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

Semester	Core (14)	Ability Enhancement Compulsory Courses AEC (2)	Skill Enhancement Courses SEC (2)	Discipline Specific Elective DSE (4)	Generic Elective GE (4)
CORE I	Non-chordates I: Protozoa and Metazoa	English Communication or MIL			GE-I
CORE II	Principles of Ecology				
CORE III	Non-chordates II: Coelomates	Environmental Science			GE - II
CORE IV	Cell Biology				
CORE V	Diversity of Chordates		SEC-I (Apiculture)		GE-III
CORE VI	Physiology: Controlling and Coordinating Systems				
CORE VII	Fundamentals of Biochemistry				
CORE VIII	Comparative Anatomy of Vertebrates		SEC-II (Aquarium Fish Keeping)		GE- IV
CORE IX	Physiology: Life Sustaining Systems				
CORE X	Biochemistry of Metabolic Processes				
CORE XI	Molecular Biology			DSE-I Immunology	
CORE XII	Principles of Genetics			DSE-II Fish & Fisheries	
CORE XIII	Developmental Biology			DSE-III Reproductive Biology	
CORE XIV	Evolutionary Biology			DSE-IV Animal Behaviour and Chronobiology	

CORE – I (Theory)

Non-chordates I: Protozoa and Metazoa

Learning Objective: **To know the general characters and classification of Non-chordates and understand the increasing complexity of body forms.**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Protozoa and Metazoa

General characteristics and Classification up to classes
Study of of *Euglena*, *Amoeba* and *Paramecium* (structure and nutrition)
Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*
Locomotion and Reproduction in Protozoa
Body symmetry and segmentation of Metazoa

Unit 2: Porifera

General characteristics and Classification up to classes
Histology of Sycon, Life history of Sycon
Canal system and spicules in sponges

Unit 3: Cnidaria and Ctenophora

General characteristics and Classification of Cnidaria up to classes
Life cycle of *Obelia*
Polymorphism in Siphonophora
Corals and coral reefs formation
General characteristics and affinities of Ctenophora

Unit 4: Platyhelminthes

General characteristics and classification up to classes
Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*
Parasitic adaptations in Platyhelminthes

Unit 5: Nemathelminthes (Pseudocoelomates)

General characteristics and Classification of Nemathelminthes up to classes
Life cycle, and pathogenicity of *Ascaris lumbricoides* and *Wuchereria bancrofti*
General characteristics and significance of rotifers

CORE – I (Practical)

Non-chordates I: Protozoa and Metazoa

Credits 2 Marks 30

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium*

2. Examination of pond water collected from different places for diversity in protista

3. Study of *Sycon* (L.S.), *Hyalonema, Euplectella, Spongilla*

4. Museum specimen for identification - *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium,Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora, Fasciola hepatica, Taenia solium*

5. One specimen/slide of any ctenophore

6. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs)

7. To submit a Project Report on any related topic on life cycles

SUGGESTED READINGS

• Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
• 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
• Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
• Ganguly, Sinha and Adhikari – Biology of Animals Vol. I, New Central
• Sinha, Chatterjee and Chattopadhyay – Advanced Practical Zoology, Books and Allied
• Lal, S.S. – A textbook of Practical Zoology, Invertebrate, Rastogi Publications
• Verma, P.S. – A manual of Practical Zoology, Invertebrate, S. Chand

Marks Distribution

Theory – 50 marks

Practical – 30 marks (Identification – 10, Project report – 8, Regularity-5, Viva voce –2, Laboratory notebook – 5)

Internal assessment – 20 marks

CORE – II (Theory)

Principles of Ecology

Learning Objective: **To understand Principles and the concepts in ecology and wildlife management**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Introduction to Ecology

Definition of ecology, Autecology and synecology
Levels of organization, Laws of limiting factors
Biotic and abiotic factors

Unit 2: Population

Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves
Exponential and logistic growth
Population regulation - density-dependent and independent factors
Population interactions – negative and positive interactions

Unit 3: Community

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

Unit 4: Ecosystem

Types of ecosystems with example
Food chain: Detritus and grazing food chains, Food web, Energy flow through the ecosystem
Ecological pyramids
Biogeochemical cycle, Nitrogen cycle, Carbon Cycle

Unit 5: Applied Ecology

Concept of sanctuary, national park, biosphere reserve,
Ecology in Wildlife Conservation and Management
Causes of depletion of wildlife
Project Tiger, Project Rhino
Application of GIS and remote sensing in wildlife biology

CORE – II (Practical)

Principles of Ecology

Credits 2 Marks 30

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 quadrate 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), Biological Oxygen Demand (BOD)
4. Report on a visit to places of zoological importance

SUGGESTED READINGS

- Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
- Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
- Robert Leo Smith Ecology and field biology Harper and Row publisher
- Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Pres
- Verma and Agarwal – Environmental Biology, S Chand
- Curningham and Curingham – Environmental Science , Mc Graw Hill

Marks Distribution

- Experiments – 14
- Field Report/Project – 7
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

CORE – III (Theory)

Non-chordates II: Coelomates

Learning Objective: **To know the general characters and classification of Coelomates and understand the increasing complexity of organization of life from lower to higher Coelomates**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Introduction to Coelomates and Annelida

Evolution of coelom and metamerism
General characteristics and classification of Annelids up to classes
Excretion in Annelida with special reference to Leech

Unit 2: Arthropoda

General characteristics and classification up to classes
Vision and Respiration in Arthropoda with special reference to prawn
Metamorphosis in Insects
Social life in bees and termites

Unit 3: Onychophora and Xiphosura

Distribution of Onychophora
Morphological and anatomical characteristics of Onychophora
Affinities of Onychophora
Limulus – structure and its phylogenetic significance

Unit 4: Mollusca

General characteristics and Classification up to classes
Respiration in Mollusca with reference to Pila
Torsion and detorsion in Gastropoda
Pearl formation in bivalves

Unit 5: Echinodermata

General characteristics and Classification up to classes
Water-vascular system in Asteroidea
Larval forms in Echinodermata
Affinities with Chordates

CORE – III (Practical)

Non-chordates II: Coelomates

Credits 2 Marks 30

1. Study of following specimens:

Annelids - *Nereis, Heteronereis, Chaetopterus, Pheretima,Hirudinaria*

Arthropods - *Limulus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Scolopendra, Julus, Bombyx, Periplaneta, termites and honey bees*

Onychophora - Peripatus

Molluscs - *Chiton, Pila, Doris, Helix, Unio, Sepia,Octopus, Nautilus*

Echinodermates - *Pentaceros/Asterias, Ophiura, Echinus, Cucumaria and Antedon*

2. Study of digestive system, nephridia of earthworm and Leech through powerpoint presentation
3. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm
4. To submit a Project Report on arthropoda and mollusca

SUGGESTED READINGS

• Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition
• Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). *TheInvertebrates: A New Synthesis*, III Edition, Blackwell Science
• Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
• Ganguly, Sinha and Adhikari – Biology of Animals, Vol I
• Parker and Hall – Text Book of Zoology, Vol I

Marks Distribution

- Spotting – 14
- Project – 7
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

CORE – IV (Theory)

Cell Biology

Learning Objective: **To understand structure and functions of Cell organelles**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Overview of Cells

History of discovery of cell, Cell theory;
Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions

Unit 2: Membrane and membrane systems

Various models of plasma membrane structure
Transport across membranes: Active and Passive transport, Facilitated transport
Cell junctions: Tight junctions, Desmosomes, Gap junctions
Structure and functions of Endoplasmic reticulum, Golgi apparatus and Lysosomes

Unit 3: Mitochondria and Peroxisomes

Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis
Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis
Peroxisomes, ATP as energy currency of the cell

Unit 4: Cytoskeleton and Nucleus

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments
Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus
Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome)

Unit 5: Cell Division and Cell Signaling

Mitosis, Meiosis, Cell cycle and its regulation
GPCR and Role of second messenger (cAMP)

CORE – IV (Practical)

Cell Biology

Credits 2 Marks 30

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.

SUGGESTED READINGS

- Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- 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.
- 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.
- 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.
- Powar, C.B. – Cell Biology, Himalaya
- Sinha, Chatterjee and Chattopadhyay – Advanced Practical Zoology, Books and Allied

Marks Distribution

- Experiment – 15
- Spotting – 6
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

CORE – V (Theory)

Diversity of Chordata

Learning Objective: **To know the Diversity of Chordata from lower to higher Chordates and their geographical distribution**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Introduction to Chordates and Protochordates

General characteristics and outline classification of chordates
General characteristics of Hemichordata, Urochordata and Cephalochordata;
Retrogressive metamorphosis in Urochordata
Advanced features of vertebrates over Protochordata

Unit 2: Agnatha and Pisces

General characteristics and classification of cyclostomes up to class
Classification of Pisces up to order
General characteristics of Chondrichthyes and Osteichthyes,
Migration, Osmoregulation and Parental care in fishes

Unit 3: Amphibia and Reptilia

General characteristics and classification up to order; Parental care in Amphibians
General characteristics, distribution and affinities of *Sphenodon*
Difference between poisonous and non-poisonous snakes
Poison apparatus and Biting mechanism in snakes

Unit 4: Aves and mammals

General characteristics and classification of Aves up to order; *Archaeopteryx* — general characteristics and phylogenetic importance
Flight adaptations and Migration in birds; Flying and perching mechanism in birds
General characters and classification of mammals up to order; Affinities of Prototheria
Echolocation of Bats
Adaptive radiation of mammals with reference to locomotory appendages

Unit 5: Zoogeography

Zoogeographical realms, geographic range, Physical features and faunal composition; Distribution of animals, types; Continental drift
Barriers: Extrinsic and intrinsic barriers; Dispersal – means of dispersal

CORE – V (Practical)

Diversity of Chordates

Credits 2 Marks 30

1. Protochordata
   Balanoglossus, Herdmania, Branchiostoma, Colonial UrochordataSections of *Balanoglossus* through proboscis and branchiogenital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions.
2. Agnatha
   Petromyzon, Myxine
3. Fishes
   Scoliodon, Sphyrna, Pristis, Torpedo, Mystus, Heteropneustes, Labeo rohuta, Catla catla, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas
4. Amphibia
   Ichthyophis, Necturus, Bufo, Hyla, Alytes, Salamandra
5. Reptilia
   Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Crocodylus
   Key for Identification of poisonous and non-poisonous snakes
6. Aves
   Study of six common birds from different orders. Types of beaks and claws
7. Mammalia
   Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes,*
   Mount of weberian ossicles, pecten from Fowl head
   Project: Power point presentation on study of any two animals from two different classes by students

SUGGESTED READINGS

- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate life,* VIII Edition, Pearson International.
- Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub Co.
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
- Ganguly, Sinha and Adhikari – Biology of Animals, Vol II
- Parker and Hall – Text Book of Zoology, Vol II

Marks Distribution

- Spotting – 14
- Project – 7
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

CORE – VI (Theory)

Animal Physiology: Controlling and Coordinating Systems

Learning Objective: **To understand structure and functions of different animal tissues and endocrine glands**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Animal Tissues

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue
Structure and types of bones and cartilages

Unit 2: Nervous System

Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and non-myelinated nerve fibers;
Types of synapse, Synaptic transmission and, Neuromuscular junction;
Reflex action and its types - reflex arc

Unit 3: Muscle

Histology of different types of muscle; Ultra structure of skeletal muscle;
Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; treppe, summation and tetanus, isotonic and isometric contraction

Unit 4: Reproductive System

Histology of testis and ovary; Physiology of male and female reproduction; reproductive cycles; Puberty, Methods of contraception in male and female
Hormones of testis and ovary and their functions; feedback mechanism of action of hormones, Placental hormones

Unit 5: Endocrine System

Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their function; Classification of hormones; Regulation of their secretion; Mechanism of hormone action – peptide and steroid hormones

CORE – VI (Practical)

Animal Physiology: Controlling and Coordinating Systems

Credits 2 Marks 30

1. Recording of simple muscle twitch with electrical stimulation through PowerPoint presentation
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
3. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
4. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
5. Microtomy: Preparation of permanent slides of mammalian (Goat/white rat) tissues (at least three)

SUGGESTED BOOKS

- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
- Singh and Kumar – Animal Physiology and Biochemistry, Vishal
- Eckert and Randal – Animal Physiology, CBS
- Rastogi, S.C. – Essentials of Animal Physiology, New Age International

Marks Distribution

- Experiment – 10
- Identification – 6
- Microtomy - 5
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

CORE – VII (Theory)

Fundamentals of Biochemistry

Learning Objective: **To understand structure and functions of Biomolecules**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Carbohydrates

Structure and Biological importance: Monosaccharides, Oligosaccharides, Polysaccharides and Glycoconjugates

Unit 2: Lipids

Classification of lipids
Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids

Unit 3: Proteins

Amino acids: Structure, Classification and General properties of α-amino acids; Physiological importance of essential and non-essential α-amino acids

Classification of proteins, bonds stabilizing protein structure; Levels of organization in proteins; Introduction to simple and conjugate proteins

Unit 4: Nucleic Acids

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids
Base pairing, Denaturation and Renaturation of DNA
Types of DNA and RNA, Complementarity of DNA

Unit 5: Enzymes

Nomenclature and classification; Specificity of enzyme action; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Regulation of enzyme action

CORE – VII (Practical)

Fundamentals of Biochemistry

Credits 2 Marks 30

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 and temperature on the action of salivary amylase
5. Demonstration of proteins separation by SDS-PAGE

SUGGESTED READING

- Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- 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.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
- 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.

Marks Distribution

- Experiment I – 11
- Experiment II - 10
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

CORE – VIII (Theory)

Comparative Anatomy of Vertebrates

Learning Objective: **To understand structure and functions of different organs of body**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Integumentary and Skeletal Systems

Structure, functions and derivatives of integument
Overview of axial and appendicular skeleton,
Visceral arches of birds and mammals

Unit 2: Digestive and Respiratory Systems

Alimentary canal and associated glands in mammals
Respiratory organs in amphibians and birds; accessory respiratory organs in fishes

Unit 3: Circulatory and Urinogenital Systems

General plan of circulation, evolution of heart and aortic arches
Succession of kidney, Evolution of urinogenital ducts
Types of mammalian uteri

Unit 4: Nervous System

Comparative account of brain in vertebrates
Autonomic nervous system, Spinal cord, Cranial nerves in mammals

Unit 5: Sense Organs

Classification of receptors, chemoreceptors and mechanoreceptors
Brief account of visual and auditory receptors in man

CORE – VIII (Practical)

Comparative Anatomy of Vertebrates

Credits 2 Marks 30

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog/Toad/Calotes/Fowl/Pigeon/Guineapig
3. Mammalian skulls: One herbivorous and one carnivorous animal
4. Dissection of rat to study arterial and urinogenital system through audio-visual aids
5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording
6. Project on skeletal modifications in vertebrates

SUGGESTED READINGS

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

Marks Distribution

- Identification – 14
- Project - 7
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

CORE – IX (Theory)

Animal Physiology: Life Sustaining Systems

Learning Objective: **To understand different physiological mechanisms in Mammal**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Physiology of Digestion in Mammals

Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical events of digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of secretion of enzymes in Gastrointestinal tract.

Unit 2: Physiology of Respiration in Mammals

Histology of lungs; Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Carbon monoxide poisoning; Control of respiration

Unit 3: Renal Physiology in Mammals

Structure of kidney and its functional unit; Mechanism of urine formation;
Regulation of water balance; Regulation of acid-base balance; Hormonal regulation of the volume of urine

Unit 4: Mammalian Blood

Components of blood and their functions; Structure and functions of haemoglobin
Haemostasis: Blood clotting system and mechanism of coagulation, Fibrinolytic system, Haemopoiesis; Blood as a buffer system; Blood groups: Rh factor, ABO

Unit 5: Physiology of Mammalian Heart

Structure of mammalian heart; Circulation of blood through the heart of mammal; Coronary circulation; Structure and working of conducting myocardial fibers; Origin and conduction of cardiac impulses Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation

CORE – IX (Practical)

Animal Physiology: Life Sustaining Systems

Credits 2 Marks 30

1. Determination of ABO Blood group
2. Enumeration of red blood cells and white blood cells using haemocytometer
3. Estimation of haemoglobin using haemoglobinometer
4. Preparation of haemin and haemochromogen crystals
5. Recording of frog's heart beat under *in situ* and perfused conditions*
6. Recording of blood pressure using a sphygmomanometer
7. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney

(*Subject to UGC guidelines)

SUGGESTED READINGS

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

Marks Distribution

- Experiment I – 8
- Experiment II – 7
- Identification – 6
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

CORE – X (Theory)

Biochemistry of Metabolic Processes

Learning Objective: **To understand biochemical processes in metabolism**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Overview of Metabolism

Catabolism *vs* Anabolism, Stages of catabolism, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Intermediary metabolism and regulatory mechanisms

Unit 2: Carbohydrate Metabolism

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

Unit 3: Lipid Metabolism

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

Unit 4: Protein Metabolism

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

Unit 5: Oxidative Phosphorylation

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

CORE – X (Practical)

Biochemistry of Metabolic Processes

Credits 2 Marks 30

1. Estimation of total protein in given solutions by Lowry's method
2. To study the enzymatic activity of Trypsin and Lipase
3. Detection of Alkaline Phosphatase assay from tissue
4. Estimation of glucose
5. Demonstration of effect of inhibitors on activity of Salivary Amylase

SUGGESTED READINGS

- Cox, M.M and Nelson, D.L. (2008). *Lehninger Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- Murray, R.K., Bende*r, 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.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.

Marks Distribution

- Experiment I – 7
- Experiment II – 7
- Experiment III – 7
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

CORE – XI (Theory)

Molecular Biology

Learning Objective: **To know structure and functions of nucleic acids as biomolecules**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Nucleic Acids

Salient features and chemical compositions of of DNA and RNA
Watson and Crick model of DNA; Structure and types of RNA

Unit 2: DNA Replication

DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, replication of telomeres

Unit 3: Transcription and Regulatory RNAs

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors

Ribo-switches, RNA interference, miRNA, siRNA

Unit 4: Translation

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process 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; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

Unit 5: Post Transcriptional Modifications, Processing of Eukaryotic RNA and Gene Regulation

Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling and RNA editing, Processing of tRNA

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon and trp operon

CORE – XI (Practical)

Molecular Biology

Credits 2 Marks 30

1. Study of Polytene chromosomes from Chironomous / Drosophila larvae
2. Quantitative estimation of DNA using colorimeter or spectrophotometer
3. Detection of DNA
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
7. McLennan A., Bates A., Turner, P. and White M. (2015). Molecular Biology IV Edition. GS, Taylor and Francis Group, New York and London.

Marks Distribution

- Experiment – 15
- Identification – 6
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

CORE – XII (Theory)

Principles of Genetics

Learning Objective: **To understand basic principles in heredity and inheritance**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Mendelian Genetics and its Extension

Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sexinfluenced and sex-limited characters inheritance.

Unit 2: Linkage, Crossing Over and Chromosomal Mapping

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Linkage map – coincidence, interference

Unit 3: Mutations

Types of gene mutations, Types of chromosomal aberrations, Molecular basis of mutations in relation to UV light and chemical mutagens

Unit 4: Sex Determination and Extra-chromosomal Inheritance

Chromosomal, environmental and hormonal mechanisms of sex determination
Extra-chromosomal inheritance
Mitochondrial mutations

Unit 5: Other Concepts in Genetics

Concept of Polygenic inheritance with suitable examples;
Conjugation, Transformation, Transduction, Complementation test in Bacteriophage
Transposons in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, Transposons in humans

CORE – XII (Practical)

Principles of genetics

Credits 2 Marks 30

1. To study the Mendelian laws and gene interactions through powerpoint presentation
2. Chi-square analyses using seeds/beads/*Drosophila*.
3. Study of human karyotype (normal and abnormal).
4. Pedigree analysis of some human inherited traits.

SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
- Russell, P. J. (2009). *Genetics- A Molecular Approach*.III Edition. Benjamin Cummings
- 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
- Fletcher H. and Hickey I. (2015). *Genetics*. IV Edition. GS, Taylor and Francis Group, New York and London.

Marks Distribution

- Experiment – 15
- Identification – 6
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

CORE-XIII (Theory)

Developmental Biology

Learning Objective: **To know various mechanisms in the development of organism**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Introduction

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

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

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

Unit 4: Post Embryonic Development

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

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

CORE – XIII (Practical)

Developmental Biology

Credits 2 Marks 30

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula
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
3. Study of the developmental stages and life cycle of *Drosophila* through audio-visual aids
4. Study of different sections of placenta (photomicropgraph/ slides)
5. Project report on *Drosophila* culture/chick embryo development

SUGGESTED READINGS

- Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
- Carlson, R. F. Patten's Foundations of Embryology
- Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
- Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

Marks Distribution

- Identification – 14
- Project – 7
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

CORE - XIV (Theory)
Evolutionary Biology

Learning Objective: **To know origin and evolution of man**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1:

Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes
Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism

Unit 2:

Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Neutral theory of molecular evolution, molecular clock;
Sources of variations: Heritable variations and their role in evolution

Unit 3:

Population genetics: Hardy-Weinberg Law (statement and derivation of equation); Natural selection (concept of fitness): Density-dependent selection, heterozygous superiority, kin selection, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies

Unit 4:

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 and mammals)
Extinctions, Background and mass extinctions (causes and effects)

Unit 5:

Origin and evolution of man, Unique hominid characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*, Phylogenetic trees, Construction of phylogenetic trees and their interpretation

CORE – XIV (Practical)
Evolutionary Biology

Credits 2 Marks 30

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 frequencies using simulation studies
4. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.

SUGGESTED READINGS

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

Marks Distribution

- Identification – 15
- Project – 6
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

DISCIPLINE SPECIFIC ELECTIVE COURSES
DSE-I (Theory)

Immunology

Learning Objective: **To understand immune system in man**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: **Overview of the Immune System**

Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system

Unit 2: **Cells and Organs of the Immune System**

Haematopoiesis, Cells of immune system and organs (primary and secondary lymphoid organs) of the immune system

Unit 3: Antigens and Antibodies

Basic properties of antigens, B and T cell epitopes, haptens and adjuvants; Structure, classes and function of antibodies, monoclonal antibodies, antigen antibody interactions as tools for research and diagnosis

Unit 4: **Working of the Immune System**

Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, Basic properties and functions of cytokines, Complement system: Components and pathways.

Unit 5: **Immune System in Health and Disease**

Introduction to concepts of autoimmunity and immunodeficiency; AIDS; General introduction to vaccines, Various types of vaccines

DSE-I (Practical)

Immunology

Credits 2 Marks 30

1. Demonstration of lymphoid organs through audio-visual aids
2. Histological study of spleen, thymus and lymph nodes through slides/ photographs
3. Preparation of stained blood film to study various types of blood cells.
4. ABO blood group determination.
5. Demonstration of ELISA and Immunoelectrophoresis through audio-visual aids

SUGGESTED READINGS

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company.
- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Publication.
- Abbas, K. Abul and Lechtman H. Andrew (2003.) *Cellular and Molecular Immunology*. V Edition. Saunders Publication.

Marks Distribution

- Experiment – 15
- Identification – 6
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

DSE-II (Theory)

Fish and Fisheries

Learning Objective: **To study fish and fisheries of India**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Introduction and Classification

General description of fish; Account of systematic classification of fishes (up to classes); Classification based on feeding habit, habitat and manner of reproduction.

Unit 2: Morphology and Physiology

Types of fins and their modifications; Locomotion in fishes; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Osmoregulation in fishes; Electric organs; Bioluminiscience; Schooling; Parental care; Migration

Unit 3: Fisheries

Inland Fisheries; Marine Fisheries; Environmental factors influencing the seasonal variations in fish catches in the Bay of Bengal; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations

Unit 4: Aquaculture

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture

Unit 5: Fish Diseases and fishery By-products

Fish diseases: Bacterial, viral and parasitic; EUS; Preservation and processing of harvested fish, Fishery by-products

DSE-II (Practical)

Fish and Fisheries

Credits 2 Marks 30

1. Morphometric and meristic characters of fishes of IMC
2. Study of *Pristis, Exocoetus, Hippocampus, Labeo, Heteropneustes, Anabas, Catla, Mirgal, Clarias, Notopterus, Cyprinus, Ompok, Telapia*
3. Study of different types of scales (through permanent slides/ photographs).
4. Study of crafts and gears used in Fisheries
5. Water quality criteria for Aquaculture: Assessment of pH, temperature
6. Study of air breathing organs in *Channa, Heteropneustes, Anabas* and *Clarias* through audio-visual aids
7. Demonstration of induced breeding in Fishes (video)
8. Demonstration of parental care in fishes (video)
9. A Project Report on visit(s) to fish farm/ pisciculture unit/ fish research laboratory

SUGGESTED READINGS

- Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
- D. H. Evans and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK von der Emde, R.J. Mogdans and B.G. Kapoor.
- The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands
- C.B.L. Srivastava, Fish Biology, Narendra Publishing House
- J.R. Norman, A history of Fishes, Hill and Wang Publishers
- S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House

Marks Distribution

- Experiment – 14
- Project Report - 7
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

DSE-III (Theory)

Reproductive Biology

Learning Objective: **To understand physiology of human reproduction**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Reproductive Endocrinology

Reproductive System of Rat and Human: Development and differentiation of gonads, genital ducts, external genitalia. Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, hypothalamo – hypophyseal – gonadal axis

Unit 2: Functional Anatomy of Male Reproduction

Outline and histology of male reproductive system in rat and human;
Testis: Cellular functions, germ cell, system cell renewal;
Spermatogenesis: kinetics and hormonal regulation; Epididymal function and sperm maturation;
Accessory glands functions; Sperm transportation in male tract

Unit 3: Functional Anatomy of Female Reproduction

Outline and histology of female reproductive system in rat and human;
Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones;

Unit 4: Hormonal regulation of Female Reproductive Cycles

Reproductive cycles (rat and human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto –maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation

Unit 5: Reproductive Health

Infertility in male and female: causes, diagnosis and management
Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization and embryo transfer
Modern contraceptive technologies; Family planning

DSE-III (Practical)

Reproductive Biology

Credits 2 Marks 30

1. Study of animal house through powerpoint presentation: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.
2. Surgical techniques through powerpoint presentation: principles of surgery in endocrinology. Ovarectomy, hysterectorny, castration and vasectomy in rats.
3. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems;
4. Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
5. Study of permanent slides of T.S. of mammalian testes and ovary
6. Project on artificial insemination in cattle population

SUGGESTED READINGS

- Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press.
- Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company.
- Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
- Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

Marks Distribution

- Identification – 15
- Project - 7
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

DSE-IV (Theory)

Animal Behaviour and Chronobiology

Learning Objective: **To study animal behaviour and controlling mechanisms of behaviour**

Credits 4 Contact hours 60 Marks 50

Each unit carries 10 marks

Unit 1: Introduction to Animal Behaviour

Origin and history of Ethology; Brief profiles of Karl Von Frish and Ivan Pavlov, Proximate and ultimate causes of behaviour, Methods and recording of a behaviour

Unit 2: Patterns of Behaviour

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

Social Behaviour: Concept of Society; Communication and the senses; Altruism; Insects' society with Honeybee as example;
Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice),

Unit 4: Introduction to Chronobiology

Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Biological clocks: Adaptive significance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy: Role of melatonin

Unit 5: Biological Rhythm

Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Circannual rhythms; Photoperiod and regulation seasonal reproduction of vertebrates;

DSE-IV (Practical)

Animal Behaviour and Chronobiology

Credits 2 Marks 30

1. To study nests and nesting habits of the birds and social insects.
2. To study geotaxis behaviour in earthworm.
3. To study the phototaxis behaviour in insect larvae.
4. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park preferably outside Assam to study behavioural activities of animals and prepare a field report on their observations.
5. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

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 Barens and Noble Inc. New York, USA
- Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

Marks Distribution

- Experiment – 7
- Field Report - 14
- Regularity – 5
- Laboratory Notebook – 2
- Viva voce - 2

SKILL ENHANCEMENT COURSES
SEC - I

Apiculture

Learning Objective: **To inculcate skills in apiary management**

Credits 4 **Contact hours 30** **Marks 50**

Unit 1: Biology of Bees

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

Unit 2: Rearing of Bees

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

Unit 3: Diseases and Enemies

Bee Diseases and Enemies
Control and Preventive measures

Unit 4: Bee Economy

Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc

Unit 5: Entrepreneurship in Apiculture

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, NewDelhi.

SEC - II

Aquarium Fish Keeping

Learning Objective: **To inculcate skills in Aquarium Fish keeping**

Credits 4 Contact hours 30 Marks 50

Unit1: Introduction to Aquarium Fish Keeping

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes

Unit 2: Biology of Aquarium Fishes

Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes

Use of live fish feed organisms. Preparation and composition of formulated fish feeds

Unit 4: Fish Transportation

Live fish transport - Fish handling, packing and forwarding techniques.

Unit 5: Maintenance of Aquarium

General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry