sponge
III. Hydra, Obelia colony and medusa, Sea anemone, Madrepora and Tubipora
IV. Fasciola, Planaria, *Taeniasolium*Bipalium and Ascaris,
V. Neries, Chaetopterus, Megascolex, Arenicola and Polygordius
VI. Daphnia, Cyclops, Naupilus, Centipede and Peripatus
VII. Fresh water mussel, Mytilus, Octopus, Sepia and Pila
VIII. Starfish, Sea urchin,Cucumaria,Thyone and Ophiothrix

T.S. of sponge – T.S. of Hydra 3 Hrs

T.S. of liver fluke – T.S. of Nereis larval forms 3 Hrs

Vertebrates Simulated animal dissections of shark and frog 6 Hrs

Five representative organisms for each Phylum 8 hrs

I. Amphioxus, Suckerfish, Mullet, Mugil and Arius
II. Cacapus, Ranahexadactyla, Icthyophis, Alytes and Rhacophorus
III. Calotes, Chameleon, Draco, Viper and Cobra
IV. Pigeon, Woodpecker,Crane,Partridge and King fisher
V. Bat, Loris, Pig embryo, Rabbit embryo and Sheep embryo
VI. Mounting the slides of Planktons and Paramecium
VII. Praparation of 5 permanent slides practical work done during the semester at the time of practical examination

Field Visit 14 Hrs

Visit to zoos andnational park
Visit to Salim Ali centre for ornithology
Visit to Sanctuaries

The candidate should submit a certified bonafide record of practical work done during the semester at the time of practical examination

Total Hours: 45

Course Outcomes:

1. Introducing the structure, function and behaviour of select invertebrate types through the observation of simulated animal dissections.
2. Reinforcing basic laboratory skills including microscopy, simulated animal dissection and careful observation
3. Providing with the ability to recognize the major groups of invertebrate
4. Record the fauna of different phylum and families through the visit to Gass Museum
5. Study the keys for the identification of bird watching through the visits to Salim Ali centre for ornithology and Silent valley

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	H	H	M	H	M	H	H	H	H	H
CO 2	H	H	H	H	H	L	H	M	H	H	H	H	H
CO 3	H	H	M	H	H	L	H	M	H	H	H	H	H
CO 4	H	H	H	H	H	M	M	H	M	M	H	H	H
CO 5	H	H	H	H	H	M	M	H	M	M	H	H	H

Practicals II-Cell and Molecular Biology and Genetics

Semester I — Hours of Instruction/week : 5
23MZOC06 — No. of credits : 3

Course Objectives:

1. To acquire skills in squash preparation, permanent slides and staining.
2. To develop practical skills in the advanced techniques of Molecular Biology
3. To enable the use of model organisms in understanding the genetic principles.

Cell Biology	Slides on tissues – Epithelial, connective, bone, muscular and germ cells	5 hrs
	Preparation of Squamous epithelial cells	3 hrs
	Cell size determination using micrometer	3 hrs
	Squash preparation of onion root tip and observation of mitotic stages	3 hrs
	Meiosis in cockroach testis	3 hrs
	Study of giant chromosomes in Chironomous larva and micrometric measurements of Puffs	3 hrs
	Separation of lymphocytes using histopaque	5 hrs
	Haemolysis	3 hrs
	Histology: Fixation, dehydration, embedding, sectioning, staining and permanent mounting of tissues - Submission of 5 best slides for Exam evaluation	16 hrs
Molecular Biology	Isolation and estimation of DNA from onion	5 hrs
	Isolation of plasmid DNA from bacteria	5 hrs
	Restriction endonuclease digestion of DNA	5 hrs
	PAGE - separation and molecular weight determination of proteins.	5 hrs
Genetics	Culture of Drosophila and *Caenorhabditiselegans* –model organism	5 hrs
	Identification of phenotypic traits in Drosophila	3 hrs
	Study of various genetic traits in man	3 hrs

The candidate should submit a certified bonafide record of practical work done during the semester at the time of practical examination

Total Hours: 75

Course Outcomes:

1. Understand transport across cell, cell-cell communication and mechanisms of signal transduction.
2. Outline the processes that control eukaryotic cell cycle.
3. Conceptualize and describe vesicular trafficking of secretory proteins and cell secretions.
4. Represent and illustrate the structural organization of genes and the control of gene expression
5. Understand and apply general concepts of cell and molecular biology to relevant, specific problems

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	M	H	M	M	H	L	H	M	M	L	H	H	H
CO 2	M	H	M	H	H	M	H	M	H	L	H	H	H
CO 3	M	H	H	M	H	L	H	M	H	L	H	H	H
CO 4	M	H	M	H	H	M	H	M	H	L	H	H	H
CO 5	M	H	H	M	H	H	H	M	M	L	H	H	H

Biochemistry

Semester II | Hours of instruction / week: 4

23MZOC07 | No of credits: 5

Course Objectives:

1. To understand the chemical basis of life.
2. To study the structure, metabolism and biological significance of biomolecules
3. To enable students to understand the basic principles, working mechanism and applications of biochemical techniques

Unit 1. **Principles of biophysical chemistry** 8 Hrs

Bioenergetics – Concept of free energy, endergonic and exergonic reactions, Relationship between free energy, enthalpy and entropy, laws of thermodynamics, Redox potential, High energy compounds, biological significance of ATP and cyclic AMP*

Biological Oxidation – Enzymes involved in biological oxidation, Electron transport chain - Components and structural organisation of electron transport, Oxidative phosphorylation- Chemiosmotic hypothesis, Uncoupling of oxidative phosphorylation, mitochondrial transport systems - malate/glycerol phosphate shuttle.

Unit 2. **Carbohydrates and Lipids** 12Hrs

Carbohydrates – Classification, structure and functions - Monosaccharides, Disaccharides, Polysaccharides - Homo and hetero polysaccharides.

Metabolism – Glycolysis, TCA cycle, HMP shunt, glycogenesis, glycogenolysis, gluconeogenesis

Lipids - Classification, structure and functions of fatty acids, triacylglycerols, phospholipids, glycolipids, lipoproteins and steroids.

Metabolism - Biosynthesis of fatty acids, β oxidation of fatty acids, ketogenesis*

Unit 3. **Amino acids, Proteins and Enzymes** 12Hrs

Amino acids - Structure, classification and properties

Metabolism - Transamination, deamination and decarboxylation, urea cycle, inborn errors of metabolism.

Proteins - Classification, levels of protein structure, bonds related to protein structure - Conformation of proteins by Ramachandran plot, domains, motif and folds*

Enzymes – Characteristics, Structure, Nomenclature, Classification, Active site, Mechanism of enzyme action, Factors affecting enzyme action, Enzyme inhibition.

Unit 4. **Biochemical techniques I** 15Hrs

Electrochemical techniques – Determination of pH by hydrogen electrode and glass electrode, Buffer systems of body fluids and pH maintenance*

Centrifugation – Principle, types and applications of preparative and analytical ultracentrifuges

Chromatography – Principle, methodology and applications of thin layer, adsorption and gas liquid chromatography

Unit 5. **Biochemical techniques II** 13 Hrs

Spectroscopy – Principle, Beer and Lamberts law, types of spectra – absorbance, emission and fluorescence, Types of spectroscopy – Principle, instrumentation and applications of UV-visible spectroscopy, atomic absorption spectroscopy* Electrophoresis – Principles, methodology and applications of agarose gel electrophoresis and poly acrylamide gel electrophoresis

***Self-Study**

Total Hours: 60

Text Books:

1. Rodwell V.W., Bender D.A., Botham K.M., Kennelly P.J.,Weil P (2018). Harper's Illustrated Biochemistry, 31st edition. Tata McGraw Hill Companies Publication, New Delhi.
2. Nelson, D.L. and Cox, M.M. (2021). Lehninger Principles of Biochemistry, Eighth edition, W.H. Freeman and Company, New York.
3. Berg, J.M., Tymoczko, J.L., Gatto, G.J. and Stryer, L. (2021) Biochemistry, Eighth edition, W.H. Freeman and Company, New York.
4. Satyanarayana, U. and Chakrapani, U. (2013). Biochemistry, Seventh Edition, Books and Allied Pvt. Ltd., Kolkatta and Elsevier, New Delhi.
5. Wilson K and Walker J. (2018) Practical Biochemistry – Principles and Techniques, Eighth Edition, Cambridge University Press, India

Reference Books:

1. Berg JM, Tymoczko JL, Stryer L. (2012), Biochemistry, Seventh Edition, W.H. Freeman & Company, New York.
2. Voet, D., Voet, D.J. and Pratt, C.W. (2013). Fundamentals of Biochemistry – Life at molecular level, Fourth edition, John Wiley and Sons Inc., New York.
3. Rodney Boyer (2006). Concepts in Biochemistry, Third Edition, John Wiley and Sons Inc., United States
4. Zubay, G. (2017), Biochemistry, 4th edition, McGraw-Hill Publication, New Delhi.

Course Outcomes:

1. Impart knowledge on the biochemical concepts of bioenergetics
2. Gain perception on the basic structure and functions of biomolecules
3. Ability to grasp insight on metabolic pathway and able to relate with well being
4. Understand fundamental concepts on enzymes and their importance in biological reactions
5. Acquire information on the principles and practical experience of a wide range of biochemical techniques.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L	L	L	L	L	H	L	L	L	H	M	H
CO 2	H	M	H	M	M	H	H	H	H	H	H	M	H
CO 3	H	M	H	M	M	H	H	H	H	H	H	H	H
CO 4	H	H	H	M	H	H	H	H	H	H	H	H	H
CO 5	H	H	H	M	H	H	H	H	H	H	H	H	H

Animal Physiology and Endocrinology

Semester II — Hours of Instruction/week : 5
23MZOC08 — No. of credits : 5

Course Objectives:

1. To enable the students to understand the functions of various systems of animal body with special reference to mammals
2. Know about the role of various hormones in coordination of activities of biological systems in animals.
3. To understand and evaluate biological processes, behavioural states and animal response to different biological, social and environmental stimuli**.**

Unit 1. **Digestive system, Circulatory and Excretory system** — 15hrs

Digestive glands in a mammal –Digestion*,BMR, Blood and Lymph composition, plasma proteins, coagulation and erythropoiesis, blood volume regulation - Heart – myogenic heart, origin and conduction of cardiac impulse- ECG – Endocytosis and exocytosis in excretion -Ultra structure of Nephron – formation and concentration of urine, micturition, Electrolyte and acid base balanc

Unit 2. **Respiratory, Nervous system and Sense organ** — 20hrs

Respiratory pigments-Blood gas transport-Respiratory quotient – Regulation of respiration. Structure and functions of Nervous tissue-Reflex action- Conduction of nerve impulse- Autonomic nervous system, Morphology and physiology of sense organs –vision, hearing, gustation, olfaction and tactile*-

Unit 3. **Skeletal and Muscular system,Communication and Animal behaviour** — 10hrs

Anatomy and physiology of axial and appendicular skeleton- Properties and mechanism of contraction of muscles -Biochemistry of muscles - Neuro muscular junction

Bioluminescence-Pheromones -Biological rhythm-Circadian and Circannual rhythm-Orientation and navigation*

Unit 4. **Endocrine glands** — 15hrs

Structure and functions of endocrine glands in Mammals – Pituitary – hypothalamus-Thyroid-Parathyroid–Pancreas-Adrenal and Prostaglandins* Thermo regulation – comfort zone, body temperature, physical, chemical and neural regulation, acclimatization

Unit 5. **Hormonal Control** — 15hrs

Ovarian cycle, Menstrual cycle and Physiology of pregnancy, Hormonal regulation of male and female reproduction, Hormonal control of Gastric metabolism Neuroendocrine systems in Crustacea and Insecta - Hormone Analogue and its applications*- Genetic disorders due to hormonal imbalance

***Self study**

Total Hours: 75

Text books

1. Rastogi SC. (2007).Essentials of Animal Physiology, New Age International, New Delhi, India.
2. Verma PS. Agarwal VK and Tyagi BS. (2010).Animal Physiology. S. Chand Publishers India

Reference books:

1. Christopher D. and Moyes. (2015).Principles of Animal Physiology. 3rd Edition, Pearson Publishers, U.S.
2. Arora MP. (2017).Animal Physiology. 7th Edition. Himalaya Publishing House, India.
3. Hadley. (2009).Endocrinology. George Bell Publishers, England .
4. Dharmalingam.(2010).Textbook of Endocrinology. Jaypee Medical PU, New Delhi, India.
5. Sherwood L. Klandorf H. and Yancey PH. (2008).Text Book of Animal Physiology. Cengage Learning India Pvt., Ltd.
6. HillR W. Wyse GA. and Anderson M. (2008).Animal Physiology. 2nd Ed., Sinauer Associates, Inc Publisher, Massachusetts.
7. Moyes CD. and Schulte PM. (2007). Principles of Animal Physiology. Pearson Education, Dorling Kindersley Publication. New Delhi.
8. Guyton AC. (2007).Textbook of Medical Physiology. W.B. Saunders Company, Philadelphia, London, Toronto and IgakuShoin/Saunders (Tokyo).

Course Outcomes:

1 Understand the physiological systems and their specific functions

2 Gain knowledge on the interactions and interdependence of physiological and biochemical processes

3 Be able to know the transfer of information from one group of animals to other using signals

4 Learn generously the life supporting properties and regulation of biological processes in the body from conception through adulthood by the endocrine glands.

5 Understanding of factors influencing the adaptations and responses of organisms to particular environment.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	H	H	H	H	H	H	H	H	H	H
CO 2	H	H	H	H	H	H	H	M	H	M	H	H	H
CO 3	H	H	H	H	H	H	H	H	H	M	H	H	H
CO 4	H	H	H	H	H	H	H	H	L	L	H	H	H
CO 5	H	M	M	M	M	M	H	H	H	M	H	H	H

Developmental Zoology

Semester II — Hours of instruction / week : 5
23MZOC09 — No of credits: 4

Course Objectives:

1. To understand the basic principles of growth and development
2. To understand the general concept of ontogeny development
3. To understand the metamorphosis and assisted reproductive techniques

Unit 1	**Spermatogenesis and Oogenesis** Origin of primordial germ cells-spermatogenesis process-sertoli cells-spermatogenesis- hormonal regulations, gene expression and control-structure and biochemistry of spermatozoa.Processof Oogenesis – Development during Oogenesis*- Vitellogenesis- egg maturation – egg cortex organization of the egg	15 hrs
Unit 2	**Fertilization, cleavage and Gastrulation** Mechanism of fertilization – biochemical aspects of cleavage –molecular changes during cleavage – morphogenetic movements*- cell adhesion molecules and pattern formation. Fate Maps	15 hrs
Unit 3.	**Nucleus and cytoplasm in development** Nuclear control of development - enucleation experiments - nuclear transplantation* - cytoplasmic determinants – cytoplasmic control of nucleus during development.	15 hrs
Unit 4.	**Induction competence and differentiation** Concept of organizer –embryonic induction – types – properties, role and chemical nature of induction-concept of competence – differentiation of embryonic cells* – stem cells- concept of determination.	15 hrs
Unit 5.:	**Metamorphosis, Regeneration and Human development** Types and hormonal mechanism of metamorphosis in amphibians – regeneration process–histological changes–metaplasia–puberty –menstrual cycle –implantation – parturition –birth defects and surrogacy and ethical laws, test tube baby* *** Self study**	15 hrs

Total Hours: 75

Text Books:

1. Muneesh Kaint. (2013) Text Book of Chordate Embryology. Wisdom Press, First edition, New Delhi, India.
2. Morgan. TH. (2010). Embryology and Genetics. Agro House Behind Nasrani Cinema. Fourth edition, Jodhpur, India.
3. Veer Bala Rastogi. (2010). Chordate Embryology. KedarNath RamNath publication, New Delhi, India.

Reference Books:

1. Scott F. Gilbert, Karen Knisely.(2010.) Developmental Biology- A Student Handbook in Writing in Biology, Third Ed, Sinauer Associates Incorporated, India.
2. Lewis Wolpert (2011). Developmental Biology: A Very Short Introduction. Oxford University Press, First edition.
3. Abhilash Jain. (2010).Advanced developmental Biology. Campus Books International, first edition , New Delhi, India.

Course Outcomes:

1. Compare and contrast the developmental stages amongst the variety of animal phyla.
2. Understand the mechanism of fertilization, cleavage and gastrulation.
3. Describe the cellular control in the development of the embryo
4. Knowledge on the potential role of stem cells and its research applications
5. Understand the human menstrual cycle, implantation, parturition, birth defects and test tube baby

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	H	L	H	H	L	L	H	L	H
CO 2	H	H	H	H	M	L	H	L	L	L	H	L	H
CO 3	H	H	M	L	L	L	H	L	M	L	H	M	H
CO 4	H	H	H	H	H	H	H	H	H	L	H	H	H
CO 5	H	H	M	H	H	H	H	H	H	L	H	H	H

Bioinformatics

Semester II | Hours of Instruction/week : 4

23MZOC10 | No. of credits : 4

Course Objectives:

1. To outline fundamentals of bioinformatics principles
2. To use bioinformatics tools to compare and analyse nucleic acids and protein databases
3. To explain functional genomics and the features of model organisms

Unit 1.	**Biological databases** **Introduction to Bioinformatics**: Definition - goals – applications; Central Bioinformatics Resources and Access Information: NCBI - EMBL-EBI; **Biological databases**: Nucleotide sequence database (GenBank, EMBL-Bank, DDBJ) - Protein database (UniProtKB, PIR, PDB, InterPro, Pfam, PRINTS, SCOP and CATH) - Specialised database (OMIM, GEO, ENA, KEGG, and PubMed);Biodiversity and ecosystem based databases.**Sequence format**: GenBank format - **FASTA format***.Applications of bioinformatics: Clinical informatics, Cheminformatic resources and pharmacoinformatics.	12 hrs
Unit 2.	**Sequence analysis** **Molecular sequence alignment**: Importance – homology – similarity – identity – Gaps; **Scoring matrices**: PAM – **BLOSUM***; **Pairwise sequence Alignment methods**: DotPlot – Dynamic Programming method (Global and Local alignment) – Heuristic method (FASTA and BLAST); **Multiple sequence alignment and Phylogeny:** CLUSTALW – phylogenetic tree building.	12 hrs
Unit 3.	**Genomics** **Gene and Genome analysis**: differences between Eukaryotes, Bacteria, Archaea and viral genome - **Human Genome project*** - UCSC Genome Browser – ENCODE – Noncoding and repetitive DNA sequences - Finding genes in genome (GENCODE) – SNPs - **Next Generation Sequencing**: Overview of Techniques - Data analysis - Applications.	12 hrs
Unit 4.	**Proteomics** **Protein sequencing**: Gel electrophoresis – **MALDI-TOF***; **Protein analysis**: ExPASy tools – protein property prediction; **Protein structure prediction**: Ramachandran plot - homology modelling – Threading – *Ab Initio* prediction – structure validation – structure visualization tools; Application in Modern drug discovery process.	12 hrs
Unit 5.	**Functional genomics** **Genome expression**: SAGE - Microarray - RNA-seq; **microarray data analysis:** GOR2 – Descriptive statistics methods; Protein-Protein interaction – Yeast Two-Hybrid System – Protein Networks – Cytoscape; **Model organisms**: E. coli – *Arabidopsis thaliana* – Yeast – *Coenorhabditiselegans* – Drosophila – **Zebra fish***– Mouse	12 hrs

Total Hours: 60

***Self study**

Text Books:

1. Xiong J. (2006). Essential Bioinformatics, Cambridge University Press.
2. Attwood TK, Parry DJ.(2005). Introduction to Bioinformatics, Pearson Education Singapore Pvt. Ltd.
3. Rastogi SC, Rastogi P, Mendiratta N. (2013). Bioinformatics Methods and Applications: Genomics Proteomics and Drug Discovery, 4thEdn, PHI Learning Pvt. Ltd.

Reference Books:

1. Richard S L, Tudor I O. (2019).Bioinformatics and Drug Discovery- Methods in Molecular Biology, 3rdEdn, Springer New York.
2. Pevsner J. (2019).Bioinformatics and functional genomics, 3rdedn, Wiley India exclusive.
3. Rui R, Xuegong Z, Michael QZ. (2013).Basic bioinformatics,Springer.
4. Chandarsekar M, Ratankumar C, Mirasif I. (2018). Basic applied bioinformatics, IstEdn, John Wiley& sons.
5. Baxevanis AD, Ouellette BF. (2005).Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edn., Wiley Interscience, Hoboken, NJ.
6. Mount DW. (2004).Bioinformatics: Sequence and Genome Analysis, 2nd Edn, Cold Spring Harbor Laboratory Press, New York.
7. Campbell AM,HeyerLJ.(2004).Discovering Genomics, Proteomics& Bioinformatics.2ndEdn. Pearson Education, New Delhi.
8. Pennington SR, Dunn MJ. (2002).Proteomics: from Protein Sequence to function. BIOS Scientific Publishers, Oxford.
9. Sensen CW.(2002). Essentials of Genomics and Proteomics. Wiley-VCH.
10. Kothekar V. (2004). Introduction to Bioinformatics – An ideal book for beginners in Bioinformatics, First edition, Dhruv Publications, NewDelhi.

Course Outcomes:

1. Locate and use the main databases at the NCBI and EBI resources and know the difference between databases, tools, repositories and be able to use each one to extract specific information
2. Extract data from specific databases using accessions numbers and gene names
3. Able to perform simple genome sequence analyses using existing tools
4. Interpret correctly the outputs from tools used to analyse biological data and make meaningful predictions from these outputs.
5. Able to describe and comprehend the fundamental concepts of molecular modelling and computational driven drug discovery

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	M	L	H	M	H	H	H	L	L	H	H	H	H
CO 2	H	M	M	H	L	H	M	L	M	L	H	H	H
CO 3	M	L	H	M	M	L	H	L	L	H	H	H	H
CO 4	H	H	M	M	L	M	M	L	H	M	H	H	H
CO 5	H	M	M	H	L	H	H	L	H	L	H	H	H

Practicals III - Biochemistry, Animal Physiology, Endocrinology, Developmental Biology and Bioinformatics

Semester II — Hours of instruction / week: 5
23MZOC11 — No of credits: 3

Course Objectives:

1. Able to demonstrate an understanding of fundamental bio chemical principles
2. To understand the general concept of endocrine glands
3. To understand the application of Developmental Zoology.

I. Biological Chemistry	Estimation of protein in fish sample	3hrs
	Estimation of carbohydrates in fish sample	3hrs
	Estimation of fat in fish sample	3hrs
	Salivary amylase activity in relation to pH	3 hrs
II. Animal Physiology & Endocrinology	Hemoglobin estimation	2 hrs
	Preparation of haemin crystals	3 hrs
	Preparation of human blood smear	3hrs
	Enumeration of RBC and WBC using haemocytometer	3hrs
	Excretory products of animals	3hrs
	Effect of salinity on the metabolic rate of fish	3hrs
	Effect of thyroxine on the oxygen consumption fish	5 hrs
	Slides on histology of endocrine glands Adrenal gland Pancreas T.S Pituitary gland Thyroid gland Thymus gland Adrenal gland	3hrs
	Study of permanent histological sections of mammalianoesophagus, stomach, duodenum, rectum, lung, adrenal, kidney, thyroid, pancreas, testis, ovary.	2hrs
III. Developmental Biology	Slides on Frog Embryology T.S. of ovary Cleavage - 2 cell, 4 cell, 8 cell and 32 cell stages Blastula-Gastrula – olk plug stage, Neural plate,Neural fold, Neural tube Tadpole – 4mm, 7mm, 10mm	10 hrs
	Slides on chick embryology - Chick embryo - 18h, 24h, 36h, 48h, 72h and 96h	10 hrs
IV. Bioinformatics	1.Search engines & important sites viz., NCBI, EBI, Swiss-Prot	2 hrs
	2.Format, distinguishing features, Uses and Applications of biological databases such viz., EMBL, DDBJ, GenBank,UniProt, PIR, TrEMBL, Prosite, PRINT, Pfam, BLOCK,PDB, KEGG,OMIM,PUBMED	2 hrs
	3.Use of BLAST and its variants (especially PSI-BLAST) for the identification of very similar and divergent sequences	2 hrs
	4.Multiple sequence alignment using Clustal W and preparation of simple phylogenetic trees using Tree View	2 hrs
	5. Detection of general signals, regulatory regions and promoter prediction	2 hrs

6. Secondary structure prediction using various available tools 2 hrs

7.Tertiary structure and function prediction using homology modeling and ab initio method 2 hrs

8. Visualization of 3D protein structure –Rasmol-Swiss PDB viewer 2 hrs

The candidate should submit a certified bonafide record of practical work done during the semester at the time of practical examination

Total Hours: 75

Reference Books:

1. Christopher D, Moyes. (2015). Principles of Animal Physiology. 3rd Edition, Pearson Publishers, U.S.
2. MuneeshKainth. (2013).Text Book of Chordate Embryology. Wisdom Press. 1st Edition, New Delhi, India.
3. Lewis Wolpert. (2011).Developmental Biology: A Very Short Introduction. Oxford University Press; 1st edition.
4. David Hames and Nigel Hopper. (2010).Biochemistry Taylor and Francis Publication Pvt. Ltd.
5. Dharmalingam. (2010).Textbook of Endocrinology, Jaypee Medical PU, New Delhi, India.
6. Sathyanarayana U. (2005).Biochemistry Book & Allied (p) Ltd. Kolkata.

Course Outcomes:

1 Assess the estimation of protein, carbohydrate and fat using fundamental biochemical principles.
2 Estimation of different physiological systems and their specific functions.
3 Identify the factors influencing the responses of organisms.
4 Describe fundamental concept of molecular mechanisms of embryological stages
5 Basic concepts of Bioinformatics and its significance in biological data analysis.

O/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	M	H	H	H	M	M	L	H	H	H
CO 2	H	H	M	M	H	H	H	M	M	L	H	H	H
CO 3	H	H	M	H	H	H	H	M	L	L	H	H	H
CO 4	H	H	M	M	H	M	H	M	L	L	H	H	H
CO5	H	H	H	H	H	H	H	H	H	H	H	H	H

Environmental Biology and Toxicology
(Open book)

Semester III | Hours of Instruction / week: 4
23MZOC13 | No of credits: 4

Course objectives:

1. To understand the various factors of environment
2. To know about the strategies for disaster management
3. To learn about the implications of environment on human health and social issues
4. To have knowledge about environmental toxicants and their hazards

Unit 1	**Introduction to Environmental Studies and Biodiversity** Definition – Types of environment – Natural resources- forest, water, mineral, food and energy. **Biodiversity:** Classification – Values of biodiversity – Biodiversity at global level, Hot spots, Biogeographical classification of India, India mega biodiversity Nation- endangered and endemic species of India-Threats of biodiversity& Conservation.	12hrs
Unit 2	**Population Ecology and Human Health -** Density, natality, mortality, life tables, fecundity tables, survivorship curves. Unique and group attributes of population: mortality, age ratio, sex ratio, dispersal. Factors regulating population dispersal and growth: Exponential and logistic growth.Populationexplosion.Public health- Value education, HIV/AIDS- Human rights.	12hrs
Unit 3	**Social Issues and Disaster management** Sustainable development- Urban problem related to energy – Water management and conservation, Resettlement and rehabilitation of people, Environmental ethics, Climate change, Wasteland reclamation, Consumerism, Environmental Protection Acts. **Disaster management –** Definition, cause and mitigation measures for Flood, Earth quake, Tsunami, Cyclone and Land slide.	12hrs
Unit 4	**Environmental Toxicants and Health hazards** Survey of environmental toxicants – pesticides, automobile emissions, heavy metals, fertilizers, food additives, radioactive substances, accumulation of toxic residues in organisms — routes of entry, absorption, distribution, excretion and biotransformation of toxicants, mode of action, dose response relationship, teratogens, carcinogens, mutagens, safety evaluation of toxicants, role of LC_{50}	12hrs
Unit 5	**Case studies***: In situ* and *Ex situ* conservation of Indian animals: Population management - Project Tiger and Elephant - Captive breeding programme- Public participation in conservation – Poching of wild animals – Man animal conflict Cauvery Water dispute - Heavy metals in water and soil, Bioaccumulation of toxicants, Mining and quarring in India - Survey of food additives – Pesticides in food commodities- Fuel conservation.	12hrs

Total Hours: 60

Text Books:

1. Verma PS and Agarwal VK. (2018). Cell biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand and Company Ltd New Delhi.
2. Kapoor M. (2009).Disaster Management. MotilalBanarsidass Publishers Private Ltd New

Delhi.

3. Raman Sivakumar. (2010). Environmental Science & Engineering. Tata McGraw Hill Education Private Ltd

Reference books:

1. Primack RB. (2010). Essentials of Conservation Biology. Sinauer Associates: USA

2. Mittermeier RA, Meyers PR, Gil and. Mittermeier CG. (2000). Hotspots: Earth'sbiologically richest and most endangered Terrestrial Ecoregions. Cemex/Conservation International USA

Course outcomes:

1. Learn about the complexity of natural resources and understand the conservation strategies of biodiversity
2. Reflect critically on their roles, responsibilities and identities as citizens, consumers and environmental actors in a complex interconnected world.
3. Develop a critical understanding of the social environment and Indian constitutional provisions concerning environmental protection.
4. Demonstrate the core concept of toxicology and identify the contemporary issues in toxicology
5. Appreciate the ethical, cross-cultural and historical context of environmental issues and application of ecological and physical sciences in environmental problem solving.

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	H	H	H	L	H	H	H	M	H
CO 2	H	H	H	H	H	H	H	H	H	H	H	M	H
CO 3	M	H	H	H	H	H	H	L	H	M	H	M	H
CO 4	H	H	H	H	H	H	H	H	H	H	H	M	H
CO 5	H	H	H	H	H	H	H	H	H	H	H	H	H

Microbiology

Semester III — Hours of instruction / week: 4

23MZOC14 — No of credits: 4

Course objectives:

1. To recognize the similarities and differences between microbial groups
2. To enable the students to know the biology and pathogenesis of infectious diseases
3. To understand the role of microbes in various fields

Unit 1	**Microbial Taxonomy** History – Contributors to Microbiology, Scope of Microbiology*, Classification of microbial kingdom, Structure and outline classification of bacteria, fungi and virus	12 hrs
Unit 2	**Methods in Microbiology** Sterilization techniques - Physical and Chemical, Culture media – Types and Preparation, Methods of growing microbes, Cultivation of aerobes – Batch and continuous culture, Anaerobes- Gas Pack method, Methods of isolation and maintenance of pure culture, Identification of bacteria, Nutritional requirements for microbes, Growth curve of microbe, Factors affecting microbial growth, Measurements of microbial growth*	12 hrs
Unit 3	**Industrial Microbiology** Bioprocessing, Fermentors- Types, Functions, Design and Operation, Microbial selection, Types of Fermentation-Submerged, Solid and Surface type, **Stages in fermentation -** Upstream and Downstream Processing, Strain Improvement, Fermented products- Single Cell Protein, Wine, Citric acid*	12 hrs
Unit 4	**Environmental Microbiology** Bioremediation - Criteria for bioremediation, Bioremediation techniques, Methods for removal of pollutants (heavy metals), Biosorption – Mechanism of biosorption, Types of biosorbents, Factors affecting biosorption, Desorption and recovery, Advantages and disadvantages, Large scale industrial effluent treatment, Bioindicators*	12 hrs
Unit 5	**Medical Microbiology** Microbial Infection – Routes of infection, types of infection, types of infectious diseases, microbe – host interaction, Approaches in diagnosis Bacteria – *Staphylococcus aureus, Salmonella typhi, Mycobacterium tuberculosis, Treponema palladium* Fungus - Mycoses – Superficial –Dermatophytoses, Subcutaneous – Mycetoma, Systemic– Histoplasmosis, Opportunistic –Candidaiasis Virus – Herpes virus, Hepatitis virus, Rabies virus, Human Immuno Virus* *** Self study** **Total Hours: 60**	12 hrs

Text Books:

1. Chess B. and Talaro KP(2021).Talaro's Foundations in Microbiology, 11th Edition, Mc-Graw – Hill Publishing Company Ltd., New Delhi .
2. Willey J, Sherwood L, WoolvertonCJ, (2016). Prescott's Microbiology, 10th Edition, Mc-Graw – Hill Publishing Company Ltd., New Delhi.
3. Ananthanarayan R, Paniker CKJ (2013). Ananthanarayan and Paniker's Textbook of Microbiology, 9th Edition, University Press, Hyderabad

Reference Books:

1. Micheal J, Pelzar JR, Chan ECS, Krieg NR (2009). Microbiology, 10th Edition, Tata Mc-Graw – Hill Publishing Company Ltd., New Delhi.
2. Dubey R and Maheshwari DK (2022). A text book of Microbiology, S. Chand and Company Ltd., New Delhi.
3. Rajan R (2007).Medical Microbiology, First Edition, MJP Publishers, Chennai,.
4. Casida, J.R. (2009). Industrial Microbiology, Fifth Edition, New Age International Publishers, New York.

Course Outcomes:

1. Gain knowledge on microbial diversity and its significance
2. Apply culture techniques in clinical and research problems
3. Describe the importance of microbes in industrial sector
4. Acquaint the interaction between microbes and environment for sustainable development
5. Identify the integral role of microbes in pathogenesis and its control measures

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	M	H	H	M	M	M	M	M	H	M	H	H	H
CO 2	H	H	H	H	M	H	M	H	H	H	H	H	H
CO 3	M	H	H	M	H	H	M	H	H	H	H	H	H
CO 4	H	H	H	H	H	H	M	H	H	H	H	H	H
CO 5	H	H	H	H	H	H	M	H	H	H	H	H	H

Immunology

Semester III | Hours of Instruction / week: 4
23MZOC15 | No of credits: 4

Course objectives:

1. To outline the key components of the innate and adaptive immune responses
2. Define the cellular/ molecular pathways of humoral /cell-mediated immune response
3. Be able to acquaint with immune system of our body

Unit 1.	**Introduction to Immunology** **Types of immunity**-Innate and Acquired immunity, Ultra structure and functions of primary and secondary lymphoid organs, Cell types - origin and differentiation of B and T cells-specific functions.	12 hrs
Unit 2.	**Antigens and Immunogens** **Antigens**- essential features, epitopes, classes of antigens, **Immunoglobulins**-3D structure-classes- antigenic determinants- class switching-generation of antibody diversity, **antigen-antibody interaction**- affinity, avidity, cross reactivity, precipitation and agglutination reaction, radio immuno assay, ELISA, immuno fluorescence. Application of Immunological techniques in disease diagnosis.Tracer techniques: Principle and Applications, Unit of radioactivity, half-life and measurement of radioactivity.	12 hrs
Unit 3.	**Immune response** **Immune response**- antigen recognition- processing and presentation-interaction of T and B cells – **cell mediated and humoral immunity** - cytokines and immune response –immunological memory, **hypersensitivity reaction**- type 1, type 2, type 3 and type 4 reactions, immuno deficiency diseases,Immunological tolerance	12 hrs
Unit 4.	**MHC and Complements** **Major Histocompatibility Complex**: structure of MHC molecules –types - MHC and antigen presentation, **Complements** - classical and alternative pathways and immunological significance	12 hrs
Unit 5.	**Transplantation and tumour immunology** **Transplantation immunology**: HLA typing-immunology of graft rejection-immuno suppressive therapy,**Tumour immunology**- tumour antigen, immunity against cancer, cancer immuno therapy, **Auto immunity**- organ specific and systemic auto immune diseases, **Immuno prophylaxis**- active immunization-recent approaches to vaccine production- passive immunization.	12 hrs

Total Hours : 60

Text Books:

1. Kuby J. (2007).Immunology, 7th edition, W. H. Freeman and Co, New York.
2. Benjamini E, Coico R, Geoffrey S. (2000).Immunology- A short course, 4th Edition, John Willey Inc., New York.
3. Roitt I, Brostoff J, Male D. (2002). Immunology,7 th edition, Mosby Publishers, London.

Reference Books:

1. Tizard IR.(1995). Immunology- an introduction, 4th Edn., Saunders College Publishing, Philadelphia.
2. Chakravarty AK. (2006). Immunology and Immunotechnology. Oxford University Press. New Delhi,.
3. Banarjee A, Nirmala B.(2008). Fundamentals of Microbiology and Immunology, 2nd Edition,New central Book Agency, Kolkata.
4. Murphy K, Travers P, Walport M. (2007).Immunology,7 th edition, Garland Science, UK.
5. David M, Jonathan B, David BR, Roitt IM.(2013). Immunology, 8th Edition, Elsevier-Saunders publications,UK.
6. Subash CP(2012).Text Book of Microbiology and Immunolgy,2nd Edn, Elsevier India.

Course Outcomes:

1. Describe the cell types and organs that are involved in immune response
2. Apply immunological techniques to solve certain clinical and research problems
3. Able to differentiate between various types of hypersensitivity reactions
4. Identify the main mechanisms of immune tolerance and autoimmunity
5. Explain adverse functions of these cellular and molecular components during abnormal circumstances

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	H	L	L	H	H	H	H	H	H	H
CO 2	M	M	H	H	H	M	H	M	H	M	H	H	H
CO 3	M	M	M	H	H	L	M	H	H	L	H	H	H
CO 4	H	H	H	M	M	L	H	M	M	L	H	H	H
CO 5	M	H	M	H	M	M	H	M	H	M	H	H	H

Biotechnology

Semester III | Hours of instruction/week: 4
23MZOC16 | No of credits: 4

Course objectives:

1. To enable the student to learn the recent advances in Biotechnology
2. To learn the application of r-DNA technology
3. To develop practical knowledge and acquire analytical skills.

Unit 1 **Introduction –Scope and importance of biotechnology** 12 hrs

Enzymes in genetic engineering- Basic principles and Enzymology, Genetic engineering. Basic steps of gene cloning, DNA manipulative enzymes. Exonucleases, Endonucleases, Restriction Endonuclease and it's types*, S1 Nuclease, DNA ligase, Alkaline phosphatase, Reverse transcriptase, DNA Polymerase, Methyl transferase, Polynucleotide kinase, Terminal transferase

Unit 2 **Vectors in gene cloning** – Cloning vehicles, Plasmids, Bacteriophages, Cosmids, Phagemids, Yeast artificial chromosomes, Bacterial artificial chromosomes, expression vectors, shuttle vectors, Transposons. Gene cloning strategies, Preparation of rDNA and its introduction into host cells - Transformation, conjugation, electroporation, microinjection, transduction, direct gene transfer, agroinfection, liposome fusion, biolistics*. 12 hrs

Unit 3 **Identification of recombinants**: Restriction enzyme analysis, Southern blotting, Northern blotting, In-situ hybridisation, DNA Sequencing, PCR, Primer-design, and RT- (Reverse transcription) PCR. DNA Probes, RFLP, RAPD*.Encoding genetic information, Decoding the codons : the role of transfer RNAs.Construction and analysis of gene libraries, site directed mutagenesis. 12 hrs

Unit 4 **Animal Biotechnology**- Facilities for animal cell culture - Sterilization- Media Preparation- Physico- chemical properties of culture media – Types of media – Balanced salt solutions – complete culture media - Serum free medium- Characterization of cultured cells – Primary cell culture – Techniques for primary cell culture – Cell lines and its types – Subculture and its types- stem cells and its types*. Applications, advantages and disadvantages of animal tissue culture. 12 hrs

Unit 5 **Applications of biotechnology in human welfare** – 12 hrs

Tissue plasminogen activator, Erythropoietin, interferon's – recombinant vaccines-Monoclonal antibodies –Gene therapy-Transgenic animals -Ethical issues related to transgenic animals.Genetically Modified Microorganisms (GEMOs) – Gene Therapy Biotechnology and Bio-safety operation guidelines and regulations. Intellectual property right and protection* –Forms of protection, General Agreement of Tariffs and Trade (GATT) and Trade Related IPR's (TRIPs), Patenting of biological Materials - significance.

Text Books:

1. Nita Verma.(2013). Biotechnology, 1st edition, PACIFIC publication, New Delhi
2. Prakash S Lohar. (2012). Text book of Biotechnology,1st edition, MJP publishers, Chennai
3. Sobti RC, Suparrna S. Pachauri. (2009). Essentials of Biotechnology, 1st edition. Ane Books Pvt. Ltd, Chennai, New Delhi, Mumbai
4. Dubey RC. (2006). A textbook of Biotechnology, S.Chand and Company Ltd., New Delhi.
5. Satyanarayan,U. Chakrapani.U (2010). Biotechnology, 2nd edition ArunabhaSen publisher, Kolkata.

Reference Books:

1. Glick BR, Pasternak JJ, Patten CL. (2010).Molecular Biotechnology: Principles and Applications of Recombinant DNA, Fourth edition, ASM Press, Canada
2. Ponmurugan P, GangatharaPrabhuB. (2012). "Biotechniques". 1st edition. MJP publishers, Chennai, New Delhi

Course Outcomes:

1. Understand the tools and techniques in rDNA technology and its applications
2. To understand the theoretical and experimental implications of vectors in research and gene cloning
3. Provide the ability to decipher, evaluate and understand data generated from biotechnology-based assays
4. Comprehend fundamental concepts and principles of establishing animal cell culture
5. Understand the importance of patent laws and intellectual property rights

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	M	M	M	L	M	H	L	M	L	H	H	H
CO 2	H	M	H	H	H	M	H	M	H	M	H	H	H
CO 3	H	M	H	H	H	H	H	L	H	M	H	H	H
CO 4	H	H	H	M	M	M	M	L	H	M	H	H	H
CO 5	H	H	M	M	L	H	M	M	H	M	H	H	H

Evolution

Semester III — Hours of instruction / week: 4

23MZOC17 — No of credits : 4

Course objectives

1. To facilitate the students
2. To understand the basic principles of Evolution
3. To know about the origin of life and theories of Evolution

Unit 1. **Origin of life and evolutionary concept** 12hrs

Concept and evidence of evolution-morphology, comparative, embryology and paleontology anatomy. Theories of Evolution- Lamarkism, Darwinism, Devries mutation theory and Modern theory.Origin of life-Oparintheory,Prebiotic synthesis and Biological evolution-origin of coacervates, Protocells.

Unit 2. **Mechanism of Evolution** 12hrs

Variation- Types of variation-Isolation- Premating and Post mating mechanism -Hardy Weinberg's law of equilibrium and significance-Natural selection-Types-Polymorphism– Types and significance -Molecular evolution - Evolution of Protein. Molecular evolution and phylogenetics: molecular clocks; rates of evolution; Species concepts and speciation; phylogenetic reconstruction; Neutral theory; molecular systematics.

Unit 3. **Consequences of Evolution** 12hrs

Adaptation – Types of adaptation, Divergent and Convergent of Evolution, Structural adaptations- Classification of adaptations, Mimicry- protection, aggressive and conscious mimicry,Protective coloration- *Biological significance of colours.

Unit 4. **Paleontology and Behavioral evolution** 12hrs

Paleontology-Classification of rocks-Fossils- Types, Formation, dating and significance. Geological time scale- Eras- Periods – Epoch. Behavioral evolution- *Group selection, Altruism, Kin selection and Sexual selection

Unit 5. **Human evolution and Philosophical issues** 12hrs

History of primates, significant stages in evolution of man , Comparison between humans and other primates – Fossil and Genetic evidence of origin of modern man.*Cultural evolution and Evolutionary future of mankind.

***Self study**

Total Hours: 60

Text Books:

1. Brian K, Hall, Benedikt Hall grímsson. Stirickberger's.(2014). Evolution, 5th Edition, Jones and Bartlett India Pvt. Ltd. Publishers.
2. Veer BalaRastogi. (2014). Organic Evolution, 12th Revised Edition, Kedarnath Ram Nath Publishers, Meerut.
3. Rao CV.(2005). Human evolution and its uniqueness, Atlantic Publishers and distributors, New Delhi.
4. Verma PS, Agarwal VK. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Second Edition, S. Chand Company Ltd, New Delhi.

Reference Books:

1. Franklin Shull A. (2008).Evolution, Second Edition, J.V.Publishing House, Jodhpur.
2. Mark Ridley. (2004). Evolution, Third edition, Blackwell Science Ltd , USA.
3. Gould SJ. (2002). The structure of evolutionary theory. Harvard University Press, Cambridge,

Course Outcomes:

1. Understand the contemporary observations of biological evolution
2. Knowledge and skills in Phylogenetic analysis and related to *molecular evolution*
3. Analyze the role of pattern, adaptive features of consequences of evolution.
4. Acquire evolutionary information of the fossil record
5. Investigate the evolutionary basis of behavior in primates and man.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	H	M	H	H	M	H	H	H	M	H
CO 2	H	H	L	M	M	H	H	H	H	M	H	M	H
CO 3	H	H	L	H	L	H	H	H	H	M	H	M	H
CO 4	H	H	L	M	M	H	H	M	H	H	H	M	H
CO 5	H	H	M	M	L	H	H	M	H	M	H	M	H

Practicals IV- Microbiology, Immunology and Biotechnology

Semester III — Hours of instruction / week: 3

23MZOC18 — No of credits: 3

Course objectives:

1. To understand the biochemical aspects of microorganisms
2. To enable the students to know the molecular based techniques
3. To describe the biotechnological techniques in research problems

	Microbiology	
1	Methods of growing microbes –Agar, Broth, Slant, Stab culture	2 Hrs
2	Techniques for pure culture of microbes – Spread, pour and streak plate methods	3 Hrs
3	Isolation and enumeration of microbes from soil, water and air.	3Hrs
4	Identification of bacteria by Gram and Negative staining	3Hrs
5	Biochemical tests – Indole, Methyl red,Voges Proskauer, Citrate Utilization, Catalase and Starch Hydrolysis Tests	3Hrs
6	Identification of fungi by lacto phenol cotton blue staining	2Hrs
7	Determination of Microbial growth – Turbidity method	3Hrs
8	Production of Wine	2Hrs
9	Bioremediation of industrial effluent/ sewage water using biosorbents	2Hrs
10	Antibiotic sensitivity test	3Hrs
	Immunology	
11	Haemagglutination	2Hrs
12	Single radial Immunodiffusion technique	3Hrs
13	Enzyme Linked Immunosorbent Assay	2Hrs
	Biotechnology	
14	Isolation and estimation of DNA from goat liver	3Hrs
15	Agarose Gel Electrophoresisof DNA	3Hrs
16	Polymerase Chain Reaction for amplification of DNA (Demonstration)	3Hrs
17	Restriction digestion of DNA	3Hrs
		Total Hours: 45

Course Outcomes:

1. Able to isolate and identify microbes
2. Analyze the pathogenicity of disease causing microorganisms
3. Execute immunological techniques to solve clinical problems
4. Assess the bio sorbentsthat clean environment
5. Apply biotechnological methods in research sectors

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	H	H	H	M	M	L	L	H	H	H
CO 2	H	M	H	H	H	H	M	M	M	L	H	H	H
CO 3	M	M	H	H	H	H	M	M	H	M	H	H	H
CO 4	H	M	H	H	H	H	H	M	H	H	H	H	H
CO 5	H	M	H	H	H	H	M	M	H	L	H	H	H

Economic Zoology
(Self-study)

Semester III — Hours of instruction/week: 1

23MZOC19 — No of credits: 4

Course objectives:

1. To disseminate information on economic aspects of Zoology
2. To inculcate knowledge on useful animals to man kind
3. To understand the modern techniques of animal culture

Unit 1 **Apiculture** 3 hrs

Life history of honey bee, kinds of honey bees- natural hives- Artificial hive – Newton's hive and other appliances-Diseases and Enemies: Diseases and enemies- control and preventive measures.Bee Economy: Products of apiculture industry and its uses (honey, bees wax, propolis, pollen)

Unit 2 **Sericulture** 3 hrs

Life cycle and rearing of silkworm moth (*Bombyxmori*), Silkworm rearing technology: Early age and Late age rearing- Types of mountages Spinning- harvesting and storage of cocoons.Diseases- Protozoan, bacterial, fungal & viral- setting up of a sericulture unit.

Unit 3 **Pisciculture** 3 hrs

Cultivable species of fishes in India –construction of a pond – polyculture-Sewage fed fish culture – induced breeding.Fish diseases: Bacterial- viral – parasitic.

Unit 4 **Vermiculture** 3 hrs

Cultivable species of earthworm – vermi composting methods – conditions required for vermicomposting – vermicast – vermiwash. Vermicompost Technology: Small Scale Earthworm farming for home gardens- Conventional commercial composting- Earthworm Farming (Vermiculture)-vermicomposting harvest and processing.

Unit 5 **Poultry Science** 3 hrs

Breeds of fowls – the deep litter system – practical aspects of chick rearing – management of growers and layers – feed formulations –Diseases- management vaccines.

Total Hours: 15

Text Books:

1. Upadhyay VB. Economic Zoology. Rastogi Publications, Meerut 2006
2. Yadav, Manju. Economic Zoology. Discovery Publishing House, New Delhi 2003

3. RavindranathanKR. Economic Zoology. Dominant Publishers & Distributors 2003

Reference Books:

1. Nigam HC. Modern Trends in Biology & Economic Zoology. Vishal Publ. Co., Jalandhar, Punjab 2006
2. JawaidAhsan, Sinha, SP.A Handbook of Economic Zoology. S. Chand Group Publ., New Delhi 2008.

Course outcomes:

1. Apply the knowledge of managing beehives for honey production and marketing
2. Acquire knowledge about the rearing of silkworms and causative agents of silkworm diseases.
3. Understand various methods of aquaculture practices.
4. Role of Vermiculture in protecting the environment and managing the waste
5. Describe poultry breeds and basic concepts related to vaccines.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	H	H	M	M	H	H	H	H	H
CO 2	H	H	H	H	H	H	M	M	H	H	H	H	H
CO 3	H	H	H	H	H	M	M	L	H	H	H	H	H
CO 4	H	H	H	H	H	H	M	L	H	H	H	H	H
CO 5	H	H	H	H	H	M	M	M	H	H	H	H	H

Biostatistics and Thesis Writing

Semester IV — Hours of instruction / week:4

23MZOC21 — No of credits: 4

Course objectives:

1. To learn the methods of data collection and the application of statistical methods in solving biological problems
2. To know the principles of research design and thesis writing

Unit 1: **Introduction to Statistics** — 12 hrs

Statistics –Scope, limitations and applications- primary and secondary data- sources of statistical data- classification and tabulation of data-*Diagrammatic and Graphical representation of statistical data – line diagram, bar diagrams, piediagram,pictogram, cartogram, pie chart, line graph , histogram, frequency polygon, frequency distribution, frequency curve and Ogive curve

Unit 2: **Descriptive statistics** — 12 hrs

Measures of central tendency – *objectives, mean, median and mode, uses, merits and demerits

Measures of dispersion – *objectives, range, quartile deviation, mean deviation, standard deviation, absolute and relative measures of dispersion, uses, merits and demerits

Correlation and regression analysis - definition, uses, types of correlation, methods of studying correlation – scatter diagram, graphic method, Karl Pearson's coefficient of correlation, rank correlation, concurrent deviation, *least squares method, regression lines, regression equations, regression coefficients

Unit 3: **Sampling and Theoretical Distribution** — 12 hrs

Sampling – meaning, advantages, concept of parameter and statistics, sample size, sampling error--*Introduction of probability and its applications-Types of samples – probability samples – simple random sample, stratified random sample, systematic sample, cluster sample, multistage. Non-probability samples– purposive sampling, quota sampling, accidental sampling- Theoretical distributions – Binomial, Poisson and Normal distributions- properties, uses and applications

Unit 4: **Testing of Hypothesis** — 12 hrs

Testing hypothesis-null hypothesis, alternative hypothesis, student's t- test- Analysis of variance - one way and two way classification- Non-parametric-chi-square test,Kruskal Wallis Test, Sign Test, Wilcoxon signed-rank testand distribution free tests.

Unit 5: **Research Design and Report Writing** 12hrs

Research – knowledge and sciences, types and application, research definition – research design – identifying the problem, reviewing the literature, designing the study – ***chapter outline

Documentation - report writing, presentation, test layout, use of tables and figures, their placement, numbering, foot notes to tables and figures, spacing and alignment, referencing – reference systems, essential information – special capitalization and alphabetical and chronological order, editing and evaluating the final report, ***components of a research thesis. Plagiarism, Plagiarism tool, Research Ethics.

***Self study**

Total Hours: 60

Textbooks:

1. Veer BalaRastogi.(2015).Biostatistics-Third revised edition,Medtech publications.
2. Agarwal , S,C.(2007). A handbook of fish farming. Narendra pub. House, Delhi.
3. Annadurai,B .(2007). A text book of Biostatistics, New age International Pvt. Ltd Publishers, Chennai.
4. Gurumani ,N.(2006). Research Methodology, MJP publishers, Chennai.
5. Gupta, S,P.(2004). Statistical methods, Sultan Chand and Sons Publishers, New Delhi.

References Books:

1. Suresh,K ,Sharma.(2016).Research Methodology & Biostatistics.
2. CharabatyNM, Chakrabaty PP, and S.C.Mondal SC.(2010). Biology, breeding and farming of important food fishes. Narendra pub. House, Delhi.
3. Ronald, N. Forthofer, EunSul Lee.(2010). Introduction to Biostatistics, Elsevier Publications India Pvt. Ltd, New Delhi.
4. Klaynekl Daniel.(2009). Biostatistics, Wiley India Pvt. Ltd., New Delhi.

Course Outcomes:

1. Understand the basic concept and applications of biostatistics.
2. Ability to calculate the descriptive statistics and its significance
3. Knowledge on implementation of hypothesis in validating a model.
4. Identify the appropriate hypothesis testing procedure related to variables and samples
5. Interpret current knowledge and skills to new methods in research design and report writing.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	H	H	H	M	H	L	H	H	H
CO 2	H	H	H	H	H	H	H	L	M	L	H	H	H
CO 3	H	H	H	H	H	H	H	L	M	L	H	H	H
CO 4	H	H	H	H	H	H	H	L	L	L	H	H	H
CO 5	H	H	H	H	H	H	H	M	L	L	H	H	H

DEPARTMENT OF ZOOLOGY
Multidisciplinary Course
Conservation of Fauna

Semester III — Hours of instruction / week: 2
23MZOM01 — No of credits: 2

Course objectives:

1. To enable the students to know about the faunal diversity and its importance
2. To enable the students to understand the importance of the conservation of fauna

Unit 1	**Introduction to biodiversity** Conservation of natural resources, Abiotic and Biotic components, Ecosystem Types of biodiversity- Genetic, species and ecosystem diversity Biodiversity measurement – Alpha, beta and gamma diversity IUCN Red list Categories – Threatened, vulnerable, endangered, rare and indeterminate, global distribution of fauna, hot spots of fauna	6 hrs
Unit 2	**Faunal distribution and faunal wealth of India** Asiatic lion, tiger, Indian rhinoceros, Indian elephant, lion tailed macaque, nilgirithar, panther, flying squirrel, emerald dove	6 hrs
Unit 3	**Human impact on faunal diversity** Habitat destruction, over exploitation, introduction of exotic species, deforestation, environmental pollution, global climate change, biological effects and control desertification, commercial trade of animal species	6 hrs
Unit 4	**Strategy for faunal conservation** Wildlife conservation and management Insitu Conservation- Sanctuary, national parks, biosphere reserve Exsitu Conservation- Zoological parks, aquaria, gene bank, cryopreservation Project to conserve Wild life- Project tiger, crocodile breeding project, operation rhino, Gir lion project, Project elephant	6 hrs
Unit 5	**Biodiversity awareness** Role of education and research institution and organizations for wild life conservation. Wild life (protection) Act, Environmental Impact Assessment- steps and methods	6hrs

Total Hours: 30

Textbooks:

1. Singh BK.(2004).Biodiversity Conservation and Management. Mangal deep publications. Jaipur
2. MallapureddiV,Reddy K.(2008).Wildlife Biodiversity Conservation. Daya publishing House Delhi
3. Deswal S, and Deswal A.(2018).Basic course in Environmental studies. DhanpatRai& Co (P) Ltd Educational & Technical publishers Delhi.
4. Raman Sivakumar.(2010). Environmental Science & Engineering. Tata McGraw Hill Education Private Ltd.

Reference Books:

1. Hosetti BB. (2008). Concepts in Wildlife Management. Daya publishing House Delhi.
2. Hosetti BB. and Ramakrishna S. (2016). Biodiversity : Concepts and Conservation. First ednAavishkarPublishers Jaipur.

Course outcomes:

1. Gain knowledge on theories in the field of systematic and biodiversity.
2. Able to understand the distribution and wealth of fauna
3. Identify various human activities on forest ecosystem
4. Acquire knowledge and skill conserve fauna
5. Understand the problems related to wildlife conservation and management.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	H	M	H	H	L	M	L	H	H	H
CO 2	H	M	M	M	M	L	H	M	H	L	H	H	H
CO 3	H	M	H	H	H	L	H	M	H	L	H	H	H
CO 4	H	H	H	H	H	L	H	H	H	L	H	H	H
CO 5	H	H	H	H	H	H	H	H	H	L	H	H	H

DEPARTMENT OF ZOOLOGY

Interdisciplinary Course

Entrepreneurial Avenues in Zoology

Semester – II | Hours of instruction / week : 4

23MZOI01 | No of credits: 4

Course objectives:

1. To disseminate information on economic aspects of Zoology
2. To inculcate knowledge on useful animals to man kind
3. To understand the marketing values animal culture

Unit 1. **Aquaculture** 12 hrs

Sustainable Aquaculture: Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Poly culture; Composite fish culture; Brood stock management; Induced breeding of fish; Preparation of compound diets for fish; Role of water quality in aquaculture;

Fish diseases: Bacterial, viral and parasitic.

Entrepreneurship in Aquaculture: Preservation and processing of harvested fish, Fishery by-products

Practicals

- Identification of common edible fishes
- Identification of ectoparasites
- Field visit to a fish farm

Unit 2. **Apiculture** 12 hrs

Biology of honey bees, social organization of bee colony, Life cycle of *Apisindica*

Rearing of Bees: Selection of bee species for apiculture, artificial bee rearing (apiary), beehives – newton bee pasturage, bee keeping equipment methods of extraction of honey (indigenous and modern)

Diseases and Enemies: Diseases and enemies, control and preventive measures

Bee Economy: Products of apiculture industry and its uses (honey, bees wax, propolis, pollen)

Entrepreneurship in Apiculture: Bee keeping industry –modern methods in apiculture.

Practicals

- Identification of honey bee
- Field visit to an Apiary

Unit 3. **Sericulture** 12 hrs

Biology of Silkworm: Life cycle of *Bombyxmori*, Structure of silk gland and secretion of silk

Rearing of Silkworms: Selection of mulberry variety and establishment of mulberry garden

Rearing house and appliances, Disinfectants-Formalin, bleaching powder, RKO

Silkworm rearing technology: Early age and Late age rearing, Types of mountagesSpinning, harvesting and storage of cocoons

Pests and Diseases: Uzi fly, dermestid beetles and vertebrates. Protozoan, viral, fungal and bacterial diseases, Control and prevention of pests and diseases

Entrepreneurship in Sericulture: Sericulture industry in different states,

employment.
*Visit to sericulture centre.

12 hrs

Vermiculture

Unit 4. Introduction to Vermiculture: definition, species selection, earthworm biology and rearing, uses of earthworm for biodegradation of organic waste materials.
Vermicompost Technology: Small Scale Earthworm farming for home gardens, Conventional commercial composting, Earthworm Farming (Vermiculture), vermicomposting harvest and processing.
Entrepreneurship in Vermiculture: Compost making, Vermiwash and marketing

Unit 5. **Poultry Science** 12 hrs

Introduction to poultry science: Biology and Breeds of fowls.Importance of poultry farming and poultry development in india.
Entrepreneurship and Production: the deep litter system, practical aspects of chick rearing, management of growers and layers, feed formulations. Diseases, management vaccines

Total Hours: 60

Text Books:

1. Upadhyay VB. (2006). Economic Zoology. Rastogi Publications, Meerut
2. YadavandManju. (2003), Economic Zoology. Discovery Publishing House, New Delhi
3. JawaidAhsan, Sinha SP. (2008). A Handbook of Economic Zoology. S. Chand Group Publ., New Delhi

Reference Books:

1. Bone TQ and Moore R. Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
2. Srivastava CBL. Fish Biology, Narendra Publishing House
3. Prost PJ. (1962).Apiculture. Oxford and IBH, New Delhi
4. Bisht DS. Apiculture, ICAR Publication.
5. Singh S. Beekeeping in India, Indian council of Agricultural Research, New Delhi
6. UllalSRandNarasimhanna MN. Handbook of Practical Sericulture: CSB, Bangalore
7. Bhatt JV and Khambata SR.(1959). "Role of Earthworms in Agriculture" Indian Council of Agricultural Research, New Delhi

Course Outcomes:

1. Demonstrate and learn the beneficial role of animals in human life
2. Understand the rearing of animals.
3. Awareness on the diseases that affect the animals and poultry
4. Knowledge on the significance of by-products and their income generation.
5. Gain knowledge of small scale industries like sericulture, fish farming, bee keeping, aquaculture, poultry farm.

DEPARTMENT OF ZOOLOGY

Professional Certification Course

Conservation Biology

Semester II — Hours of instruction/week: 48

23MZOPC1 — No. of credits: 2

Course objectives:

1. To understand the fundamentals of Conservation Biology
2. To learn about the importance and the need for conservation
3. To gain an understanding of national, regional and global level conservation work.

Unit 1. **Biodiversity; Components of Biodiversity:** 6 hrs

Definition - Components of Biodiversity - Species concepts - Animal diversity: (Marine, freshwater, terrestrial) - Biodiversity Hotspots (Western Ghats, Indo-Burma region) - Hot specks - Endemics

Unit 2. **Species threats and loss of animal diversity, species status:** 12 hrs

Extinctions: Past extinctions - Human-induced, Modern and local extinctions - Population reduction-threats to wildlife (examples) - Habitat loss, degradation and fragmentation. Threats to animal diversity in India - Status of species: threatened species - Measuring status of species in the wild - IUCN Red list (Assessments and methodologies) - Status of Indian animals.

Unit 3. **Conservation tools:** 16 hrs

In-situ and ex-situ conservation - Definition and case studies - conservation of Indian animals; - Successes and failures of conservation actions in India (Case study) - Tools in Conservation - IUCN SSC conservation initiatives (PHVA, SIS, Alliance for Zero extension, Global species conservation programmes) - Wildlife conservation in India importance of conservation - methods of wildlife conservation.

Unit 4 **Conservation laws and policies and Conservation Education:** 14 hrs

Wildlife (Protection) Act of India (1972) - The Biological Diversity Act, 2002 - Indian Board for Wildlife (IBWL): Animal welfare laws - Conventional on Biological Diversity - CITES; Conservation Education: Wildlife celebration days in India - Indian Wildlife Week - Tools and techniques in Conservation Education

Total Hours: 48

The programme also includes unit-based assignments and evaluation

Course outcomes:

1. Understand the fundamentals of conservation biology
2. Get a clear idea of the threats affecting species and causes, the root cause of species extinction.
3. Exposure to the ways and means to slow down species extinction rate. Global and regional approaches.
4. Gain knowledge of the prevailing laws related to biodiversity conservation.
5. Provide thoughts and initiatives to take conservation action on an individual basis.

References:

1. R. B. Primack 1993. Essentials of Conservation Biology, Sinauer Associates, USA
2. B. Groom bridge 1992. Global Biodiversity. Status of the Earth's Living Resources. Chapman and Hall, London.
3. R. A. Mittermeier, N. Meyers, P.R. Gil and C. G. Mittermeier 2000. Hotspots: Earth's Biologically richest and most endangered Terrestrial Ecoregions. Cemex/Conservation International, USA
4. UNEP 2001. Global Biodiversity Outlook, Montreal, Canada ISBN: 1020-9387
5. B.A. Daniel, W.R.T. Darwall, S Molur and K.G Smith (2011). The status and distribution of freshwater biodiversity in the Western Ghats, India. IUCN, Geneva. *ISBN:* 978-2-8317-1381-6
6. Annon 2022. Wildlife (Protection) Act, 1972, amended up to 2022. Natraj Publishers, New Delhi.