

Major Course:

Semester	Major Course	Course Title	Credits
I	1	Animal diversity of non chordates (Protista to Pseudocoelomate)	Theory: 03 Practical: 01

About the course

The course is a walk for the Bachelor's entrant through the amazing diversity of living forms from simple to complex one. It enlightens how each group of organisms arose and how did they establish themselves in the environment with their special characteristics. It also deals with the differences and similarities between organisms on the basis of their morphology and anatomy which led to their grouping into taxa and clades.

Course outcomes

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

1. Develop understanding on the diversity of life with regard to protists to pseudocoelomata.
2. Group animals on the basis of their morphological characteristics/ structures.
3. Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
4. Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
5. Understand how morphological change due to change in environment helps drive evolution over a long period of time.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Protista, Parazoa and Metazoa

14 Lecture

General characteristics and classification up to classes; Study of Euglena, Amoeba and Paramecium; Life cycle and pathogenicity of Plasmodium vivax and Entamoeba histolytica; Locomotion and Reproduction in Protista; Types of symmetry.

Unit 2: Porifera

08 Lecture

General characteristics and classification up to classes; Type study of Sycon; Canal system and spicules in sponges.

Unit 3: Cnidaria

10 Lecture

General characteristics and classification up to classes; Type study of Obelia; Polymorphism in Cnidaria; Corals and coral reefs.

Unit 4: Platyhelminthes**10 Lecture**

General characteristics and classification up to classes; Type study, larval forms and pathogenicity of *Fasciola hepatica*.

Unit 5: Nematelminthes**8 Lecture**

General characteristics and classification up to classes; Type study of *Ascaris lumbricoides*; Life cycle and pathogenicity of *Wuchereria bancrofti*; Parasitic adaptations in helminthes.

Practical

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*
2. Binary fission and Conjugation in *Paramecium*
3. Examination of pond water collected from different places for diversity in Protista
4. Study of Sycon (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*
5. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/microphotographs)
7. Study of adult *Ascaris lumbricoides* and its life stages (slides/micro-photographs)
8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

Suggested readings

1. Ruppert and Barnes (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JI (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science.
3. Barrington EJW (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson

Major Courses:

Semester	Major Course	Course Title	Credits
II	2	Animal diversity of non chordates (Coelomates)	Theory: 03 Practical: 01

About the course

To discuss representative lineages of the protostome coelomates, including molluscs, annelids and arthropods. Students will know how are these groups of animals similar? What morphological and developmental patterns do they have in common? How do they differ?

They will know the importance of segmentation in the annelids. Students will come to know why the animals in Phylum Arthropods are thought to be so successful.

Course Outcomes

1. Compare the two groups (Acoelomate and Coelomates) of animals with true coeloms.
2. Compare the differences in development seen in these two groups.
3. Compare the protostomes and deuterostomes
4. Explain the characteristics of arthropods that have made them successful.
5. Review the diversity of arthropod groups, including trends in arthropod evolution.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Introduction to Coelomates and Annelida

12 Lecture

Evolution of coelom and metamerism. General characteristics and Classification up to classes; Type study of *Pheretima*; Metamerism in Annelids.

Unit 2: Arthropoda

15 Lecture

General characteristics and Classification up to classes; Type study of *Periplanata*; Vision and Respiration in Arthropoda; Larval forms in Arthropoda; Metamorphosis in Insects; Social life in bees.

Unit 3: Onychophora

03 Lecture

General characteristics and Evolutionary significance with special reference to *Peripatus*.

Unit 4: Mollusca

12 Lecture

General characteristics and Classification up to classes; Type study of *Pila*; Respiration in Mollusca; Torsion and detorsion in Gastropoda; Pearl formation in bivalves; Evolutionary significance of trochophore larva.

Unit 5: Echinodermata

10 Lecture

General characteristics and Classification up to classes; Type study of *Asterias*; Water-vascular system in Asteroidea; Larval forms in Echinodermata; Affinities with Chordates.

Practical

1. Study of following specimens:

Annelids: *Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria* etc.

Arthropods : *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta*, termites and honey bees etc.

Onychophora: *Peripatus*

Molluscs: *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus* etc.

Echinodermates: *Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria* and *Antedon* etc.

2. Study of digestive system of earthworm
3. Study of septal nephridia and pharyngeal nephridia of earthworm
4. T. S. through pharynx, gizzard, and typhlosolar intestine of earthworm
5. Mount of mouth parts and dissection of digestive system of *Periplaneta*
6. Dissection of nervous system of *Periplaneta*
7. To submit a project report on any related topic to larval forms (crustacean, mollusc and echinoderm)

Suggested readings

1. Ruppert and Barnes (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JI (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science.
3. Barrington EJW (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.
4. Nigam (1997). Biology of Chordates, S. Chand.
5. Kotpal, Modern text book of Zoology: Vertebrates, Rastogi Publication.

Major Courses:

Semester	Major Course	Course Title	Credits
III	3	Diversity of chordates	Theory: 03 Practical: 01

About the course

By the study of diversity of chordates, it would be easy to know about the species of chordates surviving in different ecological areas of world. It would also be very useful that how these species may be harmful or useful for mankind.

Course outcomes

1. To get information about the diversity of chordates
2. To have awareness about the beneficial and harmful chordates
3. To know about the endangered species of chordates
4. To know about the management of chordates
5. To understand how environment helps to acquire adaptation over a long period of time in different animals.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Introduction and origin of Chordates

05 Lecture

General characteristics and outline classification, Dipleurula concept and the Echinoderm theory of origin of chordates, Advanced features of vertebrates over protochordates.

Unit 2: Protochordata

08 Lecture

General characteristics of Hemichordata, Urochordata and Cephalochordata, Study of larval forms in Protochordates, Retrogressive metamorphosis in Urochordata.

Unit 3: Agnatha and Pisces

10 Lecture

General characteristics and classification of cyclostomes up to orders; General characteristics of Chondrichthyes and Osteichthyes and Classification up to orders, Skin and Scales, Migration, Osmoregulation and Parental care in fishes.

Unit 4: Amphibia and Reptilia

13 Lecture

Origin of *Tetrapoda* (Evolution of terrestrial ectotherms), General characteristics and classification of Amphibia up to orders, Parental care in Amphibians; General characteristics and classification of Reptilia up to orders, Affinities of *Sphenodon*, Poisonous and non-poisonous snakes, Poison apparatus and biting mechanism.

Unit 5: Aves and Mammalia

16 Lecture

General characteristics and classification of Aves up to orders, *Archaeopteryx*- a connecting link; Principles and aerodynamics of flight, Flight adaptations, Migration in birds; General characters and classification of Mammalia up to orders, Affinities of Prototheria, Metatheria, Adaptive radiation in mammals: locomotory appendages.

Practical

1. Study of following specimens:

Protochordata:

Balanoglossus, *Herdmania*, *Branchiostoma*,

Colonial Urochordata,

Agnatha and Fishes

Petromyzon, *Myxine*, *Scoliodon*, *Sphyrna*, *Pristis*, *Torpedo*, *Chimaera*, *Mystus*, *Heteropneustes*, *Labeo*, *Catla*, *Cirrhinus Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon*, *Diodon*, *Anabas*, *Flat fish*.

Amphibia and Reptilia

Ichthyophis, *Necturus*, *Rana*, *Bufo*, *Hyla*, *Alytes*, *Salamandra*, *Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Ophiosaurus*, *Draco*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*, *Zamenis*, *Crocodylus*, *Key for Identification of poisonous and non-poisonous snakes*.

Aves and Mammalia

Study of common birds from different orders,

Types of beaks and claws,

Sorex, *Bat (Insectivorous and Frugivorous)*, *Rattus*, *Funambulus*, *Loris*, *Herpestes*, *Erinaceous*,

2. Sections of *Balanoglossus* through proboscis and branchiogenital regions.
3. Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions.
4. Permanent slide of *Herdmania* spicules
5. Internal ear of *scoliodon*
6. Mount of weberian ossicles of *Mystus*/ pecten from Fowl head/Power point.
7. Study of afferent and efferent arteries of fish (*scoliodon*).

Suggested readings

1. Young JZ (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
2. Darlington PJ. *The Geographical Distribution of Animals*, R.E. Krieger Pub Co.
3. Hall BK and Hallgrimsson B (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
4. Dorit, Walker and Barnes (1991). *Zoology*. Brooks Cole; 1 Edition.
5. Nigam (1997). *Biology of Chordates*, S. Chand.
6. Kotpal : *Modern text book of Zoology: Vertebrates*, Rastogi Publication.

Major Courses:

Semester	Major Course	Course Title	Credits
III	4	Cell biology	Theory: 03 Practical: 01

About the course

The course provides a detailed insight into basic concepts of cellular structure and function. It also gives an account of the complex regulatory mechanisms that control cell function.

Course outcomes

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

1. Understand the functioning of nucleus and extra nuclear organelles
2. Understand the intricate cellular mechanisms involved.
3. Acquire the detailed knowledge of different pathways related to cell signaling and apoptosis thus enabling them to understand the anomalies in cancer.
4. Develop an understanding how cells work in healthy and diseased states and to give a 'health forecast' by analyzing the genetic database and cell information.
5. Understand how tissues are produced from cells in a normal course and about any malfunctioning which may lead to benign or malignant tumor.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
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CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Overview of Cells and plasma membrane

15 Lecture

Prokaryotic and Eukaryotic cells, Cell Theory, Virus, Viroids, Prions. Various models of plasma membrane, Structure and Function of Plasma Membrane. Transport across membranes: Active and Passive transport, Facilitated transport; Cell junctions: Tight junctions, Gap junctions.

Unit 2: Cellular Organelles and Endomembrane System

10 Lecture

Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Peroxisomes, Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis, Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis.

Unit 3: Cytoskeleton

06 Lecture

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments.

Unit 4: Nucleus

10 Lecture

Structure of and function of Nucleus. Chromatin: Euchromatin and Hetrochromatin and packaging

(nucleosome). Giant Chromosomes: Polytene and Lampbrush. Structure and types of DNA and RNA.

Unit 5: Cell division and Signaling

09 Lecture

Cell cycle, cell division- mitosis and meiosis. Cell division check points and their regulation. Role of growth factors. 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.

Practical

1. Familiarization with the student's Light and dissecting microscope.
2. Staining of cell and different organelles (nucleus, mitochondria and chromosomes).
3. Permeability of plasma membrane - effect of isotonic, hypertonic solution.
4. Mitosis in onion root tips and permanent slide and chart.
5. Meiosis in grasshopper testis (from slides/photographs provided) and permanent slide.
6. Study of Polytene chromosomes in *Chironomous* larva.
7. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.

Suggested readings

1. Karp (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition, John Wiley and Sons Inc.
2. De Robertis EDP and De Robertis EMF (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper GM and Hausman RE (2009). The Cell: A Molecular Approach. V Edition; ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009). The World of the Cell, VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Albert B, Dennis B, Julian L, Martin R, Keith R and James W (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.
6. Lodish et al (2008). Molecular Cell Biology, Freeman.

Major Courses:

Semester	Major Course	Course Title	Credits
IV	5	Physiology of regulatory life process	Theory: 03 Practical: 01

About the course

To familiarize students with the principles and basic facts of animal physiology. Emphasis will be placed on control and coordination of tissues, bone and cartilage, muscle and nervous system.

Course outcomes

1. To understand fundamental principles of animal physiology.
2. To understand how these principles are incorporated into to regulate life process.
3. To understand control and coordination of various organ systems in animals i.e. tissues, bone and cartilage, muscle.
4. To understand the working and importance of nervous system in animals.
5. To gain experience in discussing, and answering questions about animal physiology.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Tissues

10 Lecture

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue.

Unit 2: Bone and cartilage

12 Lecture

Structure and types of bones and cartilages, Ossification, bone growth.

Axial skeletal: skull and vertebral column, appendicular skeletal: pectoral and pelvic girdle, limbs, joints.

Unit 3: Muscle

08 Lecture

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus.

Unit 4: Nervous system

10 Lecture

Type of nervous tissue: neuron and glia; Structure of brain, cerebrospinal fluid, neural network, cranial nerves, blood brain barrier, spinal cord anatomy, spinal nerves.

Unit 5: Electrical signal in neurons

10 Lecture

Axonal and synaptic transmission: Membrane potential and action potential; Types of synapses and synaptic knobs; Excitatory and inhibitory post-synaptic potential; Chemical transmission; Neurotransmitters (acetylcholine, catecholamines, serotonin and GABA), neuropeptides.

Practical

1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
3. Study of Axial skeletal: skull and vertebral column
4. Study of, appendicular skeletal: pectoral and pelvic girdle, limbs.
5. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
6. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell.
7. Microtomy: Preparation of permanent slide of mammalian tissues

Suggested readings

1. Guyton AC and Hall JE (2006). Textbook of Medical Physiology. XI Edition. Herculat Asia PTE Ltd. W.B. Saunders Company.
2. Tortora GJ and Grabowski S (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
3. Victor P Eroschenko (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

Major Courses:

Semester	Major Course	Course Title	Credits
IV	6	Fundamental biochemistry	Theory: 03 Practical: 01

About the course

Course is aimed to provide molecular structure of biological macromolecules (Carbohydrates, protein, and lipids) and their significance in living system. How enzymes work to perform biochemical reaction during metabolism.

Course Outcomes

To analyses and understand the basic concept of chemical reaction occur in living system that enables them to explore the applied science beneficial for mankind.

1. Understand about the importance and scope of biochemistry.
2. Understand the structure and biological significance of carbohydrates, proteins and lipids.
3. Understand the concept of enzyme, its mechanism of action and regulation.
4. Learn biochemical tests for amino acids, carbohydrates, proteins and nucleic acids.
5. Learn measurement of enzyme activity and its kinetics.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Biomolecules

04 Lecture

Chemistry of Living system: Scope and importance; Biomolecules: Organizational principle, Configuration and confirmation; Water as a biological solvent.

Unit 2: Carbohydrates

10 Lecture

Structure and Biological importance of carbohydrates. Aldose, ketose, chiral centre, polarized light and Fischer's nomenclature, cyclization reaction of glucose, anomers, pyranose, furanose, glycosidic linkage, reducing and non-reducing sugars. Sequence of reactions and regulation of glycolysis, Citric acid cycle, Pentose Phosphate pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis.

Unit 3: Lipids

08 Lecture

Structure and Significance: saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids. β -oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis.

Unit 4: Proteins

14 Lecture

Proteins: Bonds stabilizing protein structure; Denaturation; Simple and conjugate proteins.

Amino acids: Structure, Classification and properties of α -amino acids; essential and non-essential α -amino acids. Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C- skeleton of Glucogenic and Ketogenic amino acids.

Unit 5: Enzymes

14 Lecture

Nomenclature and classification; Cofactors; Specificity of enzyme action; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of K_m and V_{max} , Lineweaver-Burk plot; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action.

Practical

1. Qualitative tests of functional groups in carbohydrates: Benedict's test for reducing sugars, Iodine test for starch
2. Qualitative tests of proteins
3. Qualitative tests of lipids.
4. Paper chromatography of amino acids.
5. Action of salivary amylase under optimum conditions.
6. Effect of pH, temperature and inhibitors on the action of salivary amylase.
7. Structural study of biomolecules through models/ charts/PPT.
8. Preparation and roles of phosphate and bicarbonate buffers.

Suggested reading

1. Cox MM and Nelson DL (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
2. Berg JM, Tymoczko JL and Stryer L (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Murray RK, Bender DA, Botham KM, Kennelly PJ, Rodwell VW and Well PA (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
4. Hames BD and Hooper NM (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
5. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

Major Courses:

Semester	Major Course	Course Title	Credits
IV	7	Ecosystem dynamics and conservation	Theory: 03 Practical: 01

About the course

This course will take students on a journey through the physical workings of the Earth, the interactions between species and their environments. The course highlights on some of the important aspects viz. growth and survival of populations and communities in different habitats, energy flow in the ecosystems, interactions between the communities, exclusion of niches and consequences of changing environment on the biodiversity.

Course outcomes

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

1. Develop knowledge base covering all attributes of the environment and ecology.
2. Illustrate the flow of energy through ecosystems with reference to tropic levels and ecological efficiency.
3. Describe population structures and growth.
4. To develop an appreciation of the modern scope of the scientific study in the field of ecology.
5. Solve the environmental problems involving interaction of humans and natural systems at local or global level. To study about basic methods of wildlife conservation

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
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Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Introduction to Ecology

03 Lecture

History of ecology; Autecology and synecology; Levels of organization; Laws of limiting factors- Liebig's law of minimum and Shelford's law of tolerance; Study of physical factors-Temperature and Light.

Unit 2: Ecosystem

12 Lecture

Types of ecosystems: Trophic levels; Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains; Food web; Energy flow through ecosystem; Ecological pyramids and Ecological efficiencies; Ecological features of Tundra, Desert, Savannah and Tropical Rain forest Biomes; Human modified ecosystem. Nutrient and biogeochemical cycle (C, N, P & S).

Unit 3: Population

12 Lecture

Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age and sex ratio, dispersal and dispersion, Exponential and logistic growth,

equation and patterns, r and k strategies; Population regulation-density-dependent and independent factors; Population interactions.

Unit 4: Community

07 Lecture

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological Succession, Types of Succession, Theories pertaining to climax community.

Unit 5: Human impact on environment

06 Lecture

Environmental Pollution: Air, water and noise pollution; Greenhouse effect, Acid rain, Global Warming, Ozone depletion. Ecology in Wildlife Conservation and Management, Biodiversity; types, importance and threats. Protected areas; National parks, Bio reserves and Sanctuaries. Restoration ecology.

Practical

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO₂.
4. To measure microclimatic variables viz., temperature, humidity and light conditions in a microhabitat..
5. Making an ecosystem in a wide-mouthed bottle.
6. Constructing a food web by observing and collecting organisms from a given area.
7. Preparing and clearly present an essay based on the evaluation of 4-7 publications.
8. Studying insect diversity in a habitat.
9. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary.

Suggested readings

1. Colinvaux P A (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs C J (2001). Ecology. VI Edition. Benjamin Cummings.
3. Odum EP (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole.
4. Robert Leo Smith, Ecology and field biology Harper and Row publisher.
5. Ricklefs RE (2000). Ecology. V Edition. Chiron Press.

Minor Course:

Semester	Minor Course	Course Title	Credits
I	1	Animal diversity of non chordates (Protista to Pseudocoelomate)	Theory: 03 Practical: 01

About the course

The course is a walk for the Bachelor's entrant through the amazing diversity of living forms from simple to complex one. It enlightens how each group of organisms arose and how did they establish themselves in the environment with their special characteristics. It also deals with the differences and similarities between organisms on the basis of their morphology and anatomy which led to their grouping into taxa and clades.

Course outcomes

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

1. Develop understanding on the diversity of life with regard to protists to pseudocoelomata.
2. Group animals on the basis of their morphological characteristics/ structures.
3. Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
4. Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
5. Understand how morphological change due to change in environment helps drive evolution over a long period of time.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Protista, Parazoa and Metazoa

14 Lecture

General characteristics and classification up to classes; Study of Euglena, Amoeba and Paramecium; Life cycle and pathogenicity of Plasmodium vivax and Entamoeba histolytica; Locomotion and Reproduction in Protista; Types of symmetry.

Unit 2: Porifera

08 Lecture

General characteristics and classification up to classes; Type study of Sycon; Canal system and spicules in sponges.

Unit 3: Cnidaria

10 Lecture

General characteristics and classification up to classes; Type study of Obelia; Polymorphism in Cnidaria; Corals and coral reefs.

Unit 4: Platyhelminthes**10 Lecture**

General characteristics and classification up to classes; Type study, larval forms and pathogenicity of *Fasciola hepatica*.

Unit 5: Nematelminthes**8 Lecture**

General characteristics and classification up to classes; Type study of *Ascaris lumbricoides*; Life cycle and pathogenicity of *Wuchereria bancrofti*; Parasitic adaptations in helminthes.

Practical

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*
2. Binary fission and Conjugation in *Paramecium*
3. Examination of pond water collected from different places for diversity in Protista
4. Study of Sycon (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*
5. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/microphotographs)
7. Study of adult *Ascaris lumbricoides* and its life stages (slides/micro-photographs)
8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

Suggested readings

1. Ruppert and Barnes (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JI (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science.
3. Barrington EJW (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson

Minor Courses:

Semester	Minor Course	Course Title	Credits
II	2	Animal diversity of non chordates (Coelomates)	Theory: 03 Practical: 01

About the course

To discuss representative lineages of the protostome coelomates, including molluscs, annelids and arthropods. Students will know how are these groups of animals similar? What morphological and developmental patterns do they have in common? How do they differ?

They will know the importance of segmentation in the annelids. Students will come to know why the animals in Phylum Arthropods are thought to be so successful.

Course Outcomes

1. Compare the two groups (Acoelomate and Coelomates) of animals with true coeloms.
2. Compare the differences in development seen in these two groups.
3. Compare the protostomes and deuterostomes
4. Explain the characteristics of arthropods that have made them successful.
5. Review the diversity of arthropod groups, including trends in arthropod evolution.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Introduction to Coelomates and Annelida

12 Lecture

Evolution of coelom and metamerism. General characteristics and Classification up to classes; Type study of *Pheretima*; Metamerism in Annelids.

Unit 2: Arthropoda

15 Lecture

General characteristics and Classification up to classes; Type study of *Periplanata*; Vision and Respiration in Arthropoda; Larval forms in Arthropoda; Metamorphosis in Insects; Social life in bees.

Unit 3: Onychophora

03 Lecture

General characteristics and Evolutionary significance with special reference to *Peripatus*.

Unit 4: Mollusca

12 Lecture

General characteristics and Classification up to classes; Type study of *Pila*; Respiration in Mollusca; Torsion and detorsion in Gastropoda; Pearl formation in bivalves; Evolutionary significance of trochophore larva.

Unit 5: Echinodermata

10 Lecture

General characteristics and Classification up to classes; Type study of *Asterias*; Water-vascular system in Asteroidea; Larval forms in Echinodermata; Affinities with Chordates.

Practical

1. Study of following specimens:
2. **Annelids:** *Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria* etc.
3. **Arthropods :** *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta*, termites and honey bees etc.
4. **Onychophora:** *Peripatus*
5. **Molluscs:** *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus* etc.
6. **Echinodermates:** *Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria* and *Antedon* etc.
7. Study of digestive system of earthworm
8. Study of septal nephridia and pharyngeal nephridia of earthworm
9. T. S. through pharynx, gizzard, and typhlosolar intestine of earthworm
10. Mount of mouth parts and dissection of digestive system of *Periplaneta*
11. Dissection of nervous system of *Periplaneta*
12. To submit a project report on any related topic to larval forms (crustacean, mollusc and echinoderm)

Suggested readings

1. Ruppert and Barnes (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JI (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science.
3. Barrington EJW (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.
4. Nigam (1997). Biology of Chordates, S. Chand.
5. Kotpal, Modern text book of Zoology: Vertebrates, Rastogi Publication.

Minor Courses:

Semester	Minor Course	Course Title	Credits
III	3	Diversity of chordates	Theory: 03 Practical: 01

About the course

By the study of diversity of chordates, it would be easy to know about the species of chordates surviving in different ecological areas of world. It would also be very useful that how these species may be harmful or useful for mankind.

Course outcomes

1. To get information about the diversity of chordates
2. To have awareness about the beneficial and harmful chordates
3. To know about the endangered species of chordates
4. To know about the management of chordates
5. To understand how environment helps to acquire adaptation over a long period of time in different animals.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Introduction and origin of Chordates

05 Lecture

General characteristics and outline classification, Dipleurula concept and the Echinoderm theory of origin of chordates, Advanced features of vertebrates over protochordates.

Unit 2: Protochordata

08 Lecture

General characteristics of Hemichordata, Urochordata and Cephalochordata, Study of larval forms in Protochordates, Retrogressive metamorphosis in Urochordata.

Unit 3: Agnatha and Pisces

10 Lecture

General characteristics and classification of cyclostomes up to orders; General characteristics of Chondrichthyes and Osteichthyes and Classification up to orders, Skin and Scales, Migration, Osmoregulation and Parental care in fishes.

Unit 4: Amphibia and Reptilia

13 Lecture

Origin of *Tetrapoda* (Evolution of terrestrial ectotherms), General characteristics and classification of Amphibia up to orders, Parental care in Amphibians; General characteristics and classification of Reptilia up to orders, Affinities of *Sphenodon*, Poisonous and non-poisonous snakes, Poison apparatus and biting mechanism.

Unit 5: Aves and Mammalia

16 Lecture

General characteristics and classification of Aves up to orders, *Archaeopteryx*- a connecting link; Principles and aerodynamics of flight, Flight adaptations, Migration in birds; General characters and classification of Mammalia up to orders, Affinities of Prototheria, Metatheria, Adaptive radiation in mammals: locomotory appendages.

Practical

1. Study of following specimens:

Protochordata:

Balanoglossus, *Herdmania*, *Branchiostoma*,

Colonial Urochordata,

Agnatha and Fishes

Petromyzon, *Myxine*, *Scoliodon*, *Sphyrna*, *Pristis*, *Torpedo*, *Chimaera*, *Mystus*, *Heteropneustes*, *Labeo*, *Catla*, *Cirrhinus Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon*, *Diodon*, *Anabas*, Flat fish.

Amphibia and Reptilia

Ichthyophis, *Necturus*, *Rana*, *Bufo*, *Hyla*, *Alytes*, *Salamandra*, *Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Ophiosaurus*, *Draco*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*, *Zamenis*, *Crocodylus*, *Key for Identification of poisonous and non-poisonous snakes*.

Aves and Mammalia

Study of common birds from different orders,

Types of beaks and claws,

Sorex, *Bat (Insectivorous and Frugivorous)*, *Rattus*, *Funambulus*, *Loris*, *Herpestes*, *Erinaceous*,

2. Sections of *Balanoglossus* through proboscis and branchiogenital regions.
3. Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions.
4. Permanent slide of *Herdmania* spicules
5. Internal ear of *scoliodon*
6. Mount of weberian ossicles of *Mystus*/ pecten from Fowl head/Power point.
7. Study of afferent and efferent arteries of fish (*scoliodon*).

Suggested readings

1. Young JZ (2004). The Life of Vertebrates. III Edition. Oxford university press.
2. Darlington PJ. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
3. Hall BK and Hallgrimsson B (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
4. Dorit, Walker and Barnes (1991). Zoology. Brooks Cole; 1 Edition.
5. Nigam (1997). Biology of Chordates, S. Chand.
6. Kotpal : Modern text book of Zoology: Vertebrates, Rastogi Publication.

Minor Courses:

Semester	Minor Course	Course Title	Credits
IV	4	Physiology of regulatory life process	Theory: 03 Practical: 01

About the course

To familiarize students with the principles and basic facts of animal physiology. Emphasis will be placed on control and coordination of tissues, bone and cartilage, muscle and nervous system.

Course outcomes

1. To understand fundamental principles of animal physiology.
2. To understand how these principles are incorporated into to regulate life process.
3. To understand control and coordination of various organ systems in animals i.e. tissues, bone and cartilage, muscle.
4. To understand the working and importance of nervous system in animals.
5. To gain experience in discussing, and answering questions about animal physiology.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Tissues

10 Lecture

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue.

Unit 2: Bone and cartilage

12 Lecture

Structure and types of bones and cartilages, Ossification, bone growth.

Axial skeletal: skull and vertebral column, appendicular skeletal: pectoral and pelvic girdle, limbs, joints.

Unit 3: Muscle

08 Lecture

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus.

Unit 4: Nervous system

10 Lecture

Type of nervous tissue: neuron and glia; Structure of brain, cerebrospinal fluid, neural network, cranial nerves, blood brain barrier, spinal cord anatomy, spinal nerves.

Unit 5: Electrical signal in neurons

10 Lecture

Axonal and synaptic transmission: Membrane potential and action potential; Types of synapses and synaptic knobs; Excitatory and inhibitory post-synaptic potential; Chemical transmission; Neurotransmitters (acetylcholine, catecholamines, serotonin and GABA), neuropeptides.

Practical

1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
3. Study of Axial skeletal: skull and vertebral column
4. Study of, appendicular skeletal: pectoral and pelvic girdle, limbs.
5. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
6. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell.
7. Microtomy: Preparation of permanent slide of mammalian tissues

Suggested readings

1. Guyton AC and Hall JE (2006). Textbook of Medical Physiology. XI Edition. Herculat Asia PTE Ltd. W.B. Saunders Company.
2. Tortora GJ and Grabowski S (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
3. Victor P Eroschenko (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

Minor Courses: **ZOUATT1 and ZOUALT1**

Semester	Minor Course	Course Title	Credits
V	CC-I	Physiology of basic life process	Theory: 03 Practical: 01

Minor Courses: **ZOUATT1 and ZOUALT1**

Semester	Minor Course	Course Title	Credits
VI	CC-I	Parasitology and immunology	Theory: 03 Practical: 01

Minor Courses: **ZOUATT1 and ZOUALT1**

Semester	Minor Course	Course Title	Credits
VII	CC-I	Neuroscience	Theory: 03 Practical: 01

Minor Courses: **ZOUATT1 and ZOUALT1**

Semester	Minor Course	Course Title	Credits
VIII	CC-I	Research methodology and biostatistics	Theory: 03 Practical: 01

Multidisciplinary Course:

Semester	Multidisciplinary Course	Course Title	Credits
II	MDC-1	Elementary Biology -I	Theory: 03

About the course

The course provides a detailed insight into basic concepts of biomolecules and their importance; cellular structure and function. It also gives an account of genetics and evolutionary mechanism.

Course Outcomes

1. Understand the functioning of nucleus and extra nuclear organelles and understand the intricate cellular mechanisms involved.
2. Understand about the importance and scope of biomolecules. Understand the structure and biological significance of carbohydrates, proteins, lipids and nucleic acids.
3. Understand how DNA encodes genetic information and the function of mRNA and tRNA. Apply the principles of Mendelian inheritance.
4. Understand how developmental processes and gene functions within a particular tissue or organism can provide insight into functions during evolution.

Course Outcomes and their mapping with Programme Outcomes:

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	2	2	3	1	1
CO2	3	3	3	1	2	2	3	1	1
CO3	3	3	3	1	2	2	3	1	1
CO4	3	3	3	1	2	2	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Biomolecules

10 Lectures

Chemical foundation of life. Principle of bimolecular organization, configuration and conformation. Water as biological solvent. Structure and biological importance of carbohydrates, lipids, proteins and nucleic acids.

Unit 2: Cell

10 Lectures

General structure of prokaryotes, bacteria, archaea and eukaryotes. Cell theory. Structure and functions of endoplasmic reticulum, ribosome, golgi apparatus, lysosome, peroxisomes, mitochondria, cytoskeleton, and nucleus. Cell cycle, cell division- mitosis and meiosis.

Unit 3: Genetics

10 Lectures

Mendel's laws of inheritance; Exceptions to Mendelian Inheritance: Incomplete dominance, Codominance, Multiple allelism ; Concept of Gene; Elementary idea of gene expression and regulation; Mutation; Genetic disorders: chromosomal aneuploidy (Down, Turner and

Klinefelter syndromes), chromosome translocation (Chronic Myeloid Leukemia) and deletion (cry of cat syndrome), gene mutation (sickle cell anemia).

Unit 4: Evolutionary biology

10 Lectures

Origin of life on earth, Miller-Urey Experiment; Oparin-Haldane theory; Sources and types of variations; Theories of evolution: Lamarckism; Darwinism; Mutation theory, Modern synthetic theory; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive); Isolating mechanisms and modes of speciation.

Recommended readings

1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments (6th edition) John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology (8th edition) Lippincott Williams and Wilkins, Philadelphia.
3. Nelson, D.L. & Cox, M.M. (2017) Lehninger Principles of Biochemistry (7th edition) Worth.
4. Berg, J.M.; Tymoczko, J.L. and Stryer, L. (2012) Biochemistry (7th edition) Freeman.
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. (VIII edition) Wiley India.
6. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. (V edition) John Wiley and Sons Inc.
7. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2012). Concepts of Genetics. (X edition) Benjamin Cummings.
8. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007) Evolution. Cold Spring, Harbour Laboratory Press.
9. Hall, B. K. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and Bartlett

Multidisciplinary Course:

Semester	Multidisciplinary Course	Course Title	Credits
I	MDC-II	Elementary Biology -II	Theory: 03

About the course

The course provides an insight into elementary biology for non biology background learners.

Course outcomes

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

1. Able to identify and differentiate different types of tissue.
2. Understand the structure and function of respiratory and circulatory systems.
3. Able to understand functioning of digestive and excretory system.
4. Understand the structure and function of reproductive system and importance of endocrine system in our daily life processes.

Course outcomes and their mapping with programme outcomes

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	1	3		
CO2	3	3	3	-	2	2	2		
CO3	3	3	1	-	3	1	2		
CO4	3	3	3	2	2	2	2		

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Animal tissue

10 Lectures

General introduction of tissue; Epithelial tissue: Characteristics and types; Connective tissue: connective tissue proper; vascular tissue (composition and functions of blood and bone); muscular tissue (types, characteristics and functions); nervous tissue (types and functions).

Unit 2: Respiratory and circulatory system

10 Lectures

Structural organization and functions of respiratory system; general concept of breathing and respiration; Respiratory pigment: Structure and functions of hemoglobin. Structure and functions of mammalian heart; Circulation; Origin and conduction of cardiac impulses; Cardiac cycle; Blood clotting; Blood groups.

Unit 3: Digestive and excretory system

10 Lectures

Structural organization and functions of gastrointestinal tract and associated glands; Digestion and absorption of food (carbohydrates, lipids, proteins and vitamins); Balance diet. Structure of kidney and its functional unit; general mechanism of urine formation; Kidney function test.

Unit 4: Reproductive system and endocrinology

10 Lectures

Modes of reproduction- asexual and sexual reproduction; Male and female reproductive organs, Accessory sex organs; Reproductive cycles; Gametogenesis; Fertilization.

Definition and Classes of hormones; General structure and function of endocrine glands; Brief idea about regulation of hormone action.

Recommended readings

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Herculon Asia PTE Ltd. W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills

Skill Enhancement Course (SEC):

Semester	SEC	Course Title	Credits
I	SEC-1	Aquaculture	Theory: 02 Practical: 01

About the course

This course will give the students an understanding of the principles of aquaculture, including production systems, water quality, nutrition, spawning, larval culture and culture methodologies with special reference to fish, and prawn. The course will include an opportunity to conduct hands-on activities related to culture and husbandry of animals

Course outcomes

After completing this course the learners will be able to

1. Understand the aquaculture systems
2. Understand pond management to increase fish production
3. Understand fish breeding and health management
4. Understand the environmental impacts on aquaculture

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	1	2	-	-	1
CO2	3	1	3	1	1	2	1	1	2
CO3	3	3	2	2	2	3	1	1	2
CO4	3	1	3	1	2	3	-	1	2

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Freshwater aquaculture systems

08 Lecture

Aquaculture concept, Culture systems: Freshwater prawn culture, fish culture in paddy fields, Culture of Catfishes. Composite fish culture: Techniques of composite culture. Composite fish farming in India. Mariculture: Brackish water prawn culture. Mussel culture. Culture of aquatic weeds.

Unit 2: Preparation and management of fish culture ponds

08 Lecture

Fish culture ponds. Pond management: Fish toxicants. Predatory and Weed fishes and their control. Aquatic insects and their control. Fish manures. Water quality. Culture: Pond culture. Monoculture. Monosex culture. Supplementary feeding. Harvesting: Fishing techniques, preservation & processing of fish.

Unit 3: Fish breeding, Transportation and Pathology

09 Lecture

Fish breeding: Natural and artificial. Fish transportation: Methods for packaging and transport of fish. Transport of fish seed and Brood fish. Causes of mortality in transport. Use of chemicals in live fish transport: Anesthetic drugs. Antiseptics and Antibiotics. Fish diseases: Bacterial, fungal, protozoan and helminthes diseases. Non parasitic diseases.

Unit 4: Technologies in Fisheries development

10 Lecture

Pearl culture: Introduction, Pearl producing mollusks, pearl formation, collection of oysters, Rearing of oysters, insertion of nucleus, harvesting of pearls, composition & quality of pearl.

Recirculation technology. Geographic Information System (GIS) technology. Passive Acoustics in fisheries, Use of Information Communication Technology (ICT) in fishes: production aspects, marketing aspects.

Practical

1. Estimation of dissolved oxygen
2. Determination of pH of water samples
3. Measuring turbidity using a secchi disk
4. Measuring salinity of water
5. Total alkalinity measurement in natural waters
6. Phytoplankton analysis
7. Measurement of productivity
8. Study of major carps
9. Study of prawn species
10. Study of pearl oysters

Suggested readings

1. Jingran, V. G. (1983) Fish and fisheries of India , Hindustan pub. corp. New Delhi.
2. Hute, M. and Kahn, H. (2000) Textbook of fish culture, Blackwell Scientific Publication, Australia.
3. Srinivasulu, M., Reddy, K.R.S., Rao, S. (1999) Text book of Aquaculture, Discovery Publishing House New Delhi.
4. Yawn Mehta, Fisheries & Aquaculture Biotechnology (2011) Campus Books International, Prahalad street, Ansari Road, Durga Ganj, New Delhi.

Skill Enhancement Course (SEC):

Semester	SEC	Course Title	Credits
II	SEC-2	Apiculture	Theory: 02 Practical: 01

About the course

This course tells the students what tools and equipment will be needed, the main activities in the beekeepers year, the laws and by laws governing keeping bees; discover the principles of sustainable beekeeping and how these principles can guide your beekeeping into an enduring practice.

Course outcomes

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

1. Understand about bees and colony organization
2. Understand about beekeeping as a highly profitable occupation
3. Understand bee keeping technology and bee products
4. Understand about National Institutes and their contribution in beekeeping

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Introduction to Apiculture

08 Lectures

History of Bees and Beekeeping. Bee species: Types of Bees. Morphology Caste system. Colony organization. Bee flora, Foraging.

Unit 2: Bee keeping as an occupation

08 Lectures

Extent of Beekeeping India. Limitations on the development of beekeeping, Advantages of extensive Beekeeping. Beekeeping equipments: Rearing appliances and initiation into keeping a colony. The future of beekeeping.

Unit 3: The first step in beekeeping

10 Lectures

Apiary site. Purchase and Establishment of a bee colony. Management and manipulation of bee colony. Bee products: Honey, Bees wax, Pollens, Royal Jelly, Propolis and Bee venom. Taking care of bee diseases and enemies.

Unit 4: Beekeeping techniques and Apiary management

09 Lectures

Routine and Seasonal management, Migratory beekeeping, Harvesting and marketing of bee products. Important Institutions pertinent to Apiculture: National Bee Board, Bee research and Training Institute, Apiaries. Economics and extension of Bee keeping.

Practical

1. Study of different species of honey bee
2. Study of various host flowers of honey bee
3. Study of various caste of honey bee
4. Study of life cycle of honey bee
5. Study of Movable hive (Newton's hive) for apiculture
6. Study of various appliances used in apiculture
7. Study of foraging legs of honey bee
8. Preparation of temporary mount of mouth parts of honey bee
9. Preparation of temporary mount of sting apparatus of honey bee
10. Study of various diseases of honey bee affecting apiculture

Suggested readings

1. Abrol , D. P. (1997) Bees and Beekeeping. Kalyani Publisher, New Delhi.
2. Abrol, D. P. (2010) A Comprehensive guide to Bees and Beekeeping. Scientific Publisher, New Delhi.
3. Withhead, S. B. (2010) Honey bees and their management Axis books Publisher, Jodhpur.
4. Nagaraja, N. and Rajagopal , D. (2013) Honey bees: Diseases, Parasites, Pests, Predator and their management. M.J.P Publisher, Chennai.
5. Dharamsing and Singh, D. P. A Handbook of Beekeeping, Agrobios India (Publisher), Jodhpur.

Skill Enhancement Course (SEC):

Semester	SEC	Course Title	Credits
III	SEC-3	Sericulture	Theory: 02 Practical: 01

About the course

The course gives insight into the principles of sustainable sericulture and how these principles can guide your silkworm rearing into an enduring practice. The students will know about the laws and by laws governing keeping silkworm.

Course Outcomes

1. To know about importance of sericulture in the rural development and various species of silk moth.
2. To know biology of silkworms and technologies used in sericulture.
3. To know about the pests and diseases of silkworms and their control.
4. To know about the Institutions promoting sericulture in rural areas.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Silkworm distribution and races

08 Lecture

The silkworms: Definition, history and present status of sericulture. World silk production and silk road. Distribution and types of races. Morphological characteristics. Mulberry and non-mulberry sericulture. Sericultural practices in tropical and temperate climate.

Unit 2: Biology of silkworm and technologies used in sericulture

08 Lecture

Biology of silkworm: Life cycle of *Bombyx mori*. Structure of silk gland and Secretion of silk. Selection of mulberry variety. Propagation and establishment of mulberry garden, Rearing house and rearing appliances. Silkworm rearing technology: Early age and Late age rearing. Mounting. Spinning. Quality and storage of cocoons. Stifling. Reeling.

Unit 3: Diseases of silk worm and prevention and control

09 Lecture

Diseases and Enemies of silkworm: Uzi fly, dermestid beetles and vertebrates. Protozoan, viral, fungal and bacterial diseases. Control and prevention of pests and diseases. Disinfectants: Formalin, bleaching powder RKO.

Unit 4: Prospects of Sericulture in India

10

Lecture Prospects of Sericulture in India. Silk industry in different states. Employment generation in sericulture. Role of women in sericulture. Sericulture organization in India; Role of state departments of Sericulture, Central Silk Board, Universities and NGOs in Sericulture development.

Practical

1. Study of various species of silkmoths
2. Study of different host plants of silkmoths
3. Identification of male and female silk moths and pupae
4. Study of life cycle of mulberry silkmoth
5. Study of 5th instar larva of silk moth
6. Study of rearing appliances used in sericulture
7. Dissection of Alimentary canal of silkmoth
8. Dissection of Silk gland
9. Preparation of temporary mount of mouthparts of silkmoth
10. Study of various diseases of silkmoths affecting sericulture

Suggested readings

1. Manual on sericulture (1976). Rome: Food and Agriculture Organization of the United Nations, Agricultural Services Division.
2. Ullal, S.R. and . Narasimhanna, M.N. (1987) Handbook of Practical Sericulture: CSB, Bangalore
3. Silkworm Rearing and Disease of Silkworm (1956) Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, angalore
4. Jolly, M. S. (1986) Appropriate Sericultural Techniques; Ed., Director, CSR & TI, Mysore.
5. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1 (1972) Fuzi Pub. Co. Ltd., Tokyo, Japan.
6. Narasimhanna, M. N. (1988) Manual of Silkworm Egg Production;, CSB, Bangalore.
7. Sengupta, K. (1989) A Guide for Bivoltine Sericulture. CSR & TI, Mysore.

Value Added Courses:

Semester	VAC	Course Title	Credits
I	VAC-1	History of Indian science	Theory: 02

About the course

The course provides an insight into the status of science in ancient India, its gradual development, innovations and the pioneers in the field of science, reputed research institutions in India and cutting edge research in science.

Course outcomes

1. The students will feel pride to know the pioneer role of Indians in the development of astronomy, mathematics, engineering and medicine in the World history.
2. Develop understanding of various branches of science during different eras and analyze the role played by different Indian organizations in science.
3. Appraise the contribution of different Indian Scientists.
4. Students will be aware about the modern development of animals, agriculture and biological sciences in republic India.

Course Outcomes and their mapping with Programme Outcomes

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	3	2	3	3	2	1	3	2
CO2	3	3	2	3	2	2	2	3	3
CO3	3	2	2	2	2	1	2	3	2
CO4	3	2	1	2	1	2	2	2	1
CO5	-	-	-	-	-	-	-	-	-

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit I: Science in ancient and medieval India

10 Lecture

History of development in astronomy, mathematics, engineering and medicine subjects in Ancient India, Influence of the Islamic world and Europe on developments in the fields of mathematics, chemistry, astronomy and medicine.

Unit 2: Prominent Indian scientists

12 Lecture

Eminent scholars in mathematics and astronomy: Baudhayana, Aryabhata, Brahmgupta, Bhaskaracharya, Varahamihira, and Nagarjuna, Medical science of Ancient India (Ayurveda and Yoga): Susruta, Charak. Scientists of Modern India: Srinivas Ramanujan, C.V. Raman, Jagdish Chandra Bose, Homi Jehangir Bhabha, Vikram Sarabhai etc.

Unit III: Indian science in before and after Independence

13 Lecture

Introduction of different surveyors, zoologists and doctors as early scientist in Colonial India, Indian perception and adoption for new scientific knowledge in Modern India, Establishment of premier research organizations like CSIR, DRDO and ICAR and ICMR, IIT's, Establishment of Atomic Energy Commission, Launching of the space satellites, ISRO's accomplishments. Zoological survey of India.

Recommended readings

1. Kuppuram, G. (1990) History of Science and Technology in India, South Asia Books.
2. Handa, O.C. (2014) Reflections on the history of Indian Science and Technology, Pentagon Press.
3. Basu, A. (2006) Chemical Science in Colonial India: The Science in Social History, K.P. Bagchi & Co.
4. Habib, I. (2016) A people's history of India 20: Technology in Medieval India, 5th Edition, Tulika Books.
5. Rahman, A. et al (1982) Science and Technology in Medieval India – A Bibliography of Source Materials in Sanskrit, Arabic and Persian, New Delhi: Indian National Science Academy.
6. Subbarayappa, B.V. & Sarma, K.V. (1985), Indian Astronomy – A Source Book, Bombay.
7. Srinivasan, S., Ranganathan, S. (2013) Minerals and Metals heritage of India, National Institute of Advanced Studies.
8. Srinivasiengar, C.N. (1967) The History of Ancient Indian Mathematics, World Press Private Ltd. Calcutta.
9. Bhardwaj, H.C. (2000) Metallurgy in Indian Archaeology. Tara Book Agency

Value Added Courses:

Semester	VAC	Course Title	Credits
I	VAC-II	Food, Nutrition and Health	Theory: 02

About the course

The course covers the basic concepts of balanced diet for people of different ages besides focusing on the consequences of malnutrition and the deficiency diseases and the diseases caused due to poor hygiene.

Course outcomes

1. Imparting the basic concept of food and nutrition including the concept of a balanced diet, nutrient needs, and dietary patterns for various groups.
2. Understanding the biochemistry of major food components and the effects of their deficiency on health and evaluating the effectiveness of nutrition interventions when dealing with certain health problems.
3. Understanding the importance of lifestyle-related diseases, their causes, and prevention through dietary and lifestyle modifications.
4. Understand the importance of food and water safety and methods associated with the preservation of food and purification of contaminated water and make students aware of food, nutrition, and health needs.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	-	3	-	3	-	1
CO2	2	3	-	1	2	-	2	2	1
CO3	1	2	1	1	2	2	2	1	-
CO4	2	1	1	2	2	1	1	2	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Nutrition and dietary nutrients

08 Lectures

Basic concept of Food: Components and nutrients. Concept of balanced diet, nutrient requirements and dietary pattern for different groups viz., adults, pregnant and nursing mothers, infants, school children, adolescents and elderly people.

Unit 2: Macro nutrients and micronutrients

09 Lectures

Nutritional Biochemistry: Macronutrients. Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role. Micronutrients. Vitamins- Water-soluble and Fat-soluble vitamins- their sources and importance. Important minerals viz., Iron, Calcium, Phosphorus, Iodine, Selenium and Zinc: their biological functions.

Unit 3: Malnutrition and nutrient deficiency diseases

10 Lectures

Definition and concept of health: Common nutritional deficiency diseases- Protein Malnutrition (e.g., Kwashiorkor and Marasmus), Vitamin A deficiency, Iron deficiency and Iodine deficiency disorders- their symptoms, treatment, prevention and government initiatives, if any. Life style dependent diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention. Social health problems-

smoking, alcoholism, narcotics. Acquired Immuno Deficiency Syndrome (AIDS): causes, treatment and prevention. Other ailments viz., cold, cough, and fever, their causes and treatment.

Unit 4: Diseases caused by microorganisms

10 Lectures

Food hygiene: Potable water- sources and methods of purification at domestic level. Food and Water-borne infections: Bacterial diseases: cholera, dysentery; typhoid fever, viral diseases: Hepatitis, Poliomyelitis etc., Protozoan diseases: amoebiasis, giardiasis; Parasitic diseases: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention. Causes of food spoilage and its prevention.

Suggested readings

1. Mudambi, S.R. and Rajagopal, M.V. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed.; New Age International Publishers
2. Srilakshmi, B. (2002). Nutrition Science; New Age International (P) Ltd.
3. Srilakshmi, B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.
4. Swaminathan, M. (1986). Handbook of Foods and Nutrition; Fifth Ed; BAPPCO.
5. Bamji, M.S.; Rao, N.P. and Reddy, V. (2009). Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd.
6. Wardlaw, G.M. and Hampl, J.S. (2007). Perspectives in Nutrition; Seventh Ed; McGraw Hill.
7. Lakra, P. and Singh M.D. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.
8. Manay, M.S. and Shadaksharaswamy, M. (1998). Food-Facts and Principles; New AgeInternational (P) Ltd.
9. Gibney, M.J. et al. (2004). Public Health Nutrition; Blackwell Publishing.

Vocational Courses:

Semester	Vocational Course	Course Title	Credits
-----	VC-I	Medical diagnostics	Tutorial: 02 Practical: 02

About the course

The course covers the basic concepts, methods and importance of medical diagnostic for people of different ages.

Course outcome

1. To familiarize the students regarding various dimensions of Medical lab technology and career opportunities available in these fields.
2. To provide intensive training on collection of sample and disposal of waste.
3. To provide hands-on training regarding investigation of blood for diagnosing various disease.
4. To provide an insight to the students regarding utility of Urine & Feces Analysis Investigation

Course Outcomes and their mapping with Programme Outcomes:

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	-	3	-	3	-	1
CO2	2	3	-	1	2	-	2	2	1
CO3	1	2	1	1	2	2	2	1	-
CO4	2	1	1	2	2	1	1	2	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Tutorial + Practical

Unit 1: Introduction to medical diagnostics and its importance

15 hours

Functional components of Chemical Laboratories, Identification of common equipment, principle and care of laboratory instruments. Basic needs of clinical laboratory technician, awareness of soft skills. NABL and SOP. Basic causes of accidents in laboratories; Personnel care and protection

Unit 2: Collection of specimen and disposal of waste

15 hours

General principles, containers, rejection. Samples-Urine, Faeces, Sputum, Pus, Body Fluids, Swab, Blood. Importance of biomedical waste. Disposal of laboratory/hospital waste. Non-infectious waste, infected sharp waste disposal, infected non-sharp waste disposal.

Unit 3: Basic haematological techniques and diagnostic methods for blood analysis

20 hours

Preparation of blood collection-Basic steps for drawing blood by vein, capillary and artery puncture. Complications during and after blood collection. Specimen rejection criteria for blood. Anticoagulants-types and concentration. Transport of blood sample. Effect of storage on blood cell morphology. Universal precautions. Blood composition, Preparation of blood smear and Differential Leukocyte Count using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate, Packed Cell Volume.

Unit 4: Diagnostic methods used for urine analysis**10 hours**

Urine analysis: Urine collection, preservation. Physical examination of urine, Abnormal constituents, Urine culture. Urinary tract infection, Kidney Disease and diabetes. Urine analysis for Chemicals, Sugar, Ketone Bodies, Bile, Blood, Crystals.

Suggested readings

1. Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers
2. Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani Publishing House
3. Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
4. Guyton A.C. and Hall J.E. *Textbook of Medical Physiology*, Saunders
5. Robbins and Cortan, *Pathologic Basis of Disease*, VIII Edition, Saunders
6. Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd.

Vocational Courses:

Semester	Vocational Course	Course Title	Credits
-----	VC-2	Ornamental fish culture	Tutorial: 02 Practical: 02

About the course

To make the students aware of the vast potentials involved in ornamental fish farming and trading besides making them learn the diseases in fishes and other constraints in their culturing.

Learning outcomes

After completing this course the learners will be able to:

1. To learn the scientific method of setting an aquarium.
2. To learn the culture breeding and marketing techniques of common indigenous ornamental fishes.
3. To learn about feeding mechanism for ornamental fishes.
4. To learn about pathology of ornamental fishes.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	-	3	-	3	-	1
CO2	2	3	-	1	2	-	2	2	1
CO3	1	2	1	1	2	2	2	1	-
CO4	2	1	1	2	2	1	1	2	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Tutorial + Practical

Unit 1: Designing and preparation of aquaria with all accessories

13 Lectures

Design and construction of aquaria: aquarium fabrication- shape, size, volume, type of glass tank, preparation of glass tank; aquarium floor setting – type and size of pebbles, gravels, granites used for bed setting and its advantages. Filters- biological, chemical and mechanical. Aquarium accessories like aerators, decorative, lighting, heating and feeding trays. Water quality management in aquarium systems – sources of water, containers, storage, temperature, pH, dissolved carbon dioxide, ammonia, hardness, turbidity in aquarium. Aquarium plants: Uses of aquarium plants, different varieties of plants.

Unit 2: Common fresh water ornamental fishes.

12 Lectures

Fresh water ornamental fishes : Common ornamental fishes- indigenous and exotic species; Identification and biology of the common ornamental fishes. *Cyprinus carpio* (koi carp), *Molliensia sphenops* (black molly lyre tail), *Poecilia reticulata* (guppy), *Poecilia latipinna*, *Xiphophorous helleri* (red sword tail) *Xiphophorous maculatus* (red platy) *Pterophyllum scalare altum* (angel fish) *Carassius auratus* (red oranda) *Betta splendens* (Siamese fighting fish) *Trichogaster leeri* (pearl gourami). Live bearers and egg layers.

Unit 3: Important indigenous ornamental fishes.

13 Lectures

Indigenous ornamental fishes - Common indigenous ornamental fishes. Identification and biology of the common ornamental fishes. Cyprinids : *Puntius denisonii* (red line torpedo fish), *Puntius fasciatus* (melan barb), *Puntius filamentosus* (Indian tiger barb), *Puntius curmuca* (red tailed silver shark), *Danio malabaricus* (Malabar danio); Loaches: *Nemacheilus triangularis* (Zodiac loach), *Lepidocephalus thermalis* (Malabar loach); Cichlids: *Etroplus maculatus* (yellow and orange chromides), *E . suratensis*

(pearl spot), Anabantids: *Anabas testudineus* (climbing perch) and Catfishes : *Horabagrus brachysoma* (Yellowish catfish), *H. nigricollaris* (White collared imperial catfish).

Unit 4: Management of the brood stock

13 Lectures

Breeding and rearing of common ornamental fishes. Conditions for breeding- pH, temperature and sex ratio. Brood stock management- selection of brooders, maintenance and management of brood stocks. Induced breeding. Colour enhancement techniques. Food and feeding - live feed and formulated feed. Preparation and culture of live feed (*Artemia*, *Infusoria*, *Spirulina*). Control of algal growth, snails and other predators. Common disease of ornamental aquarium fishes - their causative agents - virus, bacteria, fungi, protozoa and nematode; symptoms, treatment.

Suggested readings

1. Axelord, H.R. (1967). Breeding aquarium fishes, T F H Publications.
2. Mills, D. (1981). Aquarium Fishes, Arco publishing.
3. Mills, D. and Vevers, G. (1982). The Practical encyclopedia of fresh water ,Tropical Aquarium fishes, Salamander Books limited, London.
4. Gahlawat, S.K., et.al. (2007). Manual of experimental Ichthyology, Daya publishing House, Delhi.
5. Brunner, G. (1973). Aquarium plants, T F H Publications, Inc. Ltd., Hongkong.
6. Hansen, J. (1979). Making your own aquarium, Bell and Hyman Ltd., London.
7. Lovell, T. (1998). Nutrition and feeding of fish second Ed. Kluwer Academic publishers.
8. Talwar, P.K., and Jhingran, A.G. (1991). Inland fishes Oxford and IBH Publishing Co. PVT LTD,New Delhi.

Vocational Courses:

Semester	Vocational Course	Course Title	Credits
-----	VC-3	Histological techniques and light microscopy	Theory: 04

About the course

This is laboratory course taught independently of lecture courses. It has full hands on approach to expose the students to study modern techniques and methodologies for histological details. The techniques of microscopy make the student well versed with anatomy and physiology of different organs.

Learning outcomes Bhaskar sir

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

1. Understand the mechanism and function of fixatives.
2. Acquire the detailed knowledge of different stages of tissue processing for histological analysis.
3. Understand the mechanism and function of dyes, mordents and specific stains.
4. Develop an understanding how cells work in healthy and diseased states with the help of histochemical localization.
5. Acquire the detailed knowledge of microscope and their biological applications

Course Outcomes and their mapping with Programme Outcomes:

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	-	3	-	3	-	1
CO2	2	3	-	1	2	-	2	2	1
CO3	1	2	1	1	2	2	2	1	-
CO4	2	1	1	2	2	1	1	2	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Tutorial + Practical

Unit 1: Fixation and tissue processing

15 hours

Types of fixatives, Chemistry of fixation, Choice of fixatives, Dehydration, Clearing and embedding. Microtomy: Types of microtome, Sectioning of paraffin blocks.

Unit 2: Principle and methods of staining

15 hours

Dyes and stains, Mordents, Histological stains: haematoxylin and eosin. Glycogen and glycoproteins by periodic acid Schiff's method, Glycoproteins by alcian blue methods, General lipids by Sudan black B method Neutral lipids by Sudan III and Sudan IV methods.

Unit 3: Staining of genetic material and enzymes

15 hours

Nucleic acids: Methyl green pyronin-Y for DNA and RNA, Feulgen reaction for DNA. Protein end groups: General protein localization by bromophenol blue method; -NH₂ groups by Ninhydrin-Schiff method. Detection of enzyme activity: Acid / alkaline phosphatases.

Unit 4: Microscopy

15 hours

Basic principle, Types of microscope and their biological applications, Bright-field microscope: numerical aperture, limit of resolution, types of objectives, ocular and stage micrometers, Dark-field

microscope, Phase contrast microscope, Differential interference contrast microscope, Fluorescence microscope.

Suggested readings

1. Bancroft & Stevens: Theory and Practice of Histological techniques (2002, Churchill- Livingstone)
2. Casselman: Histochemical techniques (1959, John Wiley)
3. Pearse: Histochemistry: Theoretical and Applied (Vol. I, II & III) (4th ed 1980-1993, Churchill-Livingstone).
4. Alberts et al: Molecular Biology of the Cell (2002, Garland)
5. Pollard & Earnshaw: Cell Biology (2002, Saunders)
6. Ruthman: Methods in Cell Research (1970, Bell & Sons)