

SCHEME AND SYLLABUS UNDER CHOICE BASED CREDIT SYSTEM
B.Sc. ZOOLOGY with HONOURS

Semesters	CORE COURSE (14)	Ability Enhancement Compulsory Courses AEC (2)	Generic Elective Courses GE(4)	Skill Enhancement Courses SEC (2)	Discipline Specific Elective DSE (4)
I	CC 1: Basic Concept of Taxonomy & Non Chordates I: Protista to Pseudocoelomates CC 2: Principles of Ecology	Environmental Science	GE 1		
II	CC 3: Non-chordates II: coelomates CC 4: Animal physiology	English Communication	GE 2		
III	CC 5: Diversity of Chordates CC 6: Comparative Anatomy of Vertebrates CC 7: Fundamentals of Biochemistry		GE 3	SEC 1	
IV	CC 8: Cell Biology CC 9: Parasitology & Immunology CC 10: Biochemistry of Metabolic		GE 4	SEC 2	
V	CC 11: Molecular Biology CC 12: Developmental Biology				DSE 1 DSE 2
VI	CC 13: Principles of Genetics CC 14: Evolutionary Biology				DSE 3 DSE 4

Discipline Core Courses: Zoology (SEM I to SEM VI)

1. Basic Concept of Taxonomy & Non Chordates I: Protista to Pseudocoelomates
2. Principles of Ecology
3. Non-chordates II: coelomates
4. Animal physiology
5. Diversity of Chordates
6. Comparative Anatomy of Vertebrates
7. Fundamentals of Biochemistry
8. Cell Biology
9. Parasitology & Immunology
10. Biochemistry of Metabolic processes
11. Molecular Biology
12. Developmental Biology
13. Principles of Genetics
14. Evolutionary Biology

Generic Elective Courses: Zoology (SEM I TO IV)

1. Animal Diversity
2. Aquatic Biology
3. Environment & Public Health
4. Physiology

Discipline Specific Elective Courses: Zoology (Any two: SEM V & VI)

1. Animal behaviour & Chronobiology
2. Biology of Insecta
3. Parasitology
4. Aquatic Biology

Skill Enhancement Courses: Zoology (SEM III to VI)

1. Apiculture
2. Sericulture
3. Aquarium Fish Keeping
4. Quantification Techniques

CORE COURSE I

Basic Concept of Taxonomy & Non Chordates I: Protista to Pseudocoelomates

THEORY (Credits 4)

Unit 1: Basics of Animal Classification

Definitions: Classification, Systematics and Taxonomy; Hierarchy, Taxonomic types;
Codes of Zoological Nomenclature; Principle of priority; Synonym and Homonym;
Species Concept – Biological and evolutionary; basic idea of cladistics

Unit 2: Protista, Parazoa and Metazoa	19
General characteristics and Classification up to classes	
Study of <i>Euglena</i> , <i>Amoeba</i> and <i>Paramecium</i> (Structure, locomotion, reproduction & nutrition)	
Life cycle and pathogenicity of <i>Plasmodium vivax</i> and <i>Entamoeba histolytica</i>	
Evolution of symmetry, grade of organization and segmentation of Metazoa	
Unit 3: Porifera and Cnidaria and Ctenophora	12
General characteristics and Classification up to classes	
Canal system and spicules in sponges	
Metagenesis in <i>Obelia</i> Polymorphism in Cnidaria Corals and coral reefs	
Unit 5: Platyhelminthes	10
General characteristics and Classification up to classes	
Life cycle and pathogenicity of <i>Fasciola hepatica</i> and <i>Taenia solium</i>	
Unit 6: Nematelminthes	8
General characteristics and Classification up to classes of phylum Nematoda	
Life cycle, and pathogenicity of <i>Ascaris lumbricoides</i> and <i>Wuchereria bancrofti</i>	
Parasitic adaptations in helminthes	

NOTE: Classification to be followed from Ruppert and Barnes Invertebrate Zoology VI edition, except for Protozoa (American Association of Protozoologist ref: Levine 1980) and Porifera (Brusca and Brusca 2002; IV edition. Invertebrate Zoology)

PRACTICALS (Credits 2)

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium*
2. Hay Culture of *Paramecium*
3. Study of diversity in Protista colonized on glass slides submerged at different places/ depth in pond water (7 to 14 days)
4. Study of *Obelia*, *Physalia*, *Porpita*, *Euspongia*, *Scypha*, *Aurelia*, *Tubipora*, Sea Anemone, *Pennatula*, *Fungia*
5. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/ micro-photographs)
6. Study of adult *Fasciola hepatica* and its life stages (Slides/micro-photographs)
7. Preparation of dichotomous key from provided taxonomic data

Note: Classification to be followed from "Ruppert and Barnes (2006) Invertebrate Zoology, 8th edition, Holt Saunders International Edition"

SUGGESTED READINGS

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

CORE COURSE II

Principles of Ecology

THEORY (Credits 4)

Unit 1: Introduction to Ecology

06

Levels of organization, Laws of limiting factors, study of physical factors

Unit 2: Population

24

Population attributes: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, 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; Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition

Unit 3: Community

12

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one example; Theories pertaining to climax community

Unit 4: Ecosystem

14

Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies

Nutrient and biogeochemical cycle with one example of Nitrogen cycle

Unit 5: Wildlife & Conservation

04

Wildlife Conservation (ideas of in-situ and ex-situ conservation) Management strategies for tiger conservation; protection laws for wildlife conservation, Bio-resource assessment and planning

PRACTICALS (Credits 2)

1. Preparation of nested quadrat and estimation of effective quadrat size
2. Determination of population density in a natural/ hypothetical community by quadrat method and calculation of Sorenson's Similarity & Shannon-Weiner diversity indices for the same community
3. Study of an aquatic ecosystem: Major Phytoplankton (Up to Family) and zooplankton (Up to Genus), temperature, turbidity/ penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method) and free CO₂
4. Estimation of Primary productivity by light & Dark bottle method
5. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary/Sea Shore

SUGGESTED READINGS

1. Colinvau, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- 3.

- Odum, E.P., Barrett GW (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Smith RL, Smith TM (2002) Ecology and Field Biology, Benjamin Cumming (Pearson education)
 5. Ricklefs, R.E., Miller G.L. (2000). Ecology. IV Edition. W.H. Freeman and Co.
 6. Stiling P. (2002). Ecology – Science and Applications 2nd edition. Prentice Hall of India

CORE COURSE III

Non-chordates II: coelomates

THEORY	(Credits 4)	
Unit 1: Introduction to Coelomates		02
Evolution of coelom and metamerism		
Unit 2: Annelida		07
General characteristics and Classification up to classes		
Excretion in Annelida		
Unit 3: Arthropoda		16
General characteristics and Classification up to classes		
Vision and Respiration in Arthropoda		
Metamorphosis in Insects		
Social life in honey bees		
Unit 4: Onychophora		04
Affinities, systematic position and evolutionary significance		
Unit 5: Mollusca		16
General characteristics and Classification up to classes		
Respiration in Mollusca		
Torsion and detorsion in Gastropoda		
Biology of pearl formation in bivalves		
Evolutionary significance of trochophore larva		
Unit 6: Echinodermata		15
General characteristics and Classification up to classes		
Water-vascular system in Asteroidea		
Larval forms in Echinodermata		
Affinities with Chordates		
Note: Classification to be followed from "Ruppert and Barnes (2006) <i>Invertebrate Zoology</i> , VI edition, Brooks Cole		
PRACTICAL	(Credits 2)	
1. Study of following specimens:		
Annelids - <i>Aphrodite</i> , <i>Sabella</i> , <i>Serpula</i> , <i>Chaetopterus</i> , <i>Pheretima</i> , <i>Hirudinaria</i>		
Arthropods - <i>Carcinoscorpius</i> , <i>Macrobrachium</i> , <i>Balanus</i> , <i>Eupagurus</i> , <i>Scolopendra</i> , <i>Julus</i> , <i>Bombyx</i> , <i>Apis dorsata</i>		
Onychophora - <i>Peripatus</i>		
Molluscs - <i>Chiton</i> , <i>Dentalium</i> , <i>Pila</i> , <i>Doris</i> , <i>Lamellidens</i> , <i>Pinctada</i> , <i>Sepia</i> , <i>Octopus</i> , <i>Nautilus</i>		
Echinodermites - <i>Astropecten</i> , <i>Ophiura</i> , <i>Strongylocentropus</i> , <i>Cucumaria</i> and <i>Antedon</i>		
2. Study of digestive system, nephridia of earthworm		

3. Study of T.S. through pharynx, gizzard, and intestine of earthworm (Permanent slide)
4. Mount of mouth parts of *Periplaneta*, Mosquito and House fly; dissection of digestive and reproductive system of *Periplaneta*

SUGGESTED READINGS

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VII Edition. Thompson Brooks Cole(International Edition)
2. Barnes, R.S.K., Callow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition,

CORE COURSE IV

Animal physiology

THEORY (Credits 4)

Unit 1: Tissues 06

Classification and functions of epithelial tissue, Connective tissues including bones and cartilages, Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Motor unit

Unit 2: Digestive System 07

Structural organization and functions of gastrointestinal tract and associated glands; digestion; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Gastrointestinal enzymes and hormonal control of their secretion

Unit 3: Respiratory system 06

Histology of trachea and lung in mammals; Mechanism and control of respiration, Respiratory volumes and capacities; Dissociation curves and the factors influencing it

Unit 4: Blood Vascular system 09

Components of mammalian blood and their functions; Structure and functions of haemoglobin; Transport of oxygen and carbon dioxide in blood; Blood groups: Rh factor, MN, ABO and Bombay phenomenon
Structure of mammalian heart, Origin and conduction of cardiac impulses; Cardiac cycle; Cardiac output and its regulation, Frank-Starling Law of the heart

Unit 5: Urino-genital System 07

Structure of kidney and nephron; Urine formation
Histology of testis and ovary; menstrual & estrous cycle

Unit 6: Endocrine System 15

Functions of endocrine glands - pineal, pituitary, thyroid, pancreas, adrenal; hormones secreted by them; regulation of endocrine secretion; Signal transduction pathways for steroidal and non-steroidal hormones; Hypothalamus and neuroendocrine control of anterior pituitary; Placental hormones

Unit 7: Nervous System 10

Structure of neuron; Types of synapse and neuromuscular junction; Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Synaptic transmission; Autonomic Nervous system with reference to V, VII, IX and X cranial nerves

PRACTICALS (Credits 2)

1. Demonstration of the unconditioned reflex action (knee jerk reflex)

2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells (from fish)
3. Study of permanent slides of Mammalian cartilage, stomach, small intestine, liver, lung, kidney, Pancreas, Testis, Ovary, Adrenal, Thyroid.
4. Microtomy: Preparation of permanent slide of five tissues (liver, stomach, kidney, testis, ovary of goat)
5. Determination of ABO Blood group
6. Enumeration of red blood cells and white blood cells using haemocytometer
7. Estimation of haemoglobin using Sahli's haemoglobinometer

SUGGESTED READINGS

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hecourt 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). di Fiore'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
5. C. L. Prosser, Comparative Animal Physiology
6. Schmidt Nielsen, K. (1994) Animal Physiology: Adaptation & Environment, Low priced Cambridge Edition

ORE COURSE V
Diversity of chordates

Theory (Credits 4)

Unit 1: Protochordata	10
General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata, Origin of Chordata	
Unit 2: Agnatha	02
General characteristics and biology of cyclostomes	
Unit 3: Pisces	08
General characteristics of Chondrichthyes and Osteichthyes, classification up to order, Migration, Osmoregulation and parental care in fishes	
Unit 4: Amphibia	07
Origin of Tetrapoda (Evolution of terrestrial ectotherms), General characteristics and classification up to order; Parental care in Amphibians	
Unit 5: Reptilia	08
General characteristics and classification up to order; Affinities of <i>Sphenodon</i> ; Poison apparatus and Biting mechanism in snakes	
Unit 6: Aves	10
General characteristics and classification up to order; Archaeopteryx - a connecting link; Principles and aerodynamics of flight and migration in birds	
Unit 7: Mammalia	09
General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages	
Unit 8: Zoogeography	06
Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms	

PRACTICAL (Credits 2)

- 1. Protochordata** Study of *Balanoglossus*, *Branchiostoma*, Colonial Urochordata, T. S. of *Balanoglossus* through proboscis and branchiogenital regions (Permanent Slide)
- 2. Agnatha** Study of *Petromyzon*, *Myxine*
- 3. Fishes** Study of *Scoliodon*, *Sphyrna*, *Pristis*, *Torpedo*, *Chimaera*, *Mystus vitattatus*, *Heteropneustes*, *Catla*, *Gudusia chapra*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon*, *Anabas*, Flat fish; Dissection of afferent and efferent Branchial system of fish, Mount of Weberian ossicles of any carp, Mount of cycloid and ctenoid scales and study of placoid scale (Permanent Slide)
- 4. Amphibia** *Ichthyophis*, *Necturus*, *Bufo*, *Rachophorous*, *Salamandra*
- 5. Reptilia** *Chelone*, *Hemidactylus*, *Varanus*, *Calotes*, *Chamaeleon*, *Draco*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*
- 6. Aves** Study (Identification & habitat) of six common birds (Crow, Parakeet, Bulbul, Bee-eater, Pigeon and Cuckoo). Types of beaks and claws; Dissection of fowl head to do Vth and VIIth cranial nerves, pecten from fowl

7.

Mammalia *Sorex, Pteropus, Funambulus, Bandicoota, Cavia*

Classification from Young, J. Z. (1981) to be followed except for for classification fishes

SUGGESTED READINGS

1.

Young, J. Z. (1981). *The Life of Vertebrates*. III Edition. Oxford university press.

2.

Pough H. *Vertebrate life*, VIII Edition, Pearson International.

3.

Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub Co.

4.

Hall B.K. and Hallgrimsson B. (2008).

5.

Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

6.

Nelson, J. S. (2006). *Fishes of the World*, Wiley

7.

Lomolino, M. V. et al (2010) *Biogeography*, 4th Edition, Sinauer Associates

CORE COURSE VI
Comparative anatomy of vertebrates

Theory (Credits 4)

Unit 1: Integumentary System Structure & functions of integument, integumentary derivatives: horn & antler, glands	10
Unit 2: Skeletal System Types of vertebrae and modification, Jaw suspension, Visceral arches	08
Unit 3: Digestive System Ruminant stomach: Structure & Function; dentition	07
Unit 4: Respiratory System Skin, gills, lungs and air sacs; Accessory respiratory organs in fishes	07
Unit 5: Circulatory System Evolution of aortic arches and heart	08
Unit 6: Urinogenital System Evolution of urinogenital ducts, Types of kidney: Pronephros, mesonephros, opisthonephros and metanephros; Types of mammalian uteri	07
Unit 7: Nervous System Comparative account of brain with special reference to shark, carp, frog, <i>Varanus</i> , <i>Columba</i> , <i>Cavia</i> Cranial nerves in Amphibia & Mammalia	08
Unit 8: Sense Organs Comparative account of eye in fish, bird and mammal	05

PRACTICAL (Credits 2)

1. Vertebrae of fish, toad, Snake, Fowl and Rabbit
2. Pectoral & pelvic girdles of fish, toad, *Varanus*, Fowl and Rabbit
3. Skulls: Toad, Snake, *Galus* and *Cavia*
4. Comparative study of digestive system in Tilapia and *Channa*
5. Study of structure of urinogenital system of fish, toad, *Galus*, *Cavia* from video recording/ Photograph
6. Project on modifications of Integumentary derivatives in vertebrates

SUGGESTED READINGS

1. Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education
2. Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies
3. Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons
4. Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House

CORE COURSE VII
Fundamentals of Biochemistry

Theory (Credits 4)

Unit 1: Biological macromolecules 10

Structure, types and Biological importance: carbohydrate, Protein, lipid and nucleic acids

Unit 2: Enzymes 15

Enzymes: Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; 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; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action

Unit 3: Carbohydrate Metabolism 10

Carbohydrate Metabolism; Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis

Unit 4: Protein Metabolism 15

Protein Metabolism; Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 5: Lipid Metabolism 10

Lipid Metabolism; β -oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis

PRACTICAL (Credits 2)

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids
2. Paper chromatography of amino acids
3. Action of salivary amylase under optimum conditions
4. Effect of pH, temperature and inhibitors on the action of salivary amylase
5. Demonstration of proteins separation by Lowry et al (1951).

SUGGESTED READING

1. Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J. L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.

4. Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
5. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

CORE COURSE VIII

Cell Biology

Theory (Credits 4)

Unit 1: Plasma Membrane	10
Fluid Mosaic model of plasma membrane; Transport across membranes: Active and Passive transport, Facilitated transport; Cell junctions: Tight junctions, Gap junctions, Desmosome	
Unit 1: Endomembrane System	10
Endoplasmic Reticulum; Golgi apparatus; Lysosome	
Unit 2: Mitochondria and Peroxisomes	08
Mitochondria: Structure, Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis Peroxisomes	
Unit 3: Cytoskeleton	08
Structure and Functions: Microtubules, Microfilaments and Intermediate filaments	
Unit 4: Nucleus	12
Structure of Nucleus: Nuclear envelope, nuclear pore complex, nucleolus	
Unit 4: Cell division	08
Mitosis; Meiosis; Cell cycle and its regulation; MTOC	
Unit 4: Cell Signaling	04
GPCR and Role of second messenger (cAMP)	

PRACTICAL (Credits 2)

1. Study of polytene chromosome from chironomid larvae
2. study of mitosis from bone marrow of goat/ Onion root tip
3. Study of various stages of meiosis grasshopper/ testis of mouse
4. Preparation of permanent slide to show the presence of Barr body in human female blood cells/ cheek cells
5. Demonstration of Preparation of permanent slide to demonstrate of:
 1. DNA by Feulgen reaction
 2. DNA and RNA by MGP
 3. Proteins by Mercurobromophenol blue/Fast Green

SUGGESTED READINGS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia

3. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco
5. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York and London

CORE COURSE IX

Parasitology and immunology

Theory

(Credits 4)

Unit 1: Parasitology

30

Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector); Host parasite relationship

Study of Morphology, Life Cycle, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica*, *Plasmodium vivax*, *Taenia solium*, *Ascaris lumbricoides*, *Wuchereria bancrofti*

Unit 2: Immunology

30

Cells and organs of the Immune system, Properties and functions of cytokines, Therapeutics Cytokines, Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation, hypersensitivity

Innate and Adaptive Immunity, Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes, Structure and functions of different classes of immunoglobulins, Antigen- antibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera, Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis

PRACTICAL

(Credits 2)

1. Study of life stages of *Entamoeba histolytica*, *Leishmania donovani* and *Plasmodium vivax*, *Taenia solium*, *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* through permanent slides/micro photographs
2. Study of *Pediculus humanus* (Head louse and Body louse), *Ctenocephalides* spp. and *Cimex lectularius* through permanent slides/ photographs
3. Study of nematode/cestodeparasites from the intestines of Poultry bird
4. Histological study of spleen, thymus and lymph nodes through slides/ photographs
5. Preparation of stained blood film to study various types of white blood cells
6. Ouchterlony's double immuno-diffusion method
7. Demonstration of ELISA

SUGGESTED READINGS

1. Arora, D. R and Arora, B. (2001) *Medical Parasitology*. II Edition. CBS Publications and Distributors
2. E.R. Noble and G.A. Noble (1982) *Parasitology: The biology of animal parasites*. V Edition, Lea & Febiger
3. Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) *Biology of Disease* Taylor and Francis Group
4. Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi
- 5.

- Rattan Lal Ichhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi
6. Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers
 7. K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.

CORE COURSE X
Biochemistry of Metabolic Processes

THEORY

(Credits 4)

Unit 1: Overview of Metabolism

10

Catabolism vs Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms

Unit 2: Carbohydrate Metabolism

16

Glycolysis and its regulation; Citric acid cycle; Phosphate pentose pathway
Gluconeogenesis, Glycogenolysis and Glycogenesis

Unit 3: Lipid Metabolism

14

β -oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis

Unit 4: Protein Metabolism

10

Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 5: Oxidative Phosphorylation

10

Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System

PRACTICALS

(Credits 2)

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT in serum/ tissue
3. To study the enzymatic activity of Trypsin and Lipase.
4. Study of biological oxidation (SDH) [goat liver]
5. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.
6. Dry Lab: To trace the labelled C atoms of Acetyl-CoA till they evolve as CO₂ in the TCA cycle

SUGGESTED READINGS

1. Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York

2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc
4. Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.

CORE COURSE XI
Molecular biology

THEORY	(Credits 4)
Unit 1: Nucleic Acids	04
Salient features of DNA and RNA; Watson and Crick model of DNA	
Unit 2: DNA Replication	12
DNA Replication in prokaryotes and eukaryotes, DNA polymerases, primosome, RNA priming, Replication of circular and linear <i>ds</i> -DNA, replication of telomeres	
Unit 3: Transcription	10
RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, transcription factors	
Unit 4: Translation	12
Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; mechanism of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain	
Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA	06
Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of hnRNA	
Unit 6: Gene Regulation	10
Transcription regulation in prokaryotes: lac operon and trp operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers	
Unit 7: DNA Repair Mechanisms and cancer	03
Pyrimidine dimerization and mismatch repair, protooncogene, oncogene, tumor suppressor gene, activation of oncogene, multy hit and two hit hypothesis	
Unit 8: Regulatory RNAs	03
Ribo-switches, RNA interference, miRNA, siRNA	

PRACTICAL

(Credits 2)

1. Isolation of DNA from blood Fish Blood (Demonstration)
2. Quantitative estimation of DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement)
3. Quantitative estimation of RNA using Orcinol reaction
4. Study and interpretation of electron micrographs/ photograph showing
 - (a) DNA replication
 - (b) Transcription
 - (c) Split genes

SUGGESTED READINGS

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
3. Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach*, V Edition, ASM Press and Sinauer Associates.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
6. Lewin B. (2008). *Gene XI*, Jones and Bartlett
7. McLennan A., Bates A., Turner, P. and White M. (2015). *Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.

CORE COURSE XII
Developmental Biology

THEORY

(Credits 4)

Unit 1: Introduction

04

Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division

Unit 2: Early Embryonic Development

28

Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers

Unit 3: Late Embryonic Development

08

Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)

Unit 4: Post Embryonic Development

12

Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories

Unit 5: Implications of Developmental Biology

08

Teratogenesis: Teratogenic agents and their effects on embryonic development; *In vitro* fertilization, Stem cell (ESC), Amniocentesis

PRACTICALS

(Credits 2)

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture
4. Study of different sections of placenta (photomicrograph/ slides)
5. Project report on *Drosophila* culture/chick embryo development

SUGGESTED READINGS

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
3. Carlson, R. F. Patten's Foundations of Embryology
4. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers

5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

CORE COURSE XIII
Principles of Genetics

THEORY (Credits 4)

Unit 1: Mendelian Genetics and its Extension	08
Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex influenced and sex-limited characters inheritance	
Unit 2: Linkage, Crossing Over and Chromosomal Mapping	12
Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization	
Unit 3: Mutations	10
Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method	
Unit 4: Sex Determination	04
Chromosomal mechanisms of sex determination in <i>Drosophila</i> and Man	
Unit 5: Extra-chromosomal Inheritance	06
Criteria for extra-chromosomal inheritance, Antibiotic resistance in <i>Chlamydomonas</i> , Mitochondrial mutations in <i>Saccharomyces</i> , Infective heredity in <i>Paramecium</i> and Maternal effects	
Unit 6: Polygenic Inheritance	03
Polygenic inheritance with suitable examples; simple numericals based on it	
Unit 7: Recombination in Bacteria and Viruses	09
Conjugation, Transformation, Transduction, Complementation test in Bacteriophage	
Unit 8: Transposable Genetic Elements	08
Transposons in bacteria, Ac-Ds elements in maize and P elements in <i>Drosophila</i> , Transposons in humans	

PRACTICALS

(Credits 2)

1. To study the Mendelian laws and gene interactions
2. Chi-square analyses using seeds/ beads/ *Drosophila*
3. Linkage maps based on data from conjugation, transformation and transduction
4. Linkage maps based on data from *Drosophila* crosses
5. Study of human karyotype (normal and abnormal)
6. Pedigree analysis of some human inherited traits

SUGGESTED READINGS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
2. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
4. Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition Benjamin Cummings
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co
6. Fletcher H. and Hickey I. (2015). *Genetics*. IV Edition. GS, Taylor and Francis Group, New York and London

CORE COURSE XIV Evolutionary Biology

THEORY	(Credits 4)
Unit 1: Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes	07
Unit 2: Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism	04
Unit 3: Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Molecular (universality of genetic code and protein synthesising machinery, three domains of life, neutral theory of molecular evolution, molecular clock, example of globin gene family, rRNA/cyt c	10
Unit 4: Sources of variations: Heritable variations and their role in evolution	08
Unit 5: Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies	13
Unit 6: Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation/ macroevolution (exemplified by Galapagos finches	07
Unit 7: Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction	03
Unit 8: Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from <i>Dryopithecus</i> leading to <i>Homo sapiens</i> , molecular analysis of human origin	06

Unit 9: Phylogenetic trees, multiple sequence alignment, construction of phylogenetic trees, interpretation of trees **02**

PRACTICALS **(Credits 2)**

1. Study of fossils from models/ pictures
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.
6. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation

SUGGESTED READINGS

1. Ridley, M (2004) Evolution III Edition Blackwell publishing
2. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
3. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin Cummings.
4. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
5. Snustad. S Principles of Genetics.
6. Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell

GENERIC ELECTIVE COURSES

GE 1

ANIMAL DIVERSITY

THEORY (Credits 4)

Unit 1. Protista General characters of Protozoa; Life cycle of Plasmodium	04
Unit 2. Porifera General characters and canal system in Porifera	03
Unit 3. Radiata General characters of Cnidarians and polymorphism	03
Unit 4. Aceolomates General characters of Helminthes; Life cycle of Taenia solium	03
Unit 5. Coelomate Protostomes General characters of Annelida; Metamerism.	03

Unit 6. Arthropoda General characters. Social life in insects.	04
Unit 7. Mollusca General characters of mollusca; Pearl Formation	03
Unit 9. Coelomate Deuterostomes General characters of Echinodermata	03
Unit 10. Protochordata Salient features	02
Unit 11. Pisces Migration of Fishes	04
Unit 12. Amphibia General characters, parental care in Amphibia.	04
Unit 13. Reptilia Origin of reptiles. General characters.	05
Unit 14. Aves: General characters of birds; Flight adaptations	05
Unit 15. Mammalia General characters of mammals; Dentition in mammals, Jaw suspension	06

PRACTICAL

(Credits 2)

Study of following specimens: Non Chordates: *Euglena*, *Paramecium*, *Sycon*, , *Physalia*, *Metridium*, *Taenia*, *Ascaris*, *Nereis*, *Aphrodite*, Hermit crab, *Daphnia*, Millipede, Centipede, Beetle, *Chiton*, *Dentalium*, *Octopus*, *Asterias*, and *Antedon*.

Chordates: *Balanoglossus*, *Amphioxus*, *Petromyzon*, *Pristis*, *Hippocampus*, *Labeo*, *Ichthyophis/ Uraeotyphlus*, Salamander, *Rhacophorus*, *Draco*, *Uromastix*, *Naja*, Viper, model/ Photograph of Archaeopteryx, any three common birds - (Crow, duck, Owl), Squirrel and Bat.

Study of following Permanent Slides:

Cross section of *Ascaris* (male and female); Bipinnaria and Pluteus larva.

Temporary mounts of Septal & pharyngeal nephridia of earthworm; Unstained mounts of Placoid, cycloid and ctenoid scales.

Dissections of Digestive and nervous system of Cockroach; Urinogenital system of *Tilapia*

SUGGESTED BOOKS

Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.

Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole

Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.

Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.

Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.

GE 2
AQUATIC BIOLOGY

THEORY (Credits 4)

UNIT 1: Aquatic Biomes

10

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT 2: Freshwater Biology

20

Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes- Nitrogen, Sulphur and Phosphorous.

Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

UNIT 3: Marine Biology

15

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

UNIT 4: Management of Aquatic Resources

15

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.

PRACTICAL

(Credits 2)

Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.

Determine the amount of Turbidity/ transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body.

Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.

A Project Report on a visit to a Sewage treatment plant/ Marine bio-reserve/ Fisheries Institutes.

SUGGESTED READINGS

Anathakrishnan : Bioresources Ecology 3rd Edition

Goldman : Limnology, 2nd Edition

Odum and Barrett : Fundamentals of Ecology, 5th Edition

Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1st Edition

Wetzel : Limnology, 3rd edition

Trivedi and Goyal : Chemical and biological methods for water pollution studies

Welch : Limnology Vols. I-II

GE 3
ENVIRONMENT AND PUBLIC HEALTH

THEORY	(Credits 4)
UNIT 1: Introduction	10
Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure Assessment.	
UNIT 2: Climate Change	10
Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health	
Unit 3: Pollution	10
Air, water, noise pollution sources and effects, Pollution control	
Unit 4: Waste Management Technologies	20
Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants, Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.	
Unit 5: Diseases	10
Causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid	
PRACTICAL	(Credits 2)
Determination pH, Cl, NO ₃ , PO ₄ in water samples from different locations.	

SUGGESTED BOOKS

- Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
- Kolluru Rao, Bartell Steven, Pitblado R and Stricoff, Risk Assessment and Management Handbook, McGraw Hill Inc., New York, 1996.
- Kofi Asante Duah, Risk Assessment in Environmental management, John Wiley and sons, Singapore, 1998.
- Kasperson, J.X. and Kasperson, R.E. and Kasperson, R. E., Global Environmental Risks, V. N. University Press, New York, 2003.
- Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.

GE 4
PHYSIOLOGY

THEORY

(Credits 4)

Unit 1: Digestion and Absorption of Food in Mammals

12

Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins; Nervous and hormonal control of digestion (in brief)

Unit 2: Functioning of Excitable Tissue (Nerve and Muscle)

10

Structure of neuron, Propagation of nerve impulse (myelinated and non-myelinated nerve fibre); Structure of skeletal muscle, Mechanism of muscle contraction (Sliding filament theory), Neuromuscular junction

Unit 3: Respiratory Physiology

06

Ventilation, External and internal Respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases.

Unit 4: Renal Physiology

08

Functional anatomy of kidney, Mechanism and regulation of urine formation.

Unit 5: Cardiovascular Physiology

10

Structure of mammalian heart, Coordination of heartbeat, Cardiac cycle in human.

Unit 6: Endocrine and Reproductive Physiology

14

Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Brief account of spermatogenesis and oogenesis, oestrous & menstrual cycle

PRACTICAL

(Credits 2)

Preparation of temporary mounts: Neurons (from fish/ Poultry bird) and Blood film.

Preparation of haemin and haemochromogen crystals.

Estimation of haemoglobin using Sahli's haemoglobinometer.

Examination of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, kidney, thyroid, pancreas, adrenal, testis, ovary.

SUGGESTED READINGS

Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley and Sons, Inc.

Widmaier, E.P., Raff, H. and Strang, K.T. (2008). Vander's Human Physiology, XI Edition, McGraw Hill.

Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.

Marieb, E. (1998). Human Anatomy and Physiology, IV Edition, Addison-Wesley.

Kesar, S. and Vashisht, N. (2007). Experimental Physiology, Heritage Publishers.

Prakash, G. (2012). Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Company Ltd.

Nielsen, Knut Schmidt (1997), Animal Physiology Adaptation and Environment, Cambridge University Press

DISCIPLINE CENTRIC ELECTIVE COURSES

DSE 1 ANIMAL BEHAVIOUR AND CHRONOBIOLOGY

THEORY (Credits 4)

Unit 1: Introduction to Animal Behaviour 08
Origin and history of Ethology; Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behaviour

Unit 2: Patterns of Behaviour 14
Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.

Unit 3: Social and Sexual Behaviour 16
Social Behaviour: Concept of Society; Communication and the senses; Altruism; Insects' society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.

Unit 4: Biological Rhythm 16
Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Circannual rhythms; Photoperiod and regulation seasonal reproduction of vertebrates; Role of melatonin.

Unit 5: Biological Clocks 06
Relevance of biological clocks; Adaptive significance of biological clocks

PRACTICAL (Credits 2)

To study nests and nesting habits of social insects (Termites and Ants).
To study geotaxis behaviour in earthworm.
Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.
Study of circadian functions in humans (daily eating, sleep and temperature patterns).
Preparation of kinematic diagram / ethogram through ad libitum study.*

SUGGESTED READINGS

David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.
John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rdEd) 2002 Baren's and Noble Inc. New York, USA
The Clock that times us. 1982. Moore Ed et al.
Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

DSE 2
BIOLOGY OF INSECTA

THEORY	(Credits 4)	
Unit 1: Introduction		04
General Features of Insects		
Distribution and Success of Insects on the Earth		
Unit 2: Insect Taxonomy		04
Basis of insect classification; Classification of insects up to orders		
Unit 3: General Morphology of Insects		08
External Features; Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits, Types of Legs adapted to diverse habitat		
Unit 4: Physiology of Insects		28
Structure and Physiology of Insect respiratory & endocrine systems		
Sensory receptors		
Growth and metamorphosis		
Unit 5: Insect Society		06
Group of social insects and their social life		
Social organization and social behaviour (w.r.t. any one example)		
Unit 6: Insect Plant Interaction		04
Theory of co-evolution, role of allelochemicals in host plant mediation		
Unit 7: Insects as Vectors		06
Insects as mechanical and Biological vectors, Brief discussion on houseflies and mosquitoes as important insect vectors		

PRACTICAL	(Credits 2)	
Study of different kinds of mouth parts of insects		
Study of insect wings and their venation.		
Methodology of collection, preservation and identification of insects		
Morphological studies of various castes of Apis, Camponotus and Odontotermes		
Study of any three insect pests and their damages		
Study of any three beneficial insects and their products		
Field study of insects and submission of a project report on the insect diversity		

SUGGESTED READINGS

- A general text book of entomology, Imms, A. D., Chapman & Hall, UK
The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK
Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA
Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication, USA
The Insect Societies, Wilson, E. O., Harvard Univ. Press, UK
Host Selection by Phytophagous insects, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
Physiological system in Insects, Klowden, M. J., Academic Press, USA
The Insects, An outline of Entomology, Gullan, P. J., and Cranston, P. S., Wiley Blackwell, UK
Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA

DSE 3
PARASITOLOGY

THEORY	(Credits 4)
Unit 1: Introduction to Parasitology	3
Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship.	
Unit 2: Parasitic Protists	15
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Entamoeba histolytica</i> , <i>Trypanosoma gambiense</i> , <i>Plasmodium vivax</i> .	
Unit 3: Parasitic Platyhelminthes	15
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Schistosoma haematobium</i> , <i>Taenia solium</i> and <i>Echinococcus granulosus</i> .	
Unit 4: Parasitic Nematodes	15
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Ascaris lumbricoides</i> , <i>Ancylostoma duodenale</i> , <i>Wuchereria bancrofti</i> .	
Unit 5: Parasitic Arthropoda	10
Biology, importance and control of ticks, mites, <i>Pediculus humanus</i> (head and body louse).	
Unit 6: Parasitic Vertebrates	02
A brief account of parasitic vertebrates; Hood Mockingbird and Vampire bat.	
PRACTICAL	(Credits 2)
Study of life stages of <i>Entamoeba histolytica</i> , <i>Trypanosoma gambiense</i> and <i>Plasmodium vivax</i> through permanent slides/micro photographs	
Study of adult and life stages of <i>Schistosoma haematobium</i> , <i>Taenia solium</i> and through permanent slides/ micro photographs	
Study of adult and life stages of <i>Ascaris lumbricoides</i> , <i>Ancylostoma duodenale</i> , <i>Wuchereria bancrofti</i> through permanent slides /micro photographs	
Study of <i>Pediculus humanus</i> (Head louse and Body louse) through permanent slides/ photographs	
Study of monogenea from the gills of fresh/marine fish (Gills can be procured from fish market as by product of the industry)	
Study of nematode/ cestode parasites from the intestines of Poultry bird (Intestine can be procured from poultry/ market as a by-product)	
Submission of a brief report on parasitic vertebrates	
SUGGESTED READINGS	
Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors	
E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea & Febiger	
Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) Biology of Disease. Taylor and Francis Group	
Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi	
Rattan Lal Ichhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi	
Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers	
Thomas C. Cheng (1986). General Parasitology, II Edition, Academic Press Inc	
K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.	

AQUATIC BIOLOGY

THEORY	(Credits 4)
UNIT 1: Aquatic Biomes	10
Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.	
UNIT 2: Freshwater Biology	20
Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.	
Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.	
UNIT 3: Marine Biology	15
Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.	
UNIT 4: Management of Aquatic Resources	15
Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.	

PRACTICAL

(Credits 2)

Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.

Determine the amount of Turbidity/ transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body.

Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.

A Project Report on a visit to a Sewage treatment plant/ Marine bio-reserve/ Fisheries Institutes.

SUGGESTED READINGS

1. Anathakrishnan : Bioresources Ecology 3rd Edition
2. Goldman : Limnology, 2nd Edition
3. Odum and Barrett : Fundamentals of Ecology, 5th Edition
4. Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1st Edition
5. Wetzel : Limnology, 3rd edition
6. Trivedi and Goyal : Chemical and biological methods for water pollution studies
7. Welch : Limnology Vols. I-II

SKILL ENHANCEMENT COURSES

SEC 1
APICULTURE

THEORY	(Credits 2)
Unit 1: Biology of Bees	05
History, Classification and Biology of Honey Bees; Social Organization of Bee Colony	
Unit 2: Rearing of Bees	10
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth; Bee Pasturage; Selection of Bee Species for Apiculture; Bee Keeping Equipment; Methods of Extraction of Honey (Indigenous and Modern)	
Unit 3: Diseases and Enemies	05
Bee Diseases and Enemies; Control and Preventive measures	
Unit 4: Bee Economy	02
Products of Apiculture Industry and its Uses (Honey, Bee Wax, Propolis), Pollen etc.	
Unit 5: Entrepreneurship in Apiculture	08
Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens	

SUGGESTED READINGS

Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.

Bisht D.S., Apiculture, ICAR Publication.

Singh S., Beekeeping in India, Indian council of Agricultural Research, New Delhi.

SEC 2

SERICULTURE

THEORY	(Credits 2)
Unit 1: Introduction	03
Sericulture: Definition, history and present status; Silk route, Types of silkworms, Distribution and Races, Exotic and indigenous races, Mulberry and non-mulberry Sericulture	
Unit 2: Biology of Silkworm	03
Life cycle of <i>Bombyx mori</i> , Structure of silk gland and secretion of silk	
Unit 3: Rearing of Silkworms	13
Selection of mulberry variety and establishment of mulberry garden; Rearing house and rearing appliances; Disinfectants: Formalin, bleaching powder, RKO; Silkworm rearing technology: Early age and Late age rearing; Types of mountages; Spinning, harvesting and storage of cocoons	
Unit 4: Pests and Diseases	04
Pests of silkworm: Uzi fly, Dermestid beetles and vertebrates Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial Control and prevention of pests and diseases	
Unit 5: Entrepreneurship in Sericulture	02
Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various Sericulture centres.	

SUGGESTED READINGS

1. Handbook of Practical Sericulture: S.R. Ullal and M. N. Narasimhanna CSB, Bangalore
2. Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.

3. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan 1972.
4. Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
5. Silkworm Rearing, Wupang Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
6. A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
7. Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986.

SEC 3

AQUARIUM FISH KEEPING

THEORY (Credits 2)

Unit1: Introduction to Aquarium Fish Keeping The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes	05
Unit 2: Biology of Aquarium Fishes Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes: Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish	10
Unit 3: Food and feeding of Aquarium fishes Use of live fish feed organisms. Preparation and composition of formulated fish feeds	06
Unit 4: Fish Transportation Live fish transport - Fish handling, packing and forwarding techniques.	03
Unit 5: Maintenance of Aquarium General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry	06

SEC 4
QUANTIFICATION TECHNIQUES

THEORY	(CREDITS 2)
Unit 1: Biological sampling and census techniques and application Sampling vs census; census techniques – point, strip and line transects, call-counts, scat/ signs survey.	08
Unit 2: Quantitative Methods in Population studies Role of statistics in science and the scientific method. Concepts of a random variable: discrete and continuous. Measures of central tendency. Tests for significance: Chi Square, one way ANOVA.	12
Unit 3: Measures of species diversity Species-area curve; Diversity indices (Shanon-Weiner/ Margalef/ Sorensen/ Pilou etc.)	05

SUGGESTED READINGS

1. Sutherland, W. J., ed. Ecological Census Techniques: A Handbook. Cambridge University Press, Cambridge, U.K. S
2. Mas, D. (2003). Statistics in Biology and Psychology. Academic Publishers. D
3. Rothofer, N. & Lee, E. S. (2006). Introduction to Biostatistics: A Guide to Design, Analysis and Discovery. Academic Press. F