

## COURSE OUTCOME

CODE	COURSE TITLE	CREDITS
<b>DISCIPLINE SPECIFIC CORE COURSE</b>		
ZOC 101 (Sem I)	Diversity of Non-chordates & Cell Biology	04T + 2P =06
ZOC 102 (Sem II)	Diversity of Chordates & Genetics	04T + 2P =06
ZOC 103 (Sem III)	Anatomy of Animal Body Systems	04T + 2P =06
ZOC 104 (Sem IV)	Animal Physiology and Biochemistry	04T + 2P =06
ZOC 105 (Sem V)	Endocrinology	04T + 2P =06
ZOC 106 (Sem V)	Biochemistry and metabolic processes	04T + 2P =06
ZOC 107 (Sem V)	Molecular biology & Evolution	04T + 2P =06
ZOC 108 (Sem VI)	Developmental Biology	04T + 2P =06
ZOC 109 (Sem VI)	Environmental Biology & Toxicology	04T + 2P =06
ZOC 110 (Sem VI)	Parasitology	04T + 2P =06
<b>SKILL ENHANCEMENT COURSES (SEC)</b>		
ZOS 101 (Sem III)	Aquarium Fish Keeping	03T + 1P =04
ZOS 102 (Sem IV)	Wildlife and Ecotourism	03T + 1P =04
<b>DISCIPLINE SPECIFIC ELECTIVES (DSE)</b>		
ZOD 102 (Sem V)	Applied Zoology	03T + 1P =04
ZOS 103 (Sem V)	Fish and Fisheries	03T + 1P =04
ZOD 103 (Sem VI)	Animal Biotechnology	03T + 1P =04
ZOS 104 (Sem VI)	Environment Impact Assessment	03T + 1P =04
ZOP 101	Project work	
<b>ABILITY ENHANCEMENT COURSE</b>		
EVS (Sem I/II of B.A &B.Com)	Environmental studies	4T

**Semester I Course Outcome (DSC):**

**ZOCG 01: DIVERSITY OF NON-CHORDATES AND CELL BIOLOGY**

**Course Objective:** To expose student to basic concepts in diversity of Non-chordates and cell biology. To know the general characteristics and classification of Non-chordates & understand the structure and function of the Animal cell.

**Learning Outcome:**

- The student is exposed to hierarchy of various Non-chordates animal groups with an emphasis on phylogeny and interrelationship with reference to characteristic of each phylum.
- This paper is quintessential in understanding non-chordates and evolution of structures.
- The student gets an insight into structural and functional unit of life.
- The cell biology components give exposure to various cell organelles as well as applied aspects such as cancer biology.
- Practical curriculum includes study representatives of various non-chordate phyla and types of malignant pathologies.

**Theory**

**Credits: 04**

**Topics**

**Duration 60** (Clock hours)

**Unit 1: Kingdom Protista**

**3**

General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa

**Unit 2: Phylum Porifera**

**3**

General characters and classification up to classes; Canal System in Sycon

**Unit 3: Phylum Cnidaria**

**3**

General characters and classification up to classes; Polymorphism in Hydrozoa

**Unit 4: Phylum Platyhelminthes**

**3**

General characters and classification up to classes; Life history of Taenia solium

**Unit 5: Phylum Nematelminthes**

General characters and classification up to classes; Life history of *Ascaris lumbricoides* and its parasitic adaptations

**Unit 6: Phylum Annelida****3**

General characters and classification up to classes; Metamerism in Annelida

**Unit 7: Phylum Arthropoda****5**

General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects

**Unit 8: Phylum Mollusca****3**

General characters and classification up to classes; Torsion in gastropods

**Unit 9: Phylum Echinodermata****3**

General characters and classification up to classes; Water-vascular system in Asteroidea

**Unit 10: Introduction to cell biology****2**

Overview of general organization of cells (Prokaryotic cells and Eukaryotic cells)

**Unit 11: Cell Environment****5**

- Chemical bonds
- Inorganic- water, salts and ions
- Organic- proteins, carbohydrates, lipids, nucleic acids, vitamins
- Effect of radiation on cells (UV radiations, photodynamic sensitization)

**Unit 12: Cell Organelles****15**

Structure and function of Plasma membrane, Mitochondria- Structure, and function (ETC system) Structure and functions of Endoplasmic reticulum, Ribosomes, Golgi complex, Lysosomes (polymorphism of lysosomes), Microbodies (Peroxisomes and Glyoxysomes), Cytoskeleton (Microtubules, microfilaments and centrioles)

**Unit 13: Nucleus** **04**

Nuclear envelope, Nucleoplasm, Euchromatin and Heterochromatin, Nucleolus, Nucleosomes

**Unit 14: Cancer Biology** **04**

Characteristics of cancer cell • Carcinomas, Sarcomas, Lymphomas, Leukemia • Carcinogenesis

**PRACTICALS**

**Credits: 02**

- Study of animals belonging to Protozoa, Porifera, Cnidaria, Ctenophora, Platyhelminthes, Nematelminthes, Annelida, Arthropoda, Mollusca, Echinodermata with special reference to systematic position up to class level, habit, habitat, characteristic features and economic importance (one example of each class and Local examples are to be given more emphasis) with the help of Museum specimens, models, charts, Microslides, Photographs and Digital sources.
- Identification of Protozoans and Coelenterates in pond water sample
- Digestive system of Earthworm (Museum specimen/digital sources)
- Nervous system of Earthworm (Museum specimen/digital sources)
- Parapodium of Nereis, Nephredia and setae in earthworm
- larval forms of liverfluke with the help of Permanent slides/ Microphotographs/ digital sources
- Study of Prokaryotic cells- Gram's staining technique
- Study of Eukaryotic Cell using suitable staining technique (Buccal epithelial Cells)
- Method of protozoan culture (Any one)
- Study of cytoplasmic movements in Paramecium
- Study of osmosis using human RBC's
- Localization of Mitochondria by Janus Green stain
- Study of Cancer cells through permanent slides
- Study of cell organelles through electron micrographs

**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
- Jordan E.L., Verma P.S. (2001), Invertebrates Zoology., S. Chand and company, New Delhi
- Barnes, R.D. Invertebrate Zoology (1982) VI Edition. Holt Saunders International Edition.
- D.W. and J.I., Spicer (2002) The Invertebrates: A New Synthesis. III Edition. Blackwell Science.
- Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
- Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
- 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.

**Semester II Course Outcome (DSC):**

**ZOCG 02: DIVERSITY OF CHORDATES AND GENETICS**

**Learning Objective:** To expose student to basic concepts in diversity of chordate and components of genetic.

**Learning Outcome:**

- To know the general characters and classification of chordates and understand the genetics and acquaint the learner with Mendelian genetics with a component of human genetic disorders.
- Practical includes study of representatives in various chordate phyla.
- Students have a hands-on experience on blood grouping and techniques of karyotyping and analyzing genetic database.

<b>Theory</b>	<b>Credits: 04</b>
<b>Topics</b>	<b>Duration- 60(Clock hours)</b>
<b>Unit 1: Introduction to Chordates</b>	<b>02</b>
General features and Phylogeny of Protochordata	
<b>Unit 2: Agnath</b>	<b>03</b>
General features of Agnatha and classification of cyclostomes up to classes	
<b>Unit 3: Pisces</b>	<b>05</b>
General features and Classification up to orders; Migration and parental care in Fishes	
<b>Unit 4: Amphibia</b>	<b>05</b>
General features and Classification up to orders; Parental care in Amphibia	
<b>Unit 5: Reptiles</b>	<b>05</b>
General features and Classification up to orders, Mesozoic Reptiles, Venomous and non-venomous snakes	
<b>Unit 6: Aves</b>	<b>05</b>
General features and Classification up to orders; Volant adaptations in birds, Migration in Birds.	

**Unit 7: Mammals** **05**  
Classification up to orders; Origin of mammals,

**Unit 9: Chromosome Structure** **06**  
Eukaryotic Chromosome, Types of Eukaryotic Chromosome  
(based on centromere position), Eukaryotic and prokaryotic chromosomal organisation,  
Giant chromosomes

**Unit 10: Gene Mutation** **05**  
Natural and Induced Mutations, Types of gene mutation (base pair substitution  
and frame shift) Types of chromosomal aberration, Spontaneous and induced mutations  
(chemical mutagens and radiations)

**Unit 11: Inbreeding and Heterosis** **04**  
Definition of Inbreeding, Inbreeding depression, Practical applications of Inbreeding.  
Heterosis – Genetic basis; Application and Evolutionary significance.

**Unit 12: Inheritance of Human traits** **05**  
Human karyotype, Pedigree analysis Inheritance of human traits: Brown eyes,  
Polydactyly, Diabetes insipidus, Sickle cell anemia, PKU Eugenics and Genetic  
counseling

**PRACTICALS** **Credits:02**

- Study of following specimens:
- Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Any six common birds from different orders, Bat, Funambulus, Loris
- Key for Identification of poisonous and non-poisonous snakes
- Problems on multiple alleles, multiple genes and epistasis (one on each)
- Inheritance problems based on Epistatic interactions
- ABO blood grouping and Rh factor in humans
- Study of Polytene chromosome in Drosophila/Chironomous larva
- Determination of genetic sex by Barr body

- Study of Human Karyotype (Normal male and female, Turner's syndrome and Down's syndrome)
- Determination of allelic frequency of following Mendelian human traits: Tongue rolling, earlobes, Widow's peak, hand clasping, folding of arms, thumb cross pattern, Hitch-hiker's thumb.

### **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.
- 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.



**Semester III Course Outcome (DSC):**

**ZOCG 03: ANATOMY OF ANIMAL BODY SYSTEMS**

**Theory**

**Credits: 04**

**Learning Objective:** To know structure and functions of the different systems in the vertebrates.

**Learning Outcome:**

- This paper imparts an understanding of structural peculiarity of various organs specific to system.
- Course attempts to compare various organ systems across the animal hierarchy.
- Practical curriculum allows detailed study of various animal structures and their peculiarities.

<b>Topics</b>	<b>Duration- 60</b> (Clock hours)
<b>Unit 1: Integumentary System</b> Structure, functions and derivatives of integument	<b>08</b>
<b>Unit 2: Skeletal System</b> Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	<b>08</b>
<b>Unit 3: Digestive System</b> Alimentary canal and associated glands, dentition	<b>08</b>
<b>Unit 4: Respiratory System</b> Skin, gills, lungs and air sacs; Accessory respiratory organs	<b>08</b>
<b>Unit 5: Circulatory System</b> General plan of circulation, evolution of heart and aortic arches	<b>08</b>
<b>Unit 6: Urinogenital System</b> Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	<b>06</b>

**Unit 7: Nervous System****08**

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

**Unit 8: Sense Organs****06**

Classification of receptors Brief account of visual and auditory receptors in man

**PRACTICALS (CREDITS 2)**

- Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
- Disarticulated skeleton of Frog, Varanus, Fowl, Rabbit
- Carapace and plastron of turtle /tortoise
- Mammalian skulls: One herbivorous and one carnivorous animal
- Dissection of rat to study arterial and urinogenital system (subject to permission)
- Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording/models/charts (may be included if dissection not permitted)
- Project on skeletal modifications in vertebrates (may be included if dissection not permitted)

**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

**Semester III Course Outcome (SEC):**

**ZOSE I: AQUARIUM FISH KEEPING**

**Learning Objective:** To know the technique of rearing /maintaining fishes in an aquarium.

**Learning Outcome:**

- On completion of the course the student should be able to know the biology of aquarium fishes, their nutritional requirements and care.
- The student should be able to know the requirements for setting up an aquarium.
- It builds capacity of learner for entrepreneurship in aquarium industry.
- Practical curriculum helps the learner to identify common aquarium fishes, feeds besides formulated feeds.

**Theory**

**Credits 3**

**Topics**

**Duration- 45 (Clock hours)**

**Unit 1: Introduction to Aquarium Fish Keeping**

**05**

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

**Unit 2: Biology of Aquarium Fishes**

**07**

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**

**06**

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

**Unit 4: Fish Transportation**

**06**

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

**Unit 5. Common Aquarium Fish diseases**

**06**

Fin rot, swim bladder disorders, body flukes and dropsy, Ich

**Unit 6: Maintenance of Aquarium**

**07**

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

Introduction to aquarium plants and their export potential, profiles of some selected aquarium plants, Indigenous ornamental plants of Western Ghats, management of ornamental aquatic plants and its trading.

**Practicals**

- Identification of common Aquarium fishes
- Identification of live feed organisms
- Study of different types of formulated feeds
- Preparation of formulated feed
- Study of slides of parasites and diseases
- Setting up of an aquarium
- Study of ornamental plants

**Suggested Readings**

- Rath, R.K. (2000) Freshwater Aquaculture. Scientific Publishers (India). PO Box:91, Jodhpur.
- Jhingran, AVG (1991) Fish and Fisheries of India. Hindustan Publishing Co.
- Baradach, JE, JH Ryther and WO Mc Larney (1972). Aquaculture. The Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York.
- Jameson, J.D. and R.Santhanam (1996). Manual of ornamental fisheries and farming technology. Fisheries College and Research Institute, Thoothukudi.
- Mitchell Beazley, 1998. The complete guide to tropical aquarium fish care. Read and Consumes Book Ltd., London.
- Everything for the aquarist. Tetra Werke Publication, West Germany.
- Jameson, J.D. Alangara Meen Valarpu (in Tamil). National Book House, New Delhi.

**Semester IV Course Outcome (DSC):**

**ANIMAL PHYSIOLOGY & BIOCHEMISTRY**

**ZOCG 04: ANIMAL PHYSIOLOGY & BIOCHEMISTRY**

**Theory**

**Credits: 04**

**Course Objectives:**

To understand the physiology of different processes of the body systems and the micro molecules and macromolecules of the cells.

**Learning Outcome:**

- On completion of the course the student should be able to know mechanism of body functions and the basic knowledge of chemistry of biomolecules.
- The learner understands the functional aspects of various organ systems and biomolecules which drive these physiological processes.
- Practical components of this paper build the capacity of learner to carry out basic investigations of body fluids (urine and blood), biochemistry, and cardio dynamics evaluation.

**Topics**

**Duration- 60** (Clock hours)

**Unit 1: Physiology of Digestion**

**06**

Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Hormonal control of secretion of enzymes in Gastrointestinal tract.

**Unit 2: Physiology of Respiration**

**07**

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; Control of respiration

**Unit 3: Renal Physiology**

**05**

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance.

**Unit 4: Cardiovascular Physiology**

**06**

Composition of blood, blood volume, Origin and conduction of the cardiac impulse, Cardiac cycle, Regulation of blood pressure and heart rate.

**Unit 5: Muscle Physiology** **06**

Types of muscles, Ultrastructure of skeletal muscles, properties of skeletal muscles, theories of muscle contraction,

**Unit 6: pH and buffer** **01**

Definition of pH, buffer, types of buffer.

**Unit 7: Carbohydrates** **07**

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

**Unit 8: Lipids** **07**

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

**Unit 9: Proteins** **08**

**Amino acids:** Structure, Classification and General properties of  $\alpha$ -amino acids; Physiological importance of essential and non-essential  $\alpha$ -amino acids **Proteins:** Bonds stabilizing protein structure; Levels of organization in proteins; Denaturation; Introduction to simple and conjugate proteins

**Unit 10: Enzymes** **07**

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions, Concept of Michaelis-Menten equation, Lineweaver-Burk plot, Enzyme inhibition.

**PRACTICALS**

- Measurement of blood pressure
- Hemoglobin estimation\
- Preparation of Haemin crystals
- Observation of Pulse rate under normal and stressed condition
- Respiratory rate of cockroach/any insect

- Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose)
- Estimation of total protein.
- Study of activity of salivary amylase under optimum conditions (pH, temperature)
- Study of normal and abnormal constituents in Urine
- Study of different types of muscle cells.

### **Suggested Readings**

- Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & 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
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
- Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/McGraw3Hill.

## **Semester IV Course Outcome (SEC):**

### **ZOSE 2: WILDLIFE AND ECOTOURISM**

**Learning Objective:** To learn the objectives and strategies of wildlife conservation and monitoring. This paper builds the foundation of responsible tourism option as against conventional mass tourism.

#### **Learning Outcome:**

- On completion of the course the student should be able to know the current status and conservation strategies for wildlife conservation and management.
- The students has a fair understanding of India's wildlife endowment and conservation status, planning, execution, ethics of wildlife tourism complimented by practical component.
- Practical components are field oriented and impart capacity to identify and develop local landscape into a potential green tourism site.

#### **Theory**

**Credits 3**

#### **Topics**

**Duration- 45** (Clock hours)

#### **Unit1: Introduction to Wildlife, Current Scenario & Conservation categories 04**

Meaning, Values, Global & Indian scenario Biogeographic zonation and wildlife endowments of India, Wildlife as a sustainable tourism resource. Contemporary status of Indian Wildlife and Impediments to conservation of wildlife in India

#### **Unit2: Causes of depletion, extinction of wildlife & Conservation Categories 10**

Causes of Wild Depletion -Proximate & Root causes. Extinct Species, Drivers of Extinction & Extinction Threshold North East and Western Ghats; as 'Centers of Endemicity' Conservation categories with relevant examples (Endangered, Vulnerable, Rare, Threatened, Out of Danger, Indeterminate, Insufficiently Known, Extinct, Extinct in Wild ,Critically Endangered, Lower Risk, Conservation Dependent, Near Threatened, Least Concern, Data Deficient, Not Evaluated) IWPA 1972, Schedule I species (Mammals, Birds and Reptiles).

#### **Unit 3: Wildlife Conservation-Objectives & Methods**

**06**

Meaning of conservation, Objectives of wildlife conservation strategies, Ex situ & In situ methods of wildlife Conservation (**PAN, CCA, Zoos, Aquaria, Captive Breeding**)



**& Ranching etc.) Centrally Sponsored Schemes for Wildlife Conservation (Integrated Development of Wildlife Habitats, Project Tiger, Project Elephant)**

**Unit 4: Wildlife Tourism in India: Prospects & Challenges** **10**

Difference between Tourism, leisure and recreation Ecotourism versus Conventional Mass tourism, a SWOT analysis. Natural area Tourism (Adventure tourism, Wildlife tourism and Ecotourism) Wildlife Tourism: **Advantages** (Sustainability of enterprise, Assured backflow of profits to local communities, Upholding conservation ethos) Wildlife Tourism: **Impacts** (Altered landscape, Impact of roads on wildlife habitats, , Tourism generated litter, Introduction of Invasive species, Zoonotic disease transmissions, Violation of 'Visitors carrying Capacity' & visitor induced stress and disturbance Tour to wildlife)

**Unit 5: Planning, Management & Monitoring of Wildlife Tourism** **15**

Wildlife as a specific component of ecosystem and major wildlife destinations in India.(Wildlife of Indian Himalayas, Indian Deserts, Indian Coral Reefs, Western Ghats) Rationale for Visitor Planning and stakeholder involvement Carrying Capacity & 'Acceptable' Change Visitor Management: Zoning, Roads & Trails, Regulating Visitor numbers, Visitor Communication & Education. Interpretation: Fundamental Principles & major interpretation techniques (Publication & Websites, Visitor Centres, Self-guided Trails, Guided Tours Visitor Monitoring: Reasons for Monitoring, Monitoring Techniques (Counting visitors, Questionnaires & Interviews, Observing visitors, Focus Groups)

**Reference Books**

- S K Singh (2010) Text Book of wildlife Management International Book Distributing Company, Lucknow
- Vivek Menon (2014) Indian Mammals :A Field Guide Hachette Book Publishing India Pvt Ltd, Gurgaon
- S S Negi (1992) Himalayan Wildlife. Indus Publishing Company, New Delhi
- Mohan Pai (2005) The Western Ghats. M/S Narcinva damodar Naik Margao ,Goa
- Richard Carmichael (2007). Indian Wildlife. Apa Publications GmbH Co. Vertag KG (Singapore )

- Ravee Chauhan (2006) Ecotourism Trends & Challenges. Vista International Publishing House Delhi
- David Newsome, Susan Moore and Ross K Dowling (2006) Natural Area Tourism Ecology, Impacts and Management. Viva Books Pvt Ltd Ac Delhi
- C.Michael Hall and Stephen Boyd (2006) Nature based tourism in peripheral areas - Development or disaster ? Viva Books Pvt Ltd New Delhi
- Ministry of Environment & Forests GoI, (2002), National Biodiversity Strategy & Action Plan

### **Practicals**

**(Credits:01)**

- Use of Maps and other GIS resources to understand the biogeographic zones of India and understand the location of our State in this scheme.
- Prepare an Inventory of state's Wildlife Resources (Forest Types, Carnivores, Wild Ungulates, Birds, Reptiles) from secondary sources and classify them under them under various PAN, IUCN conservation categories & IWPA Schedules
- Visit to a state WPA and CCA to understand and prepare Report on the management and conservation action.
- To prepare an inventory of your Taluk's existing and potential Ecotourism sites with special reference to Birdlife. Evaluate any one extant ecotourism site with reference to
  - ❖ Visitor's Carrying Capacity
  - ❖ Visitor Education & Interpretation
  - ❖ Visitor Facility
- Observing the effect Habitat improvement on diversity of butterflies (Diversity estimation pre and post food plants introduction)
- Understanding Carnivore Pug Biometry by analysis of Pug Marks/Whisker Spot study in Asiatic Lion (Printed Lion Pug Imprints / Lion Head sketches with Reference Rows & Identification Rows of Whisker Spots to be provided)
- Population enumeration by Lincoln & Peterson's Index Method (Coloured Beads to represent marked to unmarked individuals)

## References

1. Willian J. Sutherland, Lynn V. Dicks, Nancy Ockendon & Rebecca K. Smith(2015) What works in conservation. Open Book Publishers, UK
2. S K Singh (2010) Text Book of wildlife Management International Book Distributing Company, Lucknow
3. Paresh Porb, Raman Kulkarni and Varad Giri (2014) Biodiversity of Goa. Pug Marks Art Gallery, Kolhapur
4. Goa State Biodiversity Board (2014) Island Biodiversity , Goa:Biological Treasure of Chora, Divar and St Jacinto Island. National Biodiversity Authority.
5. Richard Grimmet, Tim Inskipp (2005) Birds of Southern India. Om Books International
6. Issac Kehimkar (2011) The Book of Indian Butterflies. Oxford.
7. Luigi Boitani & Roger Powell (2012) Carnivore Ecology and Conservation. Oxford University Press
8. Romulus Whitaker & Ashok captain (2008) Snakes of India. Draco Books Tamil Nadu
9. Asad R Rehmani (2012) Threatened Birds of India. Oxford University Press
10. Ravee Chauhan (2006) Ecotourism Trends & Challenges. Vista International Publishing House Delhi
11. David Newsome, Susan Moore and Ross K Dowling (2006) Natural Area Tourism Ecology, Impacts and Management. Viva Books Pvt Ltd Ac Delhi
12. The Wildlife (Protection ) Act, (1972) Natraj Publishers

## **SEMESTER V**

**T. Y. B.Sc**

**Paper: ZOC 105: ENDOCRINOLOGY**

**Learning objective:** To learn the mechanism of integrative physiology.

### **Learning outcome:**

- On completion of the course, the student will be familiarized with endocrine dysfunction involving various endocrine glands in the body.
- The students will know the internal methods on integrating the functions of different internal systems to maintain homeostasis through hormonal regulation.
- The practical curriculum of the course acquaints the student with classical as well as modern approaches in endocrinology.

### **THEORY**

**Credits: 04**

**Duration – 60 Hrs.**

#### **Unit 1: Introduction**

**07**

Endocrinology, Endocrine glands.

Concept of homeostasis - Glucose and Calcium Homeostasis.

#### **Unit II: Endocrine Hypothalamus**

**07**

Hypothalamo hypophyseal portal system, Hypothalamo hypophyseal neurosecretory tracts, Hypothalamic nuclei, - Magnocellular and Parvicellular elements. Hypothalamic releasing and inhibitory hormones/factors.

#### **Unit III: Hormones**

**07**

Chemical messengers, type of chemical messengers. Hormones, types of hormones (proteins and steroids). Hormonal regulation of secretion – Feedback system- long loop, short loop, positive and negative feedback.

#### **Unit IV: Hypophysis**

**12**

Gross anatomy, blood supply, histology of Adenohypophysis- identification of cell types based on staining affinities. Division and nomenclature of hypophysis. Hormones of Adenohypophysis, their functions and effect on target organs, Disorders of growth

hormones. Neurohypophysis – Hormones of the neurohypophysis, Biological effects of Oxytocin and Vasopressin, Diabetes insipidus.

**Unit V: Thyroid** **07**

Structure, blood supply and nerves. Structure of thyroid follicles, principle cells and parafollicular cells. Biochemistry of Thyroid Hormones, Factors affecting thyroid functions. Clinical aspects of thyroid functions (Cretinism, Myxoedema, and Graves' disease) Parathyroid – Histology, hormones, Regulation of Blood Calcium level, Parathyroid tetany.

**Unit VI: Endocrine Pancreas** **06**

Histology of Pancreas, Endocrine pancreas- Islets of Langerhans, types of cells ( $\alpha, \beta, \gamma$  and  $\delta$ ). Effects of Insulin and Glucagon. Regulation of blood glucose level – Diabetes Mellitus (IDDM and NIDM).

**Unit VII: Adrenal** **08**

Anatomy of adrenal gland, Functional morphology of adrenal cortex, Zones of adrenal cortex - Histology. Adrenal steroid hormones - Glucocorticoids, Mineralo corticoids and Adrenal sex steroids. Regulation of Adrenocortical function. Adrenal medulla – Functional morphology of adrenal medulla , Hormones of medulla, Catacholamines and their roles in metabolism. Adrenocortical disorders – Cushing's syndrome and Virilism.

**Unit VIII: Gonads as endocrine structures.** **06**

Testes – endocrine component of testes (Leydig cells and Sertoli cells). Hormones of testes – Androgens and their biological role. Ovary - Endocrine components of ovary (Follicular wall Theca and Granulosa). Corpus luteum and Interstitial cells. Hormones of ovary and their biological function . Placenta –Placenta and its Hormones.

**PRACTICALS** **2 Credits**  
**(30 Practicals)**

1. Study of histological structure of following endocrine glands
  - a) Pituitary
  - b) Thyroid
  - c) Parathyroid,

- d) Adrenal,
  - e) Islets of Langerhans
  - f) Testis
  - g) Ovary.
2. Dissect and display of endocrine glands in Laboratory bred rat.
  3. Surgical techniques of Adrenalectomy and Ovariectomy in Laboratory bred rat.
  4. Pregnancy test using human urine sample.
  5. Histological technique using Testis/ Ovary/ Adrenal gland.
  6. Effect of estrogen on ovary & uterus of Laboratory bred rat.
  7. Study of hypothalamo hypophysial portal system & neuro secretory tracts through permanent slide / photomicrograph.

**References:**

1. Bloom and Fawcet (1982). A Textbook of Histology, W. B. Saunders publications
2. Copenhaver, W.M., Kelly D.E. and R. L. Wood (1978). Bailey's Textbook of Histology, Williams & Wilkins Co., Baltimore.
3. Eckert and Randall (2005) Animal Physiology. CBS publishers.
4. Guyton . C. and Hall J. E. (2010), text book of Medical Physiology, W.B. Saunders publications, Philadelphia
5. Hadley M. E. and Levin J. E, (2009). Endocrinology. Dorling Kindersley India Pvt.Ltd.
6. Ross M. H. and W. Pawlina (2010) Histology- a text & Atlas with correlated cell and Molecular Biology, Walter Kluver health- Lippincott Williams & Wilkins Baltimore.
7. Shambulingam K. and P. Shambulingam (2010) Essentials of Medical Physiology, Jaypee Brothers, Med Publication.
8. Singh, H. R. (2012) Animal Physiology & Biochemistry, Vishal Publ. Co.
9. Turner C.D. and J. T. Bagnara (1976). General endocrinology W.B. Saunders publications, Philadelphia

## **SEMESTER-V**

**T. Y. B.Sc**

**Paper: ZOC 106 BIOCHEMISTRY AND METABOLIC PROCESSES**

**Learning Objective:** To provide students with theoretical and practical understanding of Biochemistry and metabolic processes

**Learning Outcome:**

- The student should be able to understand intricacies of Biochemistry and its role in metabolic processes.
- Students will learn optimal limits of biochemical & metabolic processes integral to life.
- Students will also understand the application of laws of thermodynamics.
- The practical component gives hands-on experience in analytical aspects of biochemistry & metabolic processes.

### **THEORY**

**Credits: 04**

**Duration: 60 Hrs**

#### **Unit 1: Overview of Metabolism**

**10**

Metabolism, Stages of catabolism, Sub divisions of Metabolism, Catabolism vs. Anabolism, regulation of Metabolic pathways, Shuttle systems and membrane transporters;

#### **Unit 2: Bioenergetics**

**05**

Concept of Energy, Laws of Thermodynamics, Free energy, ATP as “energy currency” of the cell.

#### **Unit 3: Carbohydrate Metabolism**

**15**

Sequence of Reactions and Regulation of Glycolysis, Pentose phosphate pathway, Oxidative decarboxylation, Citric acid cycle, Gluconeogenesis, Glycogenolysis and Glycogenesis., Mitochondrial respiratory Chain,

#### **Unit 4: Oxidative Phosphorylation**

**10**

Mechanism of oxidative phosphorylation - Chemical coupling Hypothesis, Conformational coupling Hypothesis, Chemiosmotic Coupling Hypothesis. Inhibitors and Uncouplers of Electronic Transport system.

**Unit 5: Amino acid metabolism****10**

Catabolism of amino acids: Transamination, Deamination, Urea Cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids, inborn errors of Amino acid catabolism (Albinism, Alkaptonuria, Phenylketonuria)

**Unit 6: Lipid Metabolism****10**

Beta-oxidation of fatty acids – a. Palmitic acid {saturated (C 16:0) b. Linoleic acid {unsaturated (C 18:2) Alpha and Omega oxidation of fatty acids, ketogenesis- Ketogenic and Antiketogenic substances, Regulation of ketogenesis.

**PRACTICALS:****2 Credit****(30 Practicals)**

1. Estimation the concentration of plasma glucose in the given sample by colorimetric / Spectrophotometric method.
2. Estimation of fatty acids from the given oil/ fat samples by titration method
3. Estimation of cholesterol concentration in the given blood sample.
4. Separation of lipids by thin layer chromatographic method in a given sample.
5. Separation of amino acids by paper chromatography.
6. Estimation of glycogen in the given sample by colorimetric / Spectrophotometric method
7. Determination of saponification value of oil.
8. Determination of iodine number of oil
9. Detection of SGOT in serum/ tissue
10. Estimation of amino acids by Ninhydrin method

**References:**

Berg, J. M., Tymoczko, J. L. and L. Stryer (2007) Biochemistry, VI Edition, W.H. Freeman and Co., New York

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

Hames, B. D. and N. M. Hooper (2000) Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K. CBCS U

Jain, J. L., Sunjay Jain, and Jain Nitin (2016) Fundamentals of biochemistry, S. Chand and Company limited, New Delhi.



Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., Rodwell, V. W. and P. A. Well, (2009) Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc

## **SEMESTER-V**

### **T.Y.B.Sc**

#### **Paper: ZOC 107: MOLECULAR BIOLOGY AND EVOLUTION**

**Learning Objective:** To understand the principles of inheritance from molecular mechanisms and evolution as the central unifying concept in biological sciences.

#### **Learning Outcome:**

- The student should be able to appreciate and know the scope of molecular biology in terms of evolution of the major groups of organisms.
- On completion of the course the students will understand the molecular mechanisms of life processes with special reference to Genomics and Proteomics. A part of the curriculum also addresses evolution
- The practical component addresses the extraction of basic molecules of life i.e. DNA & RNA, besides an exposure to paleontology & basic techniques of genetic analysis. Interpretation of biometric data is also taught.

## **THEORY**

**Credits: 04**

**(Duration 60hrs)**

### **Unit 1: DNA Replication and Repair mechanism**

**07**

Introduction to nucleic acids. DNA Replication in eukaryotes: mechanism, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, replication of telomeres, pyrimidine dimerization and mismatch repair

### **Unit 2: Transcription, Post-Transcriptional Modifications and Processing of Eukaryotic RNA**

**08**

RNA polymerase and transcription Unit, mechanism of transcription in eukaryotes, synthesis of rRNA and mRNA, transcription factors, Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA

### **Unit 3: Translation**

**09**

Genetic code, evolution and degeneracy of genetic code and Wobble Hypothesis; Process of protein synthesis in eucaryotes: Ribosome structure and assembly in prokaryotes,

fidelity of protein synthesis, 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 4: Gene Regulation** **06**

Transcription regulation in prokaryotes: Principles with examples from lac operon and trp operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting.

**Unit 5: Concept of Evolution, Origin of Life and speciation** **10**

Basic concept of organic evolution (Micro, macro and mega); Theories of evolution (Lamarckism, Darwinism, Neo-Darwinism, Contribution of Weisman, De Vries, Huxley, Haeckel); Origin of Earth; Chemogeny; Biogeny; Cognogeny; concept of species (morphological, genetic, biological) Species categories (monotypic, polytypic, sibling) subspecies; origin of species (allopatric, sympatric, parapatric).

**Unit 6: Variability and Mutations** **06**

Nature, kind, causes and role of variability. Mutations : definition, characteristics, types, causes, and effects. Induced, natural and gene mutation.

**Unit 7: Isolation and Adaptation** **08**

Classification and types of isolating mechanisms; reproductive isolation, role of isolation in evolution; types of adaptations; Convergent, Divergent and Parallel adaptations; Pre, post and Co-adaptations.

**Unit 8: Genetic basis of evolution and study of fossils** **06**

Population genetics; gene pool, frequency and equilibrium; Hardy Weinberg's Law of equilibrium. Fossils (types, formation, dating and significance)

## **PRACTICALS**

**Credit: 02**  
**30 Practicals)**

1. Extraction and qualitative Detection of DNA and RNA
2. Quantitative estimation of DNA and RNA.
3. Study and interpretation of electron micrographs / photograph showing (a) DNA replication  
(b) Transcription (c) Split genes
4. Electrophoretic separation of Protein
5. Study of fossils, homology and analogy from models / pictures, suitable specimens
6. Study and verification of Hardy-Weinberg Law by chi square analysis
7. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
8. Graphical representation and interpretation of data of height / weight of a sample of 100 humans in relation to their age and sex.

### **References:**

- Arora, M. P. (2000) Organic Evolution. 2nd Ed. Himalaya Publishing House, Mumbai.
- Becker, W. M., Kleinsmith, L. J., Hardin. J. and G. P., Bertoni, (2009) The World of the Cell. 7th Ed. Pearson Benjamin Cummings Publishing, San Francisco.
- De Robertis, E. D. P. and E. M. F. De Robertis, (2006) Cell and Molecular Biology. 8th Ed. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Ed. John Wiley and Sons. Inc.
- McLennan A., Bates A., Turner, P and M. White, (2015) Molecular Biology. 4th Ed. GS, Taylor and Francis Group, New York and London.
- Rastogi, V. B., (1998) Organic Evolution. 11th Ed. Kedar Nath Ram Nath, Meerut.

## **SEMESTER V**

**T. Y, B.Sc**

**Paper: ZOD-102 APPLIED ZOOLOGY**

**Learning Objectives:** To learn the interrelationship of animal life with special reference to human life.

### **Learning outcome:**

- On the completion of the course students will get acquainted with the different branches of Applied Zoology.
- The paper gives a comprehensive account of animal sciences in relation to animals of bionomic importance.
- It is envisioned to encourage entrepreneurship.
- The practical component imparts hands-on experience in determining qualitative aspects of animal products as also an understanding of vermicomposting.

## **THEORY**

**Credits: 03**

**Duration: 45 Hrs.**

### **Unit 1: Introduction to Applied Zoology 02**

Nature, scope & major branches of applied Zoology

### **Unit 2: Vermiculture 06**

Introduction; varieties of earthworms, types of earthworms suitable for vermicomposting, Economic importance of earthworms; Methods of vermicomposting; basic requirements, preparation of vermibed; Collection of Compost and separation of earthworms, Vermiwash; effect of vermiwash on yield and quality of crops.

### **Unit 3: Apiculture 06**

Introduction; types of honey bees; Colonial organization and division of labour; honey comb; lifecycle of honey bee;  
Bee products ( honey, wax & royal jelly); Bee keeping equipments; Bee management;  
Role of bees in pollination.

**Unit 4: Sericulture****06**

Introduction; different types of silk and silk worm in India (Mulberry, Tasar, Muga, Eri); Rearing of *Bombyx mori*; harvesting of cocoons & quality assessment of silk fibres; Silk worm diseases( Pebrine, Flacheria, Grasserie & Muscardine) & their management; silkworm peat & parasites (Uzi fly, Dermastis beetles) & their management.

**Unit 5: Poultry****09**

Introduction; types of poultry birds; breeds of fowls , exotic breeds ( birds of American class, English class, Mediterranean class); culling the flock; selection of good layers; feeding and management of laying birds; management of Young Chickens; Indian brooders; grading & marketing of eggs; poultry manure; diseases of fowls Ranikhet disease, fowl pox, fowl cholera, fowl typhoid) & their prevention.

**Unit 6: Piggery****06**

Introduction; country pig; advantages of pig production; selection of breeds( The English & American class); feeding and management of herd; Products of piggery(Pork, Bristles, Sausages, Lard); Diseases & their Control.

**Unit 7: Dairy****10**

Introduction, Dairy farm and farm organization, Indigenous and exotic breeds of cow; feed and medical care of breeds. Milk- Composition and its types( Toned milk, Standardized, Homogenized, Fortified, Condensed and Synthetic); Milk products: composition, preparation and uses (cream, butter, curd, ghee, cheddar cheese and paneer). Commercial importance of Dairy.

**PRACTICALS****Credit: 01****(15 Practicals)**

1. Mounting of mouthparts and appendages of honey bee.
2. Test to determine the homogenous / heterogenous honey.
3. Study of types of silkworm cocoons (Mulberry, Tasar, Muga, Eri)
4. Determination of quality of egg.(fresh and aged egg)
5. Determination of Lactose content in milk.
6. Determination of adulterant in ghee (sesame oil).
7. Isolation of casein from milk.

8. Study of different breeds of pigs through digital source ( English and American Class)
9. Study of different varieties of earthworms through museum specimens/digital source.
10. Demonstration of vermiculture technique.

### **References**

1. Arumugam N., Murugan T., Johnson Rajeshwar, and R. Ram Prabhu (2013) Applied Zoology, Saras Publication.
2. Clarence Henry Eckles, Willes Barnes Combs and Harold Macy (2012) Milk and milk products, Tata McGraw-Hill Publ. Co., Ltd, New Delhi.
3. Jagadish Prasad (2016) Principles and Practices of Dairy Farm Management. Kalyani publishers, New Delhi.
4. Jayasurya , Arumugam N.Thangamani , Prasannakumar, and L. M. Narayanan (2013) Economic Zoology , Saras Publication.
5. Kishore, R. Pawar, DamaL. B., Ashok E Desai and R. N. Patil (2016) A Textbook of Ecology, Ethology , Evolution and Applied Zoology. Nirali Prakashan
6. Manju Yadam (2003) Economic Zoology, Discovery Publishing House, New Delhi.
7. Pradip V. Jabde (2005) Textbook of Applied Zoology (Vermiculture, Apiculture, Sericulture, Lac Culture, Agricultural Pests and their control). Discovery publishing house, New Delhi.
8. Sukumar De (2001) Outlines of Dairy Technology, Oxford University Press, New Delhi.
9. Tarit Kumar Banerjee (2017) Applied Zoology, New Central Book Agency.
10. Tomer and Bhatnagar (2002) A Textbook of Applied Zoology. Emkay Publication, Delhi

## **SEMESTER-V**

### **T. Y. B.Sc**

#### **Paper: ZOD 103 FISH AND FISHERIES**

**Learning objectives:** To provide students with theoretical and practical understanding of Fish and fisheries

#### **Learning Outcome:**

- The student should be able to understand structure, function and behaviour of fishes and role of fisheries in improving human welfare.
- The paper aims at building students' capacity towards understanding fisheries resources including detailed account of aquaculture.
- Given the maritime status of Goa, entrepreneurial relevance.
- The practical component exposes the student to common fish resources to Goa, State specific crafts & gears, as well as hands-on experience in water analysis.
- The theory component is complemented by Fish farm visit.

#### **Theory**

**Credits 03**

**(Duration: 45hrs)**

#### **Unit 1: Introduction**

**02**

General description of fish, Classification based on feeding habit, habitat and manner of reproduction,

#### **Unit 2: Morphology, Physiology and behaviour**

**08**

Types of fins and their modifications; Locomotion in fishes; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gaseous exchange; swim bladders and their role in Respiration; Osmoregulation in Elasmobranches; Reproduction. Migration.

#### **Unit 3: Fisheries**

**16**

Definition, Scope, Global scenario, Present status of Fisheries in India , Inland Fisheries; Marine Fisheries; EEZ, Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal; Fishing crafts and Gears with special reference to Goa; Important fin fishes of west coast of India (sardine, Mackerel, Pomfret,



Bombay Duck, King – fish, Shark). Shell fishery: prawn, crab, Oyster, clams, Cuttle Fish. Inland Fisheries: Indian major carps. Depletion of fishery resources. Application of remote sensing and GIS in fisheries. Deep sea fishing: policies and problems. Fishery law, regulations and conservation

**Unit4: Aquaculture**

**16**

Types of aquaculture: Extensive, semi-intensive, intensive and super intensive aquaculture in different types of water bodies viz., freshwater, brackish water inland saline and marine water, Pond, Pen and cage culture. Mono, poly and integrated culture systems. Running water culture and zero water exchange system. Sustainable Aquaculture, Composite fish culture. Brood stock management; Induced fish breeding. Fish diseases: Bacterial, viral and parasitic. Preservation and processing of harvested fish, Fishery by-products

**Unit 5: Fish in research**

**03**

Transgenic fish, Zebra fish as a model organism in research

**Practicals:**

**1 Credit**

**(15 Practicals)**

1. Morphometric and meristic characters of fishes (Any Two)
2. Study of sardine, Mackerel, Pomfret, Bombay Duck, King fish, Shark, Shell fishery: prawn, crab, Oyster, clams, Cuttle Fish, Inland Fisheries: Indian major carps.
3. Study of different types of scales
4. Study of crafts and gears used in Fisheries
5. Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total solids, Total dissolved solids
6. Demonstration of induced breeding in Fishes (video)
7. Demonstration of parental care in fishes (video)
8. Visit to any fish farm/ pisciculture unit / Zebrafish rearing Lab / fish breeding unit.  
(Project Report)

**References:**

- Bone, Q and R. Moore (2008) *Biology of Fishes*, Talyor and Francis Group, CRC Press, U. K.
- Evans, D. H. and J. D. Claiborne (2013) *The Physiology of Fishes*, (4th Edn) Taylor and Francis Group, CRC Press, U. K.
- Khanna, S. S. and H. R. Singh (2012) *A text book of Fish Biology and Fisheries*, Narendra Publishing House, New Delhi.
- Norman, J. R. (1998) *A history of Fishes*, Hill and Wang Publishers
- Srivastava, C. L. B. (2013) *Fish Biology*, Narendra Publishing House
- Gupta S. K. and P. C. Gupta (2018) *General and applied Ichthyology*. S. Chand & Co., New Delhi
- Von der Emde, R. J., Mogdans and B. G. Kapoor (2004) *The Senses of Fish: Adaptations for the Reception of Natural Stimuli*, Springer, Netherlands

## **SEMESTER-VI**

### **T.Y.B.Sc**

#### **Paper: ZOC 108: DEVELOPMENTAL BIOLOGY**

**Learning Objectives:** To provide students with theoretical and practical understanding of animal developmental Biology

#### **Learning Outcome:**

- The student should be able to describe the science of developmental Biology and its role in advancement of research in Science
- The course imparts understanding of beginning of organismic life & subsequent organogenesis.
- Concepts are explained using chick models, also applied dimensions such as aging & regeneration makes it interesting.
- The learner is exposed to latest advances such as Teratology and assisted reproductive technology.
- The practical component imparts hands-on training in various aspects of developmental biology using chick model.

## **THEORY**

**Credits 04**

**(Duration 60 Hrs)**

### **Unit 1: Introduction**

**14**

Branches of embryology. Scope of embryology. Gametogenesis: Spermatogenesis, Oogenesis, Vitellogenesis, Types of Eggs, Egg membranes. Fertilization: Definition, activation and Amphimixis. Types of Fertilization, Biochemical changes during fertilization, Significance of Fertilization. Parthenogenesis, planes and Patterns of cleavages. Gastrulation (Emboly and Epiboly) Fate maps and Cell lineage. Organogenesis, growth and differentiation

### **Unit 2: Transplantation, embryonic inductions, concept of organizer and competence**

**10**

Definition of transplantation, nuclear transplantations, embryonic induction: Types, Concept of primary organizer, Experiments by Brachets, Spemann, and Mangold,

Characteristics of an organizer, Regional specificity of organizer. Neural induction:, mechanism. Surface interaction and chemical interaction, Gradient theory of neural induction, Secondary, Tertiary and Quaternary organizers, Eye as an example of sequential induction, Competence.

**Unit 3: Early Embryonic Development of Chick** **12**

Structure of hen's egg, cleavage, blastula, Gastrulation, Development of chick embryo up to 3 days of incubation.

**Unit 4: Late Embryonic Development** **07**

Fate of Germ Layers; Extra-embryonic membranes of chick (Development, structure and functions of yolk sac, Amnion, Chorion and Allantois, Placenta (Structure, types and functions of placenta)

**Unit 5: Regeneration and ageing** **07**

Types, Regenerative ability in different animal groups, Mechanism of regeneration, Stimulus and suppression of regeneration, Polarity in regeneration. Introduction to Ageing: Concepts and models. Apoptosis

**Unit 6: Implications of Developmental Biology:** **10**

Teratology. stage sensitivity of foetus, twins – Identical, fraternal, and conjoined - equal and unequal. Malformations in external structures of body. Causative factors in teratogenesis. Infertility, Artificial insemination, Surrogacy, ART (Assisted Reproductive technologies), IVF and Test tube babies, GIFT (Gamete intra fallopian transfer) ZIFT (Zygote intra fallopian transfer) ICSI (Intra cytoplasmic Sperm Injection)

**PRACTICALS:**

**2 Credits**

**(30 Practicals)**

- 1) Observation of different types of eggs – amphibian egg, hen's egg, insect egg.
- 2) Observation of developmental stages of frog's egg: cleavage, blastula, gastrula.
- 3) Study of morphogenetic movement in vivo in hen's egg using vital staining technique by preparing a window opening.
- 4) In vitro observation of the different extra embryonic membranes in a 6 days old chick embryo.

- 5) Mounting of eye vesicle and limb buds of a 6 day old chick embryo.
- 6) Preparation of permanent slides of chick embryo. 24 hrs., 36 hrs., 48 hrs., 72 hrs.
- 7) To study the regenerative ability in vertebrates (fish fin).

**References:**

- Armugam (2014) A text book of Embryology, Saras Publications
- Balinsky, B. I., (2016) An introduction of embryology, Saundus College pub., Philadelphia.
- Berril N. J., (1971) Developmental Biology, Mc Graw Hill, New Delhi.
- Boby Jose (2017) Developmental Biology, Reproductive Biology and teratology, Manjusha Publ. Calicut
- Bruce M. Carlson (2008) Patten's Foundations of Embryology 6th Edn. Mc Graw Hill, Inc.
- Ghose, K. C. and B. Manna (2007) Practical Zoology, New Central Book Agency. New Delhi
- Gilbert, S. F. (2017) Developmental Biology, Sinauer Associates, Sunderland.
- Jain, P.C. (2001) Elements of Developmental Biology, Vishal Publications, Jalandhar
- Lal, S. S. (2018) A Text book of practical zoology (vertebrates) Rastogi publications, Meerut
- McEwen, R. S. (1953) Vertebrate Embryology, Oxford and IBH publishing company, New Delhi.
- Nair, P. K. G. and K. P. Achar (2013) Principles of Animal Embryology, Himalaya Publishing House.
- Sastry, K. V. R. and Shukla (2010) Developmental Biology; Rastogi publications. Meerut
- Subramanian, M. A. (2014) Developmental Biology, MJP Publications,
- Suresh C. Goel, (2016) Principles of Animal Developmental Biology, Himalaya Publishing House.
- Verma, P. S. and V. K. Agarwal (2010) Chordate Embryology (Developmental Biology) S. Chand and Company Ltd., Ram Nagar, N. Delhi.

## **SEMESTER-VI**

**T. Y. B.Sc**

**Paper: ZOC 109: -ENVIRONMENTAL BIOLOGY AND TOXICOLOGY**

**Learning objectives:** To understand the concepts and application of Environmental biology and Toxicology.

### **Learning outcome:**

- On completion of the course the student will have reasonable understanding of the natural resources, population dynamics & conservation biology.
- They will also have basic and applied knowledge of toxicology and fate of toxicants in the environment.
- The course gives specific understanding of ecology & conservation biology & toxicology, in the light of contemporary scenarios; pollution, adulteration & environmental deterioration. This course builds capacity to understand problems & suggests solutions.
- The practical component builds capacity of learner for comprehensive water analysis for physio-chemical & biological parameters also there are unit specific to hands-on experience in wildlife techniques.

## **THEORY**

**Credits: 04**

**(Duration: 60 hrs.)**

### **Unit 1: Introduction to Environmental Biology**

**02**

Definition of ecology and environmental biology, brief idea of Ecological scales: levels of organization (species to Biosphere).

### **Unit 2: Natural Resources**

**08**

Introduction, resource cycle, mineral resources (Distribution and Classification of minerals, Mineral wealth of India), Marine living resources, Energy resources (Renewable and Non-renewable), Nuclear energy (Uranium and Thorium), Forest resources, Water: a vital resource. Human impact on Natural Resources.

**Unit 3: Population Dynamics****10**

Introduction to population ecology, Natality, Mortality, Fecundity, Life tables, Age distribution of population, Age pyramids, Sex ratio, Biotic potential and Environmental resistance, growth form and Growth rate of population. Population dispersion: Emigration, Immigration, Migration. Regulation of Population size.

**Unit 4: Conservation Biology****10**

History, scope and global conservation efforts, India's Biodiversity: Mega diversity status and Biodiversity Hotspots, Concerns and conservation challenges (Proximate and Root causes of biodiversity loss), Global conservation priorities and IUCN Conservation categories, IUCN- RED Data Book, Drivers of Extinction, Extinct Indian species. Strategic Species Concept: Keystone species, Indicator species, Umbrella species and Flagship species. Restoration Ecology: Scope and application.

**Unit 5: Environmental toxicology****12**

Introduction to toxicology: Definition, history, disciplines and importance of toxicology. Brief introduction of toxicants, classification of toxicants, Toxicity, poisons, classification of poisons, Environmental carcinogens, pollutants and classification of pollutants (On the basis of physical properties, primary and secondary pollutants, biodegradable and non-biodegradable pollutants )

Definition and classification of environmental toxicants-Toxicants in atmosphere- sources and effects on public health (CO, NO, NO<sub>x</sub>, NH<sub>3</sub>, and SO<sub>2</sub> and H<sub>2</sub>S, hydrocarbons, O<sub>3</sub>, photochemical products like benzopyrene, peroxybenzoyl nitrate (PB<sub>2</sub>N) and Peroxyacetyl Nitrate (PAN). lead from automobile emission and Particulate matter (mist, smoke, fumes and dusts) Toxicants in hydrosphere- Sources and effects on environment and public health (Domestic sewage, Industrial effluents, Agricultural discharges, Fertilizers, Detergents, Toxic metals, Silts, Oils, Thermal pollutants, Radioactive materials and Pesticides). Environmental levels and toxicity of heavy metals e.g. mercury, lead, arsenic and cadmium.

**Unit 6: Food toxicants and Pesticides:****06**

Food toxicants and effects on public health: Food additives: incidental or indirect additives, intentional or direct additives (Antioxidants, Emulsifiers, Enzymes, Flavoring agents, Colour and Preservatives). Artificial sweetening agents (Saccharin and Urea

derivatives). Food contaminants. Pesticides: Definition, classification and toxic effects of pesticides on public health.

### **Unit.7: Radioactive substances**

**06**

Introduction and definition of and radioactive substances,

Definition, unit and classification of radiation: Ionizing Radiations - electromagnetic radiation ( X- rays, gamma rays) and corpuscular radiation (Alpha and beta particles, neutrons). Non ionizing radiation. Sources of radiations: Natural and Anthropogenic sources. Radiation episodes (Atom bomb explosion at Hiroshima and Nagasaki). Harmful effects of Radiations on Public health and Brief information about Maximum Permissible Doses. Beneficial aspects of Radiation.

### **Unit 8: Introduction to toxicants**

**06**

Translocation, Absorption, Distribution , Storage , Biotransformation and excretion . Bio-concentration, Bioaccumulation, Bio magnification, Bioassays, Toxicity tests, Acute and Chronic toxicity tests, LC50, LD50 and EC50 value. Safety evaluation of toxicants. Environment impact assessment (Definition, objectives and Key steps in EIA process). Risk assessment (Definition and steps in Risk assessment) and safety evaluation programme.

### **PRACTICAL**

**Credits: 02**

**(30 Practicals)**

1. Determination of Calcium and Magnesium in water.
2. Determination of Salinity of water sample.
3. Estimation of Total Dissolved Solids in given water sample.
4. Estimation of Inorganic phosphates in the given water sample by Spectrophotometric method.
5. Quantitative and qualitative estimation of zooplanktons and calculation of alpha diversity indices (Shanon Simpson Evenness)
6. Tricho-taxonomical catalogue of captive wild ungulate mammalian species found in Goa.
7. Determination of species density (Sample Area Plot) and Richness( Using Chao Estimators) by simulation (Printed Sample Forest data)
8. Identification and characterization of any five common mineral resources of Goa.



9. Effect to pesticide on Oxygen consumption in fish/bivalve.
10. Analysis of Pesticide residues by Finger printing technique
11. Detection of metals in a suspected sample by means of the 'spot test'.
12. Detection of Formaldehyde in Milk and fish sample

**References:**

- Agarwal, V. K. (2017) Zoology for Degree students. Non- Chordates & Ecology. B.Sc. (Hons.) Sem-I. As per UGC CBCS, S. Chand and Company Ltd. New Delhi.
- Arora, M. P. (2004) Ecology, Himalaya Publishing House, New Delhi.
- Ballantyne, B. Mars, T. and P. Turner (1993) General & Applied Toxicology. Eds, Vol I & II, ISBN: 0333498011, McMillon, Stockton Press,
- Gad. S. C. and Chengelis, C. P (1998) Animal Models in Toxicology, ISBN: 0824784561.
- Kumar, H. D. (2014) Modern concepts of Ecology. Eighth Revised edition, Vikas publishing house Pvt. Ltd.
- Mahua Basu and S. Xavier (2016) Environmental Studies Cambridge University Press, Delhi.
- Omkar (2006) Concepts of Toxicology. Vishal Publishing Company. Jalandhar.
- Pandey, K. Shukla, J. P. and S. P. Trivedi (2009) Fundamentals of toxicology. New Central Book Agency Pvt. Ltd. Pune.
- Puspesh J. (2017): Wildlife and Forest Conservation a Status Report. Swastik publications, New Delhi.
- Singh, J. S., Singh, S. P. and S. R. Gupta (2014) Ecology, Environmental Science & Conservation, S. Chand & Company Pvt. Ltd. New Delhi.
- Sharma, S. P., Rastogi and Lamporary (1994) Environmental Biology & Toxicology. Sood A Swarup and Sons, New Delhi
- Shaw, L. C. and J. Chadwick. (1998) Principles of environmental toxicology, Taylor and Francis Ltd.
- Taylor and Francis, 1996 Basic Toxicology: Fundamentals, Target Organ & Risk Assessment. F.C. Lu, ISBN: 1560323809.
- Verma P. S. and V. K. Agarwal (2017) Environmental Biology (Principles of Ecology.

## **SEMESTER VI**

### **T.Y.B.Sc**

#### **Paper: ZOC 110: PARASITOLOGY**

**Learning objectives:** To study the different types of parasites with respect to morphology, lifecycle and control measures.

#### **Learning outcome:**

- On completion of the course students will be able to know prevalence, epidemiology, pathogenicity, diagnosis and treatment of the various parasites under the study
- This paper infuses a comprehensive account of human protozoan, helminthic & arthropod parasites with respect to their life cycle epidemiology, diagnosis & prophylaxis in particular. The paper has immense application in human public health & hygiene.

## **THEORY**

**Credits: 04**

**(Duration: 60hrs.)**

### **Unit 1: Introduction to Parasitology** **10**

Scope of parasitology, historical perspective, parasites and parasitism; parasitoid and vectors (Mechanical and Biological Vector), host- parasite relationship.

### **Unit 2: Parasitic Protists** **12**

Study of Morphology, Life cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of the following:

1) *Entamoeba histolytica* 2) *Giardia lamblia* 3) *Leishmania donovani* 4) *Plasmodium vivax* and *P. falciparum*

### **Unit 3: Parasitic Platyhelminthes** **10**

Study of morphology, life cycle, prevalence, epidemiology, pathogenicity, diagnosis, prophylaxis and treatment of the following:

1) *Fasciolopsis buski* 2) *Schistosoma haematobium* 3) *Taenia solium* 4) *Hymenolepis nana*

**Unit 4: Parasitic Nematodes****12**

Study of morphology, life cycle, prevalence, epidemiology, pathogenicity, diagnosis, prophylaxis and treatment of the following:

1) *Ascaris lumbricoides* 2) *Ancylostoma duodenale* 3) *Wuchereria bancrofti* 4) *Trichinella spiralis*

**Unit 5: Parasitic Arthropoda****10**

Biology, importance and control measures of ticks, mites, *Pediculus humanus* (Head and Body louse), *Xenopsylla cheopis* and *Cimex lectularius*

**Unit 6: Parasitic Vertebrates****06**

A brief account of parasitic vertebrates: Cookicutter shark, Candiru, Hood Mockingbird and Vampire bat.

**PRACTICAL****Credits: 02 (30 Practicals)**

1. Study of life stages of the following through permanent slides or microphotographs:

*Entamoeba histolytica*,

*Giardia intestinalis*,

*Leishmania donovani*

*Plasmodium vivax*

*Plasmodium falciparum*

2. Study of adult and life stages of the following using specimen / slides / microphotographs

*Fasciolopsis buski*,

*Schistosoma haematobium*,

*Taenia solium*

*Hymenolepis nana*

3. Study of adult and life stages of the following:

*Ascaris lumbricoides*,

*Ancylostoma duodenale*,

*Wuchereria bancrofti*

*Trichinella spiralis*

4. Study of the following specimen:

*Pediculus humanus* (Head louse and Body louse),

*Xenopsylla cheopis*

*Cimex lectularius*

5. Study of monogenea from the gills of fresh/ marine fish (Gills can be procured from fish market as byproduct of the industry)

6. Study of nematode / cestode parasites from the intestines of Poultry bird (Intestine can be procured from poultry/ market as a byproduct)

**References:**

Ahmed, N., Dawson, M., Smith, C. and Wood, (Ed.) (2007) Biology of Disease. Taylor and Francis Group

Arora, D. R and B. Arora (2001) Medical Parasitology. II Edition. CBS Publications and Distributors

Chakraborty, P. (2010) Textbook of Medical parasitology, New Central Book Agency (P) Ltd. London- Delhi

Chatterjee, K. D. (2009) Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers and Distributors (P) Ltd.

Meyer, Olsen and Schmidt's (2015) Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers

Noble E. R. and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea & Febiger

Parija, S. C.(2013) Textbook of Medical Parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi

Rajan T.V (2009): Textbook of Medical Parasitology, BI Publications Pvt. Ltd. New Delhi

Rajesh Karyakarte, Ajit Dample (2008): Medical Parasitology Books and Allied (P) Ltd. Kolkata.

Rattan Lal Ichhpujani and Rajesh Bhatia (2010) Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi

## **SEMESTER-VI**

### **T.Y.B.Sc**

#### **Paper: ZOD 103: ANIMAL BIOTECHNOLOGY**

**Learning Objective:** To provide students with theoretical and practical understanding of animal biotechnology

#### **Learning Outcome:**

- The student should be able to describe the science of biotechnology and how biotechnology methods are used to conduct experiments and develop products for bioethical use.
- The learner should understand the ethical application of technology to biological systems for human welfare.
- The course exposes the learner to molecular techniques.
- The practical component trains the learner in preparation of media, biochemical characterization of microbes and also enumeration.

### **THEORY**

**Credits: 03**

**(Duration: 45 hrs)**

#### **Unit 1: Introduction**

**03**

Concept, History, Disciplines, Importance and Scope of Biotechnology

#### **Unit 2: Microbiology**

**03**

Introduction to microbes, Classification of bacteria, Structure of bacterial cell, Nutritional requirements

#### **Unit 3: Molecular Techniques (Enzymes and Vectors) in Gene manipulation 15**

Cloning vectors: Plasmids, Cosmids, Phagemids, Shuttle Vectors, Lambda Bacteriophage, M13, BAC, YAC, MAC, pBR, pUC, SV40 and Expression vectors (characteristics). Restriction enzymes: Nucleases (Endonucleases, Exonucleases, Nomenclature, recognition sites, sequences, cleavage patterns), DNA ligases, Transcriptases, Polynucleotide Kinases, Alkaline Phosphatase and Nucleotidyl Transferase,

**Unit 4: Transformation methods and techniques: 12**

Calcium chloride method and electroporation, Construction of genomic and cDNA libraries and screening by colony and plaque hybridization, Southern, Northern and Western blotting DNA sequencing: Sanger method Polymerase Chain Reaction, DNA Finger Printing and DNA micro array.

**Unit 5: Genetically Modified Organisms 12**

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection, Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice.

**PRACTICAL**

**Credit: 01  
(15 Practicals)**

1. Sterilization techniques
2. Preparation of media for cell culture (agar plate, slants, deep)
3. Isolation and enumeration of bacteria (spread plate and streak plate method)
4. Motility study by hanging drop and stab culture methods.
5. Biochemical tests: IMViC.
6. Separation and Collection of Serum.
7. Viable count of a given cell sample

**References:**

- Brown, T. A. (1990) Gene Cloning an Introduction, VNR International Publ.
- Dubey and Maheswari (2007) Practical Microbiology, S. Chand & Co. Ltd.
- Dubey, R. C. (2014) A textbook of Biotechnology, 5th Ed. S. Chand & Co. Pvt. Ltd. New Delhi
- Freshney, R. I. (2000 ) Culture of Animal Cells – A manual of Basic Techniques, 4th Ed, A. John Wiley & Sons, Inc. Publ.
- Pelczar, (1998) Microbiology, (Reprint, 2001) Tata McGraw-Hill Publishing Co. Ltd.
- Purohit, S. S., (2000) Biotechnology Fundamentals and Applications, Agrobios Publ. New Delhi
- Ranga, M. M., (1999) Animal Biotechnology, Agrobios Publ. New Delhi
- Singh, B. D., (2010) Biotechnology, 3rd Ed., Kalyani Publ. Calcutta

## **SEMESTER VI**

### **T.Y.B.Sc**

#### **Paper: ZOS 105: ENVIRONMENT IMPACT ASSESSMENT**

**Learning objectives:** To understand the theory and application of Environmental Impact Assessment, for fostering sustainable development.

**Learning outcome:**

- On completion of the course the student will have clear understanding of Environmental Impact Assessment (EIA) as an Environmental Management Tool. The course shall impart competence for employment in EIA sector.
- This paper imparts to the learner the knowledge & skill of EIA in environmental processes in multiple functional areas, with a view to prospect & mitigate damage arising from haphazard development.

### **THEORY**

**03 Credits**

**(Duration: 45 hrs.)**

**Unit 1: Introduction and an overview of Environment Impact Assessment and its sustainability contexts. 08**

EIA- Genesis, history and progression: Global Overview, Evolution of EIA in India, purpose and principles of EIA. A brief idea of Cost-Benefit analysis of EIA, EIA Notification, 2006 and Institutional frame work for conduct of EIA in India (Constitution and role of EAC of MoEF & CC, Gol, SEIAA and SEAC), project Categorization and Public involvement and participation in Key stages of the EIA process, Effectiveness and Benefits of Public Participation in EIA.

**Unit 2: Stages of an EIA Process and Environmental Clearance for Projects 11**

Flowchart of a Generalized EIA process: Screening: Purpose and screening methods. Scoping: Role and purpose of Scoping in EIA, Guiding principle and objectives of scoping, steps involved in scoping, Terms of References (ToR), Identification and consideration of alternatives. Baseline Data-Collection, collation and analyses for Impact Identification and Assessment Methods by Checklists, Matrices, Wind Rose Diagrams,

Networks, Overlays and Geographic information system (GIS). Public Hearing, Appraisal, Grant or Rejection of Environmental Clearance (EC), Validity of the Environmental Clearance, Environmental Management Plan, Post EC Monitoring.

**Unit 3: Functional areas in appraisal of environmental impact** **08**

Capacity Building in various Functional Areas of EIA, Quality and Quality Control in EIA, The convention of Environmental Impact Assessment in a Trans-boundary Context. Brief idea of Prediction and Assessment of Impact on the Land Use, Air Environment, Surface-Water Environment, Soil and Groundwater Environments, Noise Environment, Biological Environment including Wildlife Conservation Plan, Cultural (Architectural, Historical, and Archaeological) Environment, Socio-economic Environment, Health Impact assessment.

**Unit 4: Capacity Building for effective EIA** **10**

EIA as a statutory requirement in India, QCI NABET as an Accreditation agency for EIA Consultants thereof, NABET secretariat, Committees (Technical, Accreditation), Assessors, and Specialist; requirements of accreditation and Key persons in an EIA Consultancy (EIA Coordinator, Associate EIA Coordinator, Functional Area Experts, Functional Area Associates, Team members and Mentors, Accreditation Cycles and Process, Punitive action for misconduct, fraudulent data and the Confidentiality clause, overview of project sectors listed by NABET.

**Unit 5: EIA in practice in some important sectors and case studies.** **08**

Knowledge of EIA related organizations including International Association of Impact Assessment- US (IAIA), Important Consultants and NGOs working in the field of EIA, EIA generic structure for Mining, Building constructions & Township, Common Municipal Solid wastes treatment Facility, and Sea Ports; Case studies of National and state relevance for critical analysis; EIA of Sardar Sarovar Project and CEE's report on EIA of Iron Ore Mining in Goa.



## **PRACTICAL Credit: 01**

### **(15 Practicals)**

1. Determination of the Suspended Particulate Matter (SPM) using plant leaves from control and polluted sites. (For assessment during exams exposed leaves from control and polluted sites be given with data on pre exposure weights)
2. Calculating Density, Frequency & Abundance of flora in a plot using Quadrate sampling (For assessment during examination, compiled data be provided)
3. Measuring the sound levels in control and noisy sites especially during the festive season using portable digital Sound Level Meter/ Decibel Meters. The sound levels shall be compared with prescribed dB level limits.
4. Determining of Important Value Index (IVI) of different plant species in a forest /garden plot
5. Measuring the wind Speed and Direction using Portable Anemometer.
6. Determining of Calcium, Magnesium, Carbonates and Bicarbonates from water samples collected from control and polluted sites by titrimetric methods.
7. Compiling an inventory of the Birds based on Snap-Shot survey of a nearby area and classify the species based on the IWPA, 1972 Schedule and IUCN categories
8. Preparing a Concise Wildlife Conservation Plan for any TWO IWPA Schedule I mammalian species found in Goa.
9. Preparing an inventory of local tree Species for Green Belt Plantation in the following sectors.
  - a) Mining
  - c) Common Municipal Solid Waste Treatment Facility
10. Visit to any NABET accredited EIA consultancy firm in Goa to get acquainted with EIA process and submission of report.

### **References:**

- Charles H. Eccleston (2011) Environmental Impact Assessment A Guide To Best Professional Practices, CBS Publ, New Delhi
- Colombo, A. G. (Ed.) (1992) Environmental Impact Assessment, Springer Publ. New York
- Marriott, B. B. (1997) Environmental impact assessment: a practical guide. McGraw Hill. Inc. New York

Morgan, Richard K. (1998) Environmental Impact Assessment: A Methodological Approach

Morris, P and R Therivel (2001) Methods of Environmental Impact assessment, books.google.com

Raman, N.S. Gajbhiye, A. R. and S. R. Khandeshwar (2014) Environmental Impact Assessment,, L K Intl. Publ. House, New Delhi

Riki Therivel and Graham Wood (2017) Methods of Environmental and Social Impact Assessment

4th Edition Routledge, Taylor and Francis Group, New York

Trivedi P. R. (2014) Environmental Impact Assessment, APH Publ. Corp. New Delhi

**Semester I Course Outcome (AECC):**

**ENVIRONMENTAL STUDIES**

(No. of credits = 4; No. of contact hours = 60; for B.A. and B.Sc.)

**Learning Objectives:** This course is mandatory by Honorable Supreme Court of India with the objective of promoting eco-sensitive citizenry.

**Learning Outcome:**

- The course is a comprehensive approach to understanding the various dynamics of ecological process as also sensitizes the learner to the menace of pollution and resource depletion.
- The student is expected to understand principle of environmental and sustainable development.

**SECTION – A Natural Endowments: Status, Issues, concerns and responses**

**Unit 1: The Multi-Disciplinary Nature of Environmental Studies** (2 hours)

Definition, Scope and Importance; need for public awareness.

**Unit 2: Natural Resources:** (8 hours)

- Renewable and Non-Renewable resources: natural resources and associated problems
  - a) Forest Resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.
  - b) Water Resources: use and over-exploitation of surface and ground water; floods, droughts, conflicts over water, dams-benefits and problems.
  - c) Mineral Resources: use and exploitation, environmental effects of extracting and using mineral resources; case studies related to mining and its effect on siltation and loss of biodiversity.
  - d) Food Resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity; case studies.
  - e) Energy Resources: growing energy needs, renewable and non-renewable energy sources, use of alternative energy sources, case studies

f) Land Resources: land as a resource, land degradation, man-induced landslides, coastal erosion, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

**Unit 3: Ecosystems** (6 hours)

Concept of an ecosystem, structure and functions of ecosystems; producers, consumers and decomposers, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids.

Introduction, types, features, structure and functions of the following ecosystems: forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystem (ponds, streams, lakes, rivers, oceans, coastal zone, estuaries).

**Unit 4: Biodiversity and its Conservation** (8 hours)

Introduction, definition, genetic, species and ecosystem diversity; bio-geographical classification of India; value of biodiversity - consumptive use, productive use, social, ethical, aesthetic and option values; biodiversity at global, national, regional and local levels; India as a mega-diversity nation; hotspots of biodiversity; threats to biodiversity - habitat loss, poaching of wildlife, man-wildlife conflicts, bio-invasion, and over exploitation; endangered and endemic species of India (at least 5 examples of animals and plants each); conservation of biodiversity- in-situ and ex-situ conservation, role of biotechnology in conservation of biodiversity.

**Unit 5: Field visit to different ecosystems/Landscapes and to learn biodiversity**

(6 hours)

Visit to a local area to document environmental assets - river/ forest/ grassland/ hill/ mountain; study of common plants, insects, birds; study of simple ecosystems-pond/ river/ hill slopes, etc. A report of field visit(s) to be maintained.

**SECTION – B Socio-economic dimensions of Environment**

**Unit 6: Environmental Pollution** (7 hours)

Definition, causes, effects and measures to control air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards; waste – types, causes, effects; waste management –solid, sewage and effluents; measures to

control industrial and urban wastes; role of an individual in prevention of pollution; pollution case studies (Bhopal gas tragedy and mining); disaster mitigation and management-floods, droughts, earthquakes, landslides, cyclones, Tsunami.

**Unit 7: Social issues and the Environment** (8 hours)

From unsustainable to sustainable development; urban problems related to energy; water conservation, rainwater harvesting, watershed management; resettlement and rehabilitation of people - problems and concerns, case studies; environmental ethics - issues and concerns; climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies; wasteland reclamation; consumerism and associated waste products; Objectives and scope of Environment (Protection) Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Forest Conservation Act, Wildlife Protection Act, Forest Rights Act and Biodiversity Act; Issues involved in enforcement of environmental legislation; public awareness.

**Unit 8: Human Population and the Environment** (5 hours)

Population growth, variation among nations; population explosion - Family Welfare Programme; environment and human health; human rights; value education; HIV/AIDS; women and child welfare; role of Information Technology in environment and human health; case studies.

**Unit 9: Tourism and Environment** (4 hours)

Definition and typology of tourism; mass tourism and environment - aspects of degradation and exploitation, physical and social impacts; examples at local, regional, national and international levels. Sustainable tourism.

**Unit 10: Field visit local polluted / waste treatment site(s)** (6 hours)

Visit to a local polluted site - urban/rural/ industrial/ agricultural and waste treatment plant(s)/sustainable tourism site(s). A report of field visit to be maintained.

**Recommended Readings**

1. Agarwal K.C. (2001): Environmental Biology, Bikaner, Nidi
2. Bharucha E.: The Biodiversity of India, Ahmedabad, Mapin
3. Bharucha E.: Textbook of Environmental Studies. Orient BlackSwan

4. Brunner R.C. (1989): Hazardous Waste Incineration, New York, McGraw-Hill
5. Chatwal G.R. & Sharma H. (2005): A Textbook of Environmental Studies, Mumbai, Himalaya
6. Clark R.S.: Marine Pollution, Oxford, Clarendon
7. Cunningham W.P., Cooper T.H., Gorani E. & Hepworth M.T. (2001): Environmental Encyclopaedia, Mumbai, Jaico.
8. De A.K.: Environmental Chemistry, Wiley
9. Desai R.J. (2003): Environmental Studies, Mumbai, Vipul

**Semester I Course Outcome (AECC):**

**ENVIRONMENTAL STUDIES**

(No. of credits = 4; No. of contact hours = 60; for B.Com.)

**Learning Objectives:** This course is mandatory by Honorable Supreme Court of India with the objective of promoting eco-sensitive citizenry.

**Learning Outcome:**

- The course is a comprehensive approach to understanding the various dynamics of ecological process as also sensitizes the learner to the menace of pollution and resource depletion.
- The student is expected to understand principle of environmental and sustainable development.

**SECTION – A Natural Endowments: Status, Issues, concerns and responses**

**Unit 1: The Multi-Disciplinary Nature of Environmental Studies** (2 hours)

Definition, Scope and Importance; need for public awareness.

**Unit 2: Natural Resources:** (8 hours)

- Renewable and Non-Renewable resources: natural resources and associated problems
  - a) Forest Resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.
  - b) Water Resources: use and over-exploitation of surface and ground water; floods, droughts, conflicts over water, dams-benefits and problems.
  - c) Mineral Resources: use and exploitation, environmental effects of extracting and using mineral resources; case studies related to mining and its effect on siltation and loss of biodiversity.
  - d) Food Resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity; case studies.
  - e) Energy Resources: growing energy needs, renewable and non-renewable energy sources, use of alternative energy sources, case studies

f) Land Resources: land as a resource, land degradation, man-induced landslides, coastal erosion, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

### **Unit 3: Ecosystems**

(6 hours)

Concept of an ecosystem, structure and functions of ecosystems; producers, consumers and decomposers, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids.

Introduction, types, features, structure and functions of the following ecosystems: forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystem (ponds, streams, lakes, rivers, oceans, coastal zone, estuaries).

### **Unit 4: Biodiversity and its Conservation**

(8 hours)

Introduction, definition, genetic, species and ecosystem diversity; bio-geographical classification of India; value of biodiversity - consumptive use, productive use, social, ethical, aesthetic and option values; biodiversity at global, national, regional and local levels; India as a mega-diversity nation; hotspots of biodiversity; threats to biodiversity - habitat loss, poaching of wildlife, man-wildlife conflicts, bio-invasion, and over exploitation; endangered and endemic species of India (at least 5 examples of animals and plants each); conservation of biodiversity- in-situ and ex-situ conservation, role of biotechnology in conservation of biodiversity.

### **Unit 5: Field visit to different ecosystems/Landscapes and to learn biodiversity**

(6 hours)

Visit to a local area to document environmental assets - river/ forest/ grassland/ hill/ mountain; study of common plants, insects, birds; study of simple ecosystems-pond/ river/ hill slopes, etc. A report of field visit(s) to be maintained.



**Semester I Course Outcome (AECC):****ENVIRONMENTAL STUDIES**

(No. of credits = 4; No. of contact hours = 60; for B.Com.)

**Learning Objectives:** This course is mandatory by Honorable Supreme Court of India with the objective of promoting eco-sensitive citizenry.

**Learning Outcome:**

- The course is a comprehensive approach to understanding the various dynamics of ecological process as also sensitizes the learner to the menace of pollution and resource depletion.
- The student is expected to understand principle of environmental and sustainable development.

**SECTION – B Socio-economic dimensions of Environment****Unit 6: Environmental Pollution**

(7 hours)

Definition, causes, effects and measures to control air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards; waste – types, causes, effects; waste management –solid, sewage and effluents; measures to control industrial and urban wastes; role of an individual in prevention of pollution; pollution case studies (Bhopal gas tragedy and mining); disaster mitigation and management-floods, droughts, earthquakes, landslides, cyclones, Tsunami.

**Unit 7: Social issues and the Environment**

(8 hours)

From unsustainable to sustainable development; urban problems related to energy; water conservation, rainwater harvesting, watershed management; resettlement and rehabilitation of people - problems and concerns, case studies; environmental ethics - issues and concerns; climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies; wasteland reclamation; consumerism and associated waste products; Objectives and scope of Environment (Protection) Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Forest Conservation Act, Wildlife Protection Act, Forest Rights Act and Biodiversity Act; Issues involved in enforcement of environmental legislation; public awareness.

**Unit 8: Human Population and the Environment** (5 hours)

Population growth, variation among nations; population explosion - Family Welfare Programme; environment and human health; human rights; value education; HIV/AIDS; women and child welfare; role of Information Technology in environment and human health; case studies.

**Unit 9: Tourism and Environment** (4 hours)

Definition and typology of tourism; mass tourism and environment - aspects of degradation and exploitation, physical and social impacts; examples at local, regional, national and international levels. Sustainable tourism.

**Unit 10: Field visit local polluted / waste treatment site(s)** (6 hours)

Visit to a local polluted site - urban/rural/ industrial/ agricultural and waste treatment plant(s)/sustainable tourism site(s). A report of field visit to be maintained.

**Recommended Readings**

1. Agarwal K.C. (2001): Environmental Biology, Bikaner, Nidi
2. Bharucha E.: The Biodiversity of India, Ahmedabad, Mapin
3. Bharucha E.: Textbook of Environmental Studies. Orient BlackSwan
4. Brunner R.C. (1989): Hazardous Waste Incineration, New York, McGraw-Hill
5. Chatwal G.R. & Sharma H. (2005): A Textbook of Environmental Studies, Mumbai, Himalaya
6. Clark R.S.: Marine Pollution, Oxford, Clanderson
7. Cunningham W.P., Cooper T.H., Gorani E. & Hepworth M.T. (2001): Environmental Encyclopaedia, Mumbai, Jaico.
8. De A.K.: Environmental Chemistry, Wiley
9. Desai R.J. (2003): Environmental Studies, Mumbai, Vipul

