# UNIVERSITY OF CALCUTTA

## Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

| Sl. No. | Subject | Sl. No. | Subject |
|---|---|---|---|
| 1 | Anthropology (Honours / General) | 29 | Mathematics (Honours / General) |
| 2 | Arabic (Honours / General) | 30 | Microbiology (Honours / General) |
| 3 | Persian (Honours / General) | 31 | Mol. Biology (General) |
| 4 | Bengali (Honours / General /LCC2 /AECC1) | 32 | Philosophy (Honours / General) |
| 5 | Bio-Chemistry (Honours / General) | 33 | Physical Education (General) |
| 6 | Botany (Honours / General) | 34 | Physics (Honours / General) |
| 7 | Chemistry (Honours / General) | 35 | Physiology (Honours / General) |
| 8 | Computer Science (Honours / General) | 36 | Political Science (Honours / General) |
| 9 | Defence Studies (General) | 37 | Psychology (Honours / General) |
| 10 | Economics (Honours / General) | 38 | Sanskrit (Honours / General) |
| 11 | Education (Honours / General) | 39 | Social Science (General) |
| 12 | Electronics (Honours / General) | 40 | Sociology (Honours / General) |
| 13 | English ((Honours / General/ LCC1/ LCC2/AECC1) | 41 | Statistics (Honours / General) |
| 14 | Environmental Science (Honours / General) | 42 | Urdu (Honours / General /LCC2 /AECC1) |
| 15 | Environmental Studies (AECC2) | 43 | Women Studies (General) |
| 16 | Film Studies ( General) | 44 | Zoology (Honours / General) |
| 17 | Food Nutrition (Honours / General) | 45 | Industrial Fish and Fisheries – IFFV (Major) |
| 18 | French (General) | 46 | Sericulture – SRTV (Major) |
| 19 | Geography (Honours / General) | 47 | Computer Applications – CMAV (Major) |
| 20 | Geology (Honours / General) | 48 | Tourism and Travel Management – TTMV (Major) |
| 21 | Hindi (Honours / General /LCC2 /AECC1) | 49 | Advertising Sales Promotion and Sales Management –ASPV (Major) |
| 22 | History (Honours / General) | 50 | Communicative English –CMEV (Major) |
| 23 | Islamic History Culture (Honours / General) | 51 | Clinical Nutrition and Dietetics CNDV (Major) |
| 24 | Home Science Extension Education (General) | 52 | Bachelor of Business Administration (BBA) (Honours) |
| 25 | House Hold Art (General) | 53 | Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours) |
| 26 | Human Development (Honours / General) | 54 | Bachelor of Fine Art (B.F.A.) (Honours) |
| 27 | Human Rights (General) | 55 | B. Music (Honours / General) and Music (General) |
| 28 | Journalism and Mass Communication (Honours / General) | | |

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul 4/6/18
(Dr. Santanu Paul)
Deputy Registrar

# UNIVERSITY OF CALCUTTA

## CBCS SYLLABUS OF ZOOLOGY

## 2018

**F**

**O**

**R**

**THREE-YEAR HONOURS**

**DEGREE COURSE OF STUDIES**

# Outline Structure of CBCS Curriculum for Zoology (Hons), C.U.

| PART I; SEM I | | | | |
|---|---|---|---|---|
| **Subject Code** | **Name of Paper** | **Theory** | **Practical** | **Internal assessment** |
| CC 1 | Non Chordata – I (Protists to Pseudocoelomates) | 50 | 30 | 20 |
| CC 2 | Molecular Biology | 50 | 30 | 20 |
| **PART I; SEM II** | | | | |
| CC 3 | Non Chordata – II (All Coelomate Phyla) | 50 | 30 | 20 |
| CC 4 | Cell Biology | 50 | 30 | 20 |
| **PART II; SEM III** | | | | |
| CC 5 | Chordata | 50 | 30 | 20 |
| CC 6 | Animal Physiology: Controlling & Co-ordinating System | 50 | 30 | 20 |
| CC 7 | Fundamentals of Biochemistry | 50 | 30 | 20 |
| SEC-A (1/2) | Apiculture / Sericulture | 80 | NA | 20 |
| **PART II; SEM IV** | | | | |
| CC 8 | Comparative Anatomy of Vertebrate | 50 | 30 | 20 |
| CC 9 | Animal Physiology: Life sustaining system | 50 | 30 | 20 |
| CC 10 | Immunology | 50 | 30 | 20 |
| SEC- B(1/2) | Aquarium Fisheries/ Medical Diagnosis | 80 | NA | 20 |
| **PART III; SEM V** | | | | |
| CC 11 | Ecology | 50 | 30 | 20 |
| CC 12 | Principle of Genetics | 50 | 30 | 20 |
| DSE A(1/2) | Parasitology/Biology of Insect | 50 | 30 | 20 |
| DSE B (1/2) | Endocrinology/Reproductive Biology | 50 | 30 | 20 |
| **PART III; SEM VI** | | | | |
| CC 13 | Developmental Biology | 50 | 30 | 20 |
| CC 14 | Evolutionary Biology | 50 | 30 | 20 |
| DSE A (1/2) | Animal Biotechnology/Animal Cell Biotechnology | 50 | 30 | 20 |
| DSE B (1/2) | Animal Behaviour & Chronology/Fish & Fisheries | 50 | 30 | 20 |

**Abbreviations:**

**CC: Core Course; DSE A/B: Discipline Specific Elective A/B; SEC A/B: Skill Enhancement Course.**

## SUBJECT/PAPER CODE FORMAT

1. **Subject Code: ZOO**
2. **Honours Code: A**
3. **Course Code: a) Core Course: CC**

   **b) Discipline Specific Elective: DSE-A/DSE-B**

   **c) Skill Enhancement Course: SEC-A/SEC-B**
4. **Semester Code: 1/2/3/4/5/6**
5. **Paper No. Code: 1/2/3…../14**
6. **Paper Component Code: a) Theory: TH, b) Practical: P**

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## INDEX

### CBCS ZOOLOGY (HONOURS), Papers & Their Codes

# PART I: SEMESTER 1

## CORE COURSE 1. Non-Chordates I

## ZOOA-CC1-1-TH

| | | |
|---|---|---|
| **Full Marks 50** | **4 Credits** | **50 Hours** |
| **Non-Chordates I: Protists to Pseudocoelomates** | | |
| **Unit 1: Basics of Animal Classification** | | 4 |
| Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types<br>Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy; Concept of classification – three kingdom concept of Carl Woese, 1977 and five kingdom concept of Whittaker, 1969 | | |
| **Unit 2: Protista and Metazoa** | | 15 |
| **Protozoa**<br>General characteristics and Classification up to phylum (according to Levine *et. al.*, 1980) Locomotion in *Euglena*, *Paramoecium* and *Amoeba*; Conjugation in *Paramoecium*.<br>Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*<br>**Metazoa**<br>Evolution of symmetry and segmentation of Metazoa | | |
| **Unit 3: Porifera** | | 6 |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6$^{th}$ Ed.); Canal system and spicules in sponges | | |
| **Unit 4: Cnidaria** | | 10 |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6$^{th}$ Ed.), Metagenesis in *Obelia*; Polymorphism in Cnidaria; Corals and coral reef diversity, Role of symbiotic algae in reef formation. Conservation of coral and coral reefs. | | |
| **Unit 5: Ctenophora** | | 2 |
| General characteristics | | |
| **Unit 6: Platyhelminthes** | | 6 |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6$^{th}$ Ed.)<br>Life cycle and pathogenicity and control measures of *Fasciola hepatica* and *Taenia solium* | | |
| **Unit 7: Nematoda** | | 7 |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6$^{th}$ Ed.)<br>Life cycle, and pathogenicity and control measures of *Ascaris lumbricoides* and *Wuchereria bancrofti*<br>Parasitic adaptations in helminthes | | |

## Non-Chordates I Lab; ZOOA-CC-1-1-P

**Non-Chordates I: Protists to Pseudocoelomates**

| **Full Marks 30** | **60 Hours** | 2 credits |
|---|---|---|
| **List of Practical** | | |
| Study of whole mount of *Euglena*, *Amoeba* and *Paramoecium*<br>Identification with reason & Systematic position of *Amoeba*, *Euglena*, *Entamoeba*, *Paramecium*, *Plasmodium*, *Balantidium*, *Vorticella* (from the prepared slides)<br>Identification with reason & Systematic position of *Sycon*, *Poterion* (Neptune's Cup), *Obelia*, *Physalia*, *Aurelia*, *Gorgonia*, *Metridium*, *Pennatula*, *Madrepora*, *Fasciola hepatica*, *Taenia solium* and *Ascaris lumbricoides.*<br>Staining/mounting of any protozoa/helminth from gut of *Periplaneta* sp. | | |

## CORE COURSE 2: Molecular Biology

## ZOOA-CC1-2-TH

| **Full Marks 50** | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Nucleic Acids** | | 3 |
| Salient features of DNA, Chargaff's Rule, Hypo and Hyperchromic shift. Watson and Crick Model of DNA. RNA types & Function. | | |
| **Unit 2: DNA Replication** | | 9 |
| Mechanism of DNA Replication in Prokaryotes, Prove that replication is Semi-conservative, bidirectional and discontinuous, RNA priming, Replication of telomeres. | | |
| **Unit 3: Transcription** | | 9 |
| Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription. | | |
| **Unit 4: Translation** | | 9 |
| Genetic code, Degeneracy of the genetic code and Wobble Hypothesis.<br>Mechanism of protein synthesis in prokaryotes. | | |
| **Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA** | | 8 |
| Capping and Poly A tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing and RNA editing | | |

| | |
|---|---|
| **Unit 6: Gene Regulation** | 7 |
| Regulation of Transcription in prokaryotes: *lac* operon and *trp* operon;<br>Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing.<br>Epigenetic Regulation: DNA Methylation, Histone Methylation & Acetylation. | |
| **Unit 7: DNA Repair Mechanisms** | 2 |
| Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair | |
| **Unit 8: Molecular Techniques** | 3 |
| PCR, Western and Southern blot, Northern Blot | |

## Molecular Biology Lab; ZOOA-CC-1-2-P

| | | |
|---|---|---|
| **Full Marks 30** | **60 Hours** | 2 Credits |
| **List of Practical** | | |
| 1. Demonstration of polytene and lampbrush chromosome from photograph<br>2. Isolation and quantification of genomic DNA from goat liver.<br>3. Agarose gel electrophoresis for DNA.<br>4. Histological staining of DNA and RNA in prepared slides | | |

## PART I: SEMESTER 2

### CORE COURSE 3: Non-Chordates II – Coelomates

## ZOOA-CC2-3-TH

| | | |
|---|---|---|
| **Full Marks 50** | 4 Credits | 50 Hours |
| **Unit 1: Introduction** | | 2 |
| Evolution of coelom | | |
| **Unit 2: Annelida** | | 10 |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994)<br>Excretion in Annelida through nephridia; Metamerism in Annelida. | | |
| **Unit 3: Arthropoda** | | 16 |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Insect Eye (Cockroach only).<br>Respiration in Prawn and Cockroach; Metamorphosis in Lepidopteran Insects; Social life in Termite | | |
| **Unit 4: Onychophora** | | 2 |
| General characteristics and Evolutionary significance | | |

| | |
|---|---|
| **Unit 5: Mollusca** | 10 |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Nervous system in *Pila sp*. Torsion in Gastropoda. Feeding and respiration in *Pila* sp. | |
| **Unit 6: Echinodermata** | 8 |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Water-vascular system in *Asterias*. Echinoderm larva and affinities with chordates | |
| **Unit 7: Hemichordata** | 2 |
| General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates | |

## Non-Chordates II Lab, ZOOA-CC-2-3-P

| | |
|---|---|
| **Full Marks 30** | **2 Credits** |
| **List of Practical** | |

1. Study of following specimens:
   - **a.** Annelids - *Aphrodite, Nereis, Chaetopterus,* Earthworm, *Hirudinaria*
   - **b.** Arthropods - *Limulus, Palaemon, Balanus, Eupagurus, Scolopendra, Peripatus,* Silkworm – life history stages, Termite – members of a colony and Honey bee – members of the colony
   - **c.** Molluscs - *Dentalium, Patella, Chiton, Pila, Achatina, Pinctada, Sepia, Octopus, Nautilus*
   - **d.** Echinoderms - *Asterias, Ophiura, Clypeaster, Echinus, Cucumaria* and *Antedon*
2. Anatomy study: Nervours system, Reproductive system (Male & female), Mouth parts & Salivary apparatus in *Periplaneta* sp.

## PART I: SEMESTER 2

### CORE COURSE 4: Cell Biology

## ZOOA-CC2-4-TH

| | | |
|---|---|---|
| **Full Marks 50** | **4 Credits** | **50 Hours** |
| **Unit 1: Plasma Membrane** | | 7 |
| Ultra-structure and composition of Plasma membrane: Fluid mosaic model, Transport across membrane - Active and Passive transport, Facilitated transport, Cell junctions: Tight junctions, Gap junctions, Desmosomes | | |
| **Unit 2: Cytoplasmic organelles I** | | 5 |
| Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes; Protein sorting and mechanisms of vesicular transport | | |
| **Unit 3: Cytoplasmic organelles II** | | 7 |
| Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemiosmotic hypothesis; Peroxisomes: Structure and Functions | | |

| | |
|---|---|
| Centrosome (Kinetochore and centromeric DNA): Structure and Functions | |
| **Unit 4: Cytoskeleton** | 5 |
| Type, structure and functions of cytoskeleton; Accessory proteins of microfilament & microtubule | |
| **Unit 5: Nucleus** | 8 |
| Nuclear envelope, Nuclear pore complex, Nucleolus; Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome), | |
| **Unit 6: Cell Cycle** | 10 |
| Cell cycle and its regulation, Cancer (Concept of oncogenes and tumor suppressor genes with special reference to p53, Retinoblastoma and Ras. Process of Proto-oncogene activation | |
| **Unit 7: Cell Signalling** | 8 |
| Cell signalling transduction pathways; Types of signalling molecules and receptors (Classification and Example only): RTK & JAK/STAT. Apoptosis | |

## Cell Biology Lab; ZOOA-CC-2-4-P

| | | |
|---|---|---|
| **Full Marks 30** | **60 Hours** | 2 Credits |
| **List of Practical** | | |

1. Preparation of temporary stained squash of onion/arum root tip to study various stages of mitosis
2. Study of various stages of meiosis from grasshopper testis
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
    a. DNA by Feulgen reaction
    b. Cell viability study by Trypan Blue staining

# PART II: SEMESTER 3.

### CORE COURSE 5 : Chordata

## ZOOA-CC3-5-TH

| | | |
|---|---|---|
| **Full Marks 50** | 4 Credits | 50 Hours |
| **Unit 1: Introduction to Chordates** | | 2 |
| General characteristics and outline classification of Phylum Chordata (Young, 1981) | | |
| **Unit 2: Protochordata** | | 7 |
| General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes (Young, 1981). Metamorphosis in *Ascidia*. Chordate Features, structure of pharynx and feeding in *Branchiostoma* | | |

| | |
|---|---|
| **Unit 3: Agnatha** | 2 |
| General characteristics and classification of cyclostomes up to order (Young, 1981) | |
| **Unit 4: Pisces** | 7 |
| General characteristics and classification up to living sub classes (Young, 1981); Accessory respiratory organ, Migration in fishes; Parental care in fishes; Swim bladder in fishes. | |
| **Unit 5: Amphibia** | 7 |
| General characteristics and classification up to living Orders (Young, 1981); Metamorphosis, Paedomorphosis, Parental care in Amphibia | |
| **Unit 6: Reptilia** | 8 |
| General characteristics and classification up to living Orders (Young, 1981); Poison apparatus and Biting mechanism in Snake. Poisonous & Non-Poisonous snake. | |
| **Unit 7: Aves** | 8 |
| General characteristics and classification up to living Sub-Classes (Young, 1981); Exoskeleton and migration in Birds; Principles and aerodynamics of flight | |
| **Unit 8: Mammals** | 9 |
| General characters and classification up to living sub classes (Young, 1981); Exoskeleton derivatives of mammals; Adaptive radiation in mammals with reference to locomotory appendages; Echolocation in Micro chiropterans | |

## Chordata Lab; ZOOA-CC-3-5-P

| | | |
|---|---|---|
| **Full Marks 30** | **60 Hours** | 2 Credits |
| **List of Practical** | | |

Identification with Reasons

a) **Protochordata**: *Balanoglossus*, *Branchiostoma*
b) **Agnatha**: *Petromyzon*
c) **Fishes**: *Scoliodon, Sphyrna, Pristis, Torpedo, Mystus, Heteropneustes, Labeo rohita, Exocoetus, Hippocampus, Anabas,* Flat fish
d) **Amphibia**: *Necturus, Bufo (Duttaphrynus) melanostictus, Rana (Hoplobatrachus) tigerinus, Hyla, Tylototriton,* Axolotl larva
e) **Reptilia**: Chelone, Trionyx, Hemidactylus, Varanus, *Calotes*, *Chamaeleon, Draco, Vipera, Naja, Hydrophis,*
f) **Mammalia**: Bat (Insectivorous and Frugivorous), *Funambulus* (Indian Palm squirrel)

Dissection of brain and pituitary – *ex situ*, digestive and Urino-genital system of *Tilapia*

Pecten from Fowl head

Power point presentation on study of habit, habitat or behaviour of any one animal by student – for internal assessment only

## PART II: SEMESTER 3.

## CORE COURSE 6: Animal Physiology: Controlling and Co-ordinating System

## ZOOA-CC3-6-TH

| **Full Marks 50** | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Tissues** | | 4 |
| Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue | | |
| **Unit 2: Bone and Cartilage** | | 4 |
| Structure and types of bones and cartilages, Ossification | | |
| **Unit 3: Nervous System** | | 10 |
| Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and non-myelinated nerve fibres; Types of synapse, Synaptic transmission and Neuromuscular junction | | |
| **Unit 4: Muscular system** | | 10 |
| Histology of different types of muscle; Ultra-structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle fibre | | |
| **Unit 5: Reproductive System** | | 6 |
| Histology of mammalian testis and ovary; physiology of mammalian reproduction – menstrual and oestrous cycle | | |
| **Unit 6: Endocrine System** | | 16 |
| Histology and function of thyroid, pancreas and adrenal. Function of pituitary<br>Classification of hormones; Mechanism of Hormone action; Signal transduction pathways for Steroidal and Non- steroidal hormones; Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary; Placental hormones | | |

## Animal Physiology: Controlling & Coordinating Systems, Lab;

## ZOOA-CC3-6-P

| **Full Marks 30** | **60 Hours** | 2 Credits |
|---|---|---|
| **List of Practical** | | |
| 1. Recording of cardiac and simple muscle twitch with electrical stimulation<br>2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells<br>3. Study of permanent slides of Mammalian Skin, Spinal cord, Pancreas, Testis, Ovary, Adrenal, Lung, pyloric stomach, cardiac stomach, Thyroid, small intestine and large intestine of mammal (white rat)<br>4. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues | | |

## PART II: SEMESTER 3

## CORE COURSE 7: Fundamentals of Biochemistry

## ZOOA-CC3-7-TH

| **Full Marks 50** | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Carbohydrates** | | 8 |
| Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides; Derivatives of Monosaccharides; Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis | | |
| **Unit 2: Lipids** | | 7 |
| Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpinoids. Lipid metabolism: β-oxidation of fatty acids - a. Palmitic acid {saturated (C 16:0)}, b. Linoleic acid {unsaturated (C 18:2)}; Fatty acid biosynthesis | | |
| **Unit 3: Proteins** | | 10 |
| Amino acids: Structure, Classification, General and Electro chemical properties of α-amino acids; Physiological importance of essential and non-essential amino acids, Proteins Bonds stabilizing protein structure; Levels of organization; Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids | | |
| **Unit 4: Nucleic Acids** | | 10 |
| Structure of Purines, Pyrimidines, Nucleosides and Nucleotides; Nucleic Acid Metabolism: Catabolism of adenosine, Guanosine, cytosine and thymine. | | |
| **Unit 5: Enzymes** | | 13 |
| Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver-Burk plot; Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition. | | |
| **Unit 5: Oxidative Phosphorylation** | | **2** |
| Redox systems; Mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System | | |

## Fundamentals of Biochemistry Lab; ZOOA-CC-7-3-P

| Fundamentals of Biochemistry | | |
|---|---|---|
| **Full Marks 30** | **60 Hours** | **2 Credits** |
| **List of Practical** | | |
| 1. Qualitative tests for carbohydrates, proteins and lipids<br>2. Qualitative estimation of Urea & Uric acid<br>3. Paper chromatography of amino acids.<br>4. Quantitative estimation of water soluble proteins following Lowry Method | | |

# PART II: SEMESTER 4

### CORE COURSE 8.Comparative Anatomy of Vertebrates

## ZOOA-CC4-8-TH

| **Full Marks 50** | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Integumentary System** | | 10 |
| Structure, function and derivatives of integument in amphibian, birds and mammals | | |
| **Unit 2: Digestive System** | | 6 |
| Comparative anatomy of stomach; dentition in mammals | | |
| **Unit 3: Respiratory System** | | 6 |
| Respiratory organs in fish, birds and mammals | | |
| **Unit 4: Circulatory System** | | 7 |
| General plan of circulation, Comparative account of heart and aortic arches | | |
| **Unit 5: Urinogenital System** | | 5 |
| Succession of kidney in different vertebrate groups; evolution of urino-genital ducts | | |
| **Unit 6: Nervous system and sense organs** | | **8** |
| Comparative account of brain in vertebrates; cranial nerves; olfactory and auditory receptors in vertebrates | | |
| **Unit 7: Skeletal system** | | **8** |
| Overview of axial and appendicular skeleton – limbs, girdles of pigeon; jaw suspension in mammals | | |

## Comparative Anatomy of Vertebrates Lab; ZOOA-CC4-8-P

| Full Marks 30 | 60 Hours | 2 Credits |
|---|---|---|
| **List of Practical** | | |
| 1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs<br>2. Study of disarticulated skeleton of toad, Pigeon, Guineapig (limb bones, vertebrae, limb and girdle)<br>3. Comparative study of heart and brain, with the help of model/picture<br>4. Identification of skulls: Pigeon, one herbivore (Guineapig) and one carnivore (Dog) animal | | |

## PART II: SEMESTER 4

## CORE COURSE 9: Animal Physiology: Life Sustaining Systems

## ZOOA-CC4-9-TH

| Full Marks 50 | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Physiology of Digestion** | | 10 |
| Structural organisation and function of gastro-intestinal tract; Mechanical and chemical digestion of food, absorption of Carbohydrates, Lipids and Proteins in Human | | |
| **Unit 2: Physiology of Respiration** | | 10 |
| Mechanism of Respiration, Respiratory volumes and capacities, transport of Oxygen and Carbon dioxide in blood, Dissociation curves and the factors influencing it, respiratory pigments; Carbon monoxide poisoning | | |
| **Unit 3: Physiology of Circulation** | | 8 |
| Structure and functions of haemoglobin; Blood clotting system; Haematopoiesis; Basic steps and its regulation; Blood groups; ABO and Rh factor | | |
| **Unit 4: Physiology of Heart** | | **8** |
| Coronary Circulation, Structure and working of conducting myocardial fibres, Origin and conduction of cardiac impulses; Cardiac Cycle and cardiac output | | |
| **Unit 5: Thermoregulation & Osmoregulation** | | 6 |
| Thermal regulation in camel and polar bear, Osmoregulation in aquatic vertebrates | | |
| **Unit 6: Renal Physiology** | | 8 |
| Structure of Kidney and its functional unit, Mechanism of urine formation, Regulation of acid-base balance | | |

## Animal Physiology: Life Sustaining Systems Lab; ZOOA-CC4-9-P

| Full Marks 30 | 60 Hours | 2 Credits |
|---|---|---|
| **List of Practical** | | |
| 1. Determination of ABO Blood group<br>2. Estimation of haemoglobin using Sahli's haemoglobin meter<br>3. Identification of blood cells from human blood<br>4. Preparation of haemin crystals and haemochromogen crystals<br>5. Identification of blood cells from cockroach haemolymph<br>6. Demonstration of blood pressure by digital meter | | |

# PART II: SEMESTER 4

### CORE COURSE 10: Immunology

## ZOOA-CC4-10-TH

| Full Marks 50 | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Overview of Immune System** | | 3 |
| Introduction – concept of health and disease; Cells and organs of the Immune system | | |
| **Unit 2: Innate and Adaptive Immunity** | | 9 |
| Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral). | | |
| **Unit 3: Antigens** | | 6 |
| Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes | | |
| **Unit 4: Immunoglobulins** | | 10 |
| Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Monoclonal antibody production | | |
| **Unit 5: Major Histocompatibility Complex** | | 6 |
| Structure and functions of MHC molecules.<br>Structure of T cell Receptor and its signalling, T cell development & selection | | |
| **Unit 6: Cytokines** | | 3 |
| Types, properties and functions of cytokines. | | |

| | |
|---|---|
| **Unit 7: Complement System** | 5 |
| Components and pathways of complement activation. | |
| **Unit 8: Hypersensitivity** | 4 |
| Gell and Coombs' classification and brief description of various types of hypersensitivities. | |
| **Unit 9: Vaccines** | 4 |
| Various types of vaccines. Active & passive immunization (Artificial and natural). | |

## Immunology Lab; ZOOA-CC4-10-P

| | | |
|---|---|---|
| **Full Marks 30** | **60 Hours** | 2 Credits |
| **List of Practical** | | |
| 1. Demonstration of lymphoid organs (by picture).<br>2. Histological study of Bursa fabricius, spleen, thymus and lymph nodes through slides/ photographs<br>3. Demonstration of ELISA | | |

## PART III: SEMESTER 5

## CORE COURSE 11.Ecology

## ZOOA-CC5-11-TH

| | | |
|---|---|---|
| **Full Marks 50** | 4 Credits | 50 Hours |
| **Unit 1: Introduction to Ecology** | | 4 |
| Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere. | | |
| **Unit 2: Population** | | 20 |
| Unitary and Modular populations Unique and group attributes of population: Demographic factors, life tables, fecundity tables, survivorship curves, dispersal and dispersion. Geometric, exponential and logistic growth, equation and patterns, r and K strategies Population regulation - density-dependent and independent factors, Population Interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition. | | |
| **Unit 3: Community** | | 11 |
| Community characteristics: species diversity, abundance, dominance, richness, Vertical stratification, Ecotone and edge effect; Ecological succession with one example. | | |

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|---|---|
| **Unit 4: Ecosystem** | 8 |
| Types of ecosystem with an example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow, Ecological pyramids and Ecological efficiencies; Nitrogen cycle. | |
| **Unit 5: Applied Ecology** | 7 |
| Types & level of biodiversity Mega-diversity countries, Biodiversity Hot spot, Flagship species, Keystone species, Wildlife Conservation (*in situ* and *ex situ* conservation), concept of protected areas. Red data book, Indian wild life act & Schedule. Concept of corridor, advantages and problem of corridor.<br>Threats to survival and conservation strategies for Tiger, Olive ridley, White Rumped Vulture. | |

## Ecology Lab, ZOOA-CC5-11-P

| **Full Marks 30** | **60 Hours** | 2 Credits |
|---|---|---|
| **List of Practical** | | |
| 1. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community<br>2. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, salinity, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free $CO_2$<br>**3.** Report on a visit to National Park/Biodiversity Park/Wild life sanctuary/ any place of ecological interest/ ecological uniqueness/ Zoological garden | | |

## PART III: SEMESTER 5

### CORE COURSE 12.Principle of Genetics

## ZOOA-CC5-12-TH

| **Full Marks 50** | 4 Credits | Class |
|---|---|---|
| **Unit 1: Mendelian Genetics and its Extension** | | 12 |
| Principles of inheritance, Incomplete dominance and co-dominance, Epistasis, Multiple alleles, Isoallele (White eye mutations), Pseudoallele (Lozenge Locus) & Cis-trans test for allelism, Lethal alleles, Pleiotropy, Penetrance & Expressivity | | |
| **Unit 2: Linkage, Crossing Over and Linkage Mapping** | | 8 |
| Linkage and Crossing, Complete & Incomplete Linkage, Measuring Recombination frequency and linkage map construction using three factor crosses, Interference and coincidence<br>Sex linkage in *Drosophila* (White eye locus) & Human (Haemophilia). | | |

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|---|---|
| **Unit 3: Mutations** | 12 |
| Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example from *Drosophila* and Human of each), variation in chromosome number; Non-disjunction of X chromosome in *Drosophila*; Non-disjunction of Human Chromosome 21.<br>Molecular basis of mutations in relation to UV light and chemical mutagens. Mutation detection in *Drosophila* by attached X method. Biochemical mutation detection in *Neurospora*. | |
| **Unit 4: Sex Determination** | 8 |
| Mechanisms of sex determination in *Drosophila* and in man; Dosage compensation in *Drosophila* & Human | |
| **Unit 5: Extra-chromosomal Inheritance** | 2 |
| Kappa particle in *Paramoecium*, Shell spiralling in snail | |
| **Unit 6: Genetic Fine Structure** | 2 |
| Complementation test in Bacteriophage (Benzer's experiment on rII locus) | |
| **Unit 7: Transposable Genetic Elements** | 6 |
| IS element in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, LINE, SINE, Alu elements in humans | |

## Principles of Genetics Lab, ZooA-CC5-12-P

| | | |
|---|---|---|
| **Full marks 30** | **60 Hours** | 2 Credits |
| **List of Practical** | | |
| 1. Chi-square analyses for genetic ratio test<br>2. Identification of chromosomal aberration in *Drosophila* and man from photograph<br>3. Pedigree analysis of some inherited traits in animals | | |

# PART III: SEMESTER 6

### CORE COURSE 13: Developmental Biology

## ZOOA-CC6-13-TH

| | | |
|---|---|---|
| **Full Marks 50** | 4 Credits | 50 Hours |
| **Unit 1: Early Embryonic Development** | | 20 |
| Gametogenesis: Spermatogenesis, Oogenesis (sea urchin & mammal); Types of eggs, Egg membranes; Fertilization in sea urchin and mammal; Planes and patterns of cleavage; Types of Blastula [frog and chick]; Fate map in chick embryo, fate mapping using vital dye and radioactive technique; Gastrulation in frog and chick; Embryonic induction and organizers in *Xenopus* (Spemann & Mangold's experiment) | | |

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|---|---|
| **Unit 2: Late Embryonic Development** | 10 |
| Extra-embryonic membranes in Chick; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta) | |
| **Unit 3: Post Embryonic Development** | 8 |
| Development of brain and Eye in Chick. Molecular Induction in Brain and Eye development. | |
| **Unit 4: Implications of Developmental Biology** | 12 |
| *In vitro* fertilization (IVF), Stem cell: Concept of potency, types, markers and applications of stem cell therapy in bone marrow transplantation and cartilage regeneration | |

## Developmental Biology Lab; ZOOA-ZooA-CC6-13-P

| **Full Marks 30** | **60 Hours** | 2 Credits |
|---|---|---|
| **List of Practical** | | |
| 1. Study of whole mounts of developmental stages of chick embryo through permanent slides: 24, 48, and 96 hours of incubation<br>2. Study of the developmental stages and life cycle of *Drosophila*<br>3. Study of different sections of placenta (photomicropgraph/ slides)<br>4. Identification of Invertebrate larva through slides/ photographs of Phylum Annelida, Arthropoda, Mollusca and Echinodermata | | |

## PART III: SEMESTER 6

## CORE COURSE 14.Evolutionary Biology

## ZOOA-CC6-14-TH

| **Full Marks 50** | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1** | | **5** |
| Origin of Life (Chemical basis), RNA world hypothesis | | |
| **Unit 2** | | 5 |
| Historical review of Evolutionary concepts: Lamarkism, Darwinism and Neo Darwinism | | |
| **Unit 3** | | 6 |
| Geological time scale, Fossil: types and age determination by Carbon dating, Evolution of horse | | |
| **Unit 4** | | 6 |
| Natural Selection: Modes with Examples; | | |

| | |
|---|---|
| **Unit 5** | 10 |
| Species concept, Isolating mechanisms, modes of speciation; Speciation by chromosome rearrangement in *Drosophila*. Adaptive radiation/macroevolution (exemplified by Galapagos finches). | |
| **Unit 6** | 2 |
| Origin and Evolution of Man, Unique Hominid characteristics contrasted with primate characteristic | |
| **Unit 7** | 10 |
| Population genetics: Hardy-Weinberg Law; factors disrupting H-W equilibrium (Genetic Drift, Migration and Mutation and Selection in changing allele frequencies (only derivations required). Simple problems related to estimation of allelic and gene frequencies. | |
| **Unit 8** | **3** |
| Extinction, back ground and mass extinctions, detailed example of K-T extinction | |
| **Unit 9** | **5** |
| Phylogenetic trees, construction and interpretation of Phylogenetic tree using parsimony, convergent and divergent evolution. | |

## Evolutionary Biology Lab, ZooA-CC6-14-P

| **Full Marks 30** | **60 Hours** | 2 Credits |
|---|---|---|
| **List of Practical** | | |
| 1. Study of fossils from models/ pictures: Dickinsonia, Paradoxides (Trilobita), Asteroceras (Ammonoid), Pentremites (Blastoid Echinoderm), Ichthyosaur, Archaeopteryx, Cynodont.<br>2. Study of homology and analogy from suitable specimens.<br>3. Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony, Construction of dendrogram following principles of phenetics & cladistics from a data table. | | |

# Discipline Specific Elective

**[Students will choice either of ZOOA-DSE(A)-5-1-TH or ZOOA-DSE(A)-5-2-TH]**

## PART III: SEMESTER 5

## DSE1. Parasitology

## ZOOA-DSE(A)-5-1-TH

| **Full Marks 50** | **4 Credits** | **50 hours** |
|---|---|---|
| **Unit 1: Introduction to Parasitology** | | 2 |
| Brief introduction of Parasitism, Parasite, 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 *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* | | |
| **Unit 3: Parasitic Platyhelminthes** | | 12 |
| Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Schistosoma haematobium*, *Taenia solium* | | |
| **Unit 4: Parasitic Nematodes** | | 12 |
| Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti*, Nematode plant interaction. | | |
| **Unit 5: Parasitic Arthropods** | | 10 |
| Biology, importance and control of ticks: Soft tick (*Ornithodoros)*, Hard tick (*Ixodes*), mites (*Sarcoptes*), Lice (*Pediculus*), Flea (*Xenopsylla*) and Bug (*Cimex*). Parasitoid. | | |
| **Unit 6: Parasite Vertebrates** | | **2** |
| Cookicutter Shark, Hood Mocking bird, Vampire bats their parasitic behaviour and effect on host. | | |

## Parasitology Lab, ZOOA-DSE(A)-5-1-P

| **Full Marks 30** | **60 Hours** | 2 Credits |
|---|---|---|
| **List of Practical** | | |

1. Study of life stages of *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*, *Plasmodium vivax*, *Plasmodium falciparum* through permanent slides/micro photographs
2. Study of adult and life stages of *Schistosoma haematobium*, *Taenia solium* through permanent slides/micro photographs
3. Study of adult and life stages of *Ancylostoma duodenale* through permanent slides/micro photographs.

4. Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry]
5. Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a by-product] & Goat.

Submission of a brief report on parasitic vertebrates

# PART III: SEMESTER 5

## DSE2. Biology of Insects

## ZOOA-DSE(A)-5-2-TH

| **Full Marks 50** | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Insect Taxonomy** | | 4 |
| Basis of insect classification; Classification of insects up to orders (Ruppert and Barnes, 1994) | | |
| **Unit 2: General Morphology of Insects** | | 6 |
| External Features; Head – Eyes, Types of antennae, Mouth parts with respect to feeding habits<br>Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat Abdominal appendages and genitalia | | |
| **Unit 3: Physiology of Insects** | | 20 |
| Structure and physiology of Insect body systems - Digestive, respiratory, endocrine and nervous system<br>Photoreceptors: Types, Structure and Function<br>Metamorphosis: Types and Neuroendocrine control of metamorphosis | | |
| **Unit 4: Insect Society** | | 7 |
| Social insects with special reference to termites<br>Trophallaxis in social insects such as ants, termites and bees | | |
| **Unit 5: Insect Plant Interaction** | | 4 |
| Theory of co-evolution, role of allelochemicals in host plant mediation Host-plant selection by phytophagous insects, Major insect pests in paddy | | |
| **Unit 6: Insects as Vectors** | | **9** |
| Insects as mechanical and biological vectors, Brief discussion on houseflies and mosquitoes as important vectors | | |

## Biology of Insect Lab, ZOOA-DSE(A)-5-2-P

| **Full Marks 30** | **60 Hours** | 2 Credits |
|---|---|---|
| **List of Practical** | | |
| 1. Study of life cycle of Mosquito<br>2. Study of different kinds of antennae, legs and mouth parts of insects<br>3. Mounting of insect wings any insects<br>4. Methodology of collection, preservation and identification of insects.<br>*5.* Morphological studies of various castes of *Apis*, Ant-*Camponotus*, Termite-*Odontotermes*<br>6. Study of major insect pests of paddy and their damages<br>7. Study of Mulberry silk moth as beneficial insect | | |

**Students will choice either of ZOOA-DSE(B)-5-1-TH or ZOOA-DSE(B)-5-2-TH**

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## PART III: SEMESTER 5

## DSE1. Endocrinology

## ZOOA-DSE(B)-5-1-TH

| **Full Marks 50** | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Introduction to Endocrinology** | | **6** |
| General idea of Endocrine systems, Classification, Characteristic and Transport of Hormones, Neuro-secretions and Neuro-hormones: Examples and Functions | | |
| **Unit 2: Hypothalamo-Hypophyseal Axis** | | 12 |
| Structure and functions of hypothalamus and Hypothalamic nuclei, Regulation of neuroendocrine glands, Feedback mechanisms, Hypothalamo-Hypophyseal-Gonadal Axis. Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophyseal portal system | | |
| **Unit 3: Peripheral Endocrine Glands** | | 12 |
| Structure, Hormones and Functions of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis. Disorders of endocrine glands (*Diabetes mellitus* type I & Type II; Graves' Disease). | | |
| **Unit 4: Regulation of Hormone Action** | | 12 |
| Mechanism of action of steroidal, non-steroidal hormones with receptors (cAMP, IP3-DAG), Calcium and Glucose homeostasis in mammals. Bioassays of hormones using RIA & ELISA, Estrous cycle in rat and menstrual cycle in human. | | |

| **Unit 5. Non Mammalian Vertebrate Hormone** | **8** |
|---|---|
| Functions of Prolactin in Fishes, Amphibia & Birds<br>Function of Melanotropin in Teleost fishes, Amphibians and Reptiles. | |

## Endocrinology Lab, ZOOA-DSE(B)-5-1-P

| **Full Marks 30** | **60 Hours** | **2 Credits** |
|---|---|---|

**List of Practical**

1. Dissect and display of Endocrine glands in laboratory bred rat.
2. Study of the permanent slides of all the endocrine glands
3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland.
4. H-E staining of Histological slides.

# PART III: SEMESTER 5

### DSE2. Reproductive Biology

## ZOOA-DSE(B)-5-2-TH

| **Full Marks 50** | **4 Credits** | **50 Hours** |
|---|---|---|
| **Unit 1: Reproductive Endocrinology** | | **10** |
| Mechanism of action of steroid and glycoprotein hormones. Hypothalamo – Hypophyseal – gonadal axis, regulation of gonadotrophin secretion in human (male and female); Reproductive system: Development and differentiation of gonads, genital ducts and external genitalia | | |
| **Unit 2: Functional anatomy of male reproduction** | | 14 |
| Histoarchitechture of testis in human; Spermatogenesis and its hormonal regulation; Androgen synthesis and metabolism; Accessory glands functions | | |
| **Unit 3: Functional anatomy of female reproduction** | | 18 |
| Histoarchitechture of ovary in human; Oogenesis and its hormonal regulation; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (human) and their regulation, Fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, feto-maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation | | |
| **Unit 4: Reproductive Health** | | 8 |
| Infertility in male and female: causes, diagnosis and management, Assisted Reproductive Technology: Sex selection, sperm banks, frozen embryos, *in vitro* fertilization IVF & IUI<br>Modern contraceptive technologies | | |

## Reproductive Biology Lab, ZOOA-DSE(B)-5-2-P

| **Full Marks 50** | **60 Hours** | 2 Credits |
|---|---|---|
| **List of Practical** | | |
| 1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals ( only demonstration through chart).<br>2. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland.<br>3. H-E staining of histological slides.<br>4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina. | | |

**Students will choice either of ZOOA-DSE(A)-6-1-TH or ZOOA-DSE(A)-6-2-TH**

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# PART III: SEMESTER 6

### DSE1. Animal Cell Biotechnology

## ZOOA-DSE(A)-6-1-TH

| **Full Marks 50** | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Introduction** | | 2 |
| Concept and Scope of Biotechnology | | |
| **Unit 2: Techniques in Gene manipulation** | | 15 |
| Recombinant DNA technology, Restriction endonucleases.<br>Cloning Vectors & their features: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, and HAC. Shuttle and Expression Vectors.<br>Construction of Genomic libraries and cDNA libraries<br>Transformation techniques: Cloning in bacteria and detection technique of clone | | |
| **Unit 3: Animal cell Culture** | | 15 |
| Basic techniques in animal cell culture and organ culture, Primary Culture and Cell lines, Culture media – Natural and Synthetic, Stem cells, Cryopreservation of cultures.<br>Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, Polymerase chain reaction: Allele specific, RAPD & RT PCR. | | |
| **Unit 4: Fermentation** | | 10 |
| Different types of Fermentation: Submerged & Solid state; batch, Fed batch & Continuous; Stirred tank, Air Lift, Fixed Bed and Fluidized.<br>Downstream Processing: Filtration, centrifugation, extraction, chromatography, spray drying and lyophilization. | | |

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| **Unit 5: Application in Health** | 8 |
| Hybridoma technology, Production of recombinant Proteins: Insulin and growth hormones. | |

## Animal Cell Biotechnology Lab, ZOOA-DSE(A)-6-1-P

| | | |
|---|---|---|
| **Full Marks 50** | **60 Hours** | 2 Credits |
| **List of Practical** | | |

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of culture media.
3. Preparation of genomic DNA from E. coli/animals/ human.
4. Plasmid DNA isolation (pUC 18/19) and DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard).
5. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting, PCR, DNA Microarrays (By Photograph).

## PART III: SEMESTER 6

## DSE2. Animal Biotechnology

## ZOOA-DSE(A)-6-2-TH

| | | |
|---|---|---|
| **Full Marks 50** | 4 Credits | Class |
| **Unit 1: Introduction** | | 5 |
| Organization of *E.coli* and *Drosophila* genome. | | |
| **Unit 2: Molecular Techniques in Gene manipulation** | | 23 |
| Recombinant DNA technology, Restriction endonucleases.<br>Cloning Vectors & their features: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, and HAC. Shuttle and Expression Vectors.<br>Construction of Genomic libraries and cDNA libraries<br>Transformation techniques: Cloning in bacteria and detection technique of clone<br>Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, Polymerase chain reaction: Allele specific, RAPD & RT PCR, DNA Fingerprinting | | |
| **Unit 3: Genetically Modified Organisms** | | 12 |
| Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection.<br>Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock-out mice. | | |
| **Unit 4: Culture Techniques and Applications** | | 10 |
| Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of | | |

| | |
|---|---|
| genetic diseases (Cystic fibrosis, Sickle cell anaemia, Thalassemia).<br>Dolly &Polly cloning<br>Genetically modified economically important animal<br>Gene Therapy | |

## Animal Biotechnology Lab, ZOOA-DSE(A)-6-2-P

| **Full Marks 30** | **60 Hours** | 2 Credits |
|---|---|---|
| **List of Practical** | | |

1. Genomic DNA isolation from *E. coli* and Plasmid DNA isolation (pUC 18/19) from *E. coli*
2. To study following techniques through photographs - Southern Blotting, Northern Blotting, Western Blotting, PCR, DNA fingerprinting
3. Project report on animal cloning & Application & ethical Issues.

**Students will choice either of ZOOA-DSE(B)-6-1-TH or ZOOA-DSE(B)-6-2-TH**

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# PART III: SEMESTER 6

### DSE1. Animal Behaviour and Chronobiology

## ZOOA-DSE(B)-6-1-TH

| **Full Marks 50** | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Patterns of Behaviour** | | 10 |
| Stereotyped Behaviours (Orientation, Reflex); Individual Behavioural patterns; Instinct vs. Learned Behaviour; FAP, Associative learning, classical and operant conditioning, Habituation, Imprinting. | | |
| **Unit 2: Social and Sexual Behaviour** | | 20 |
| Social organisation in termites; Communication (dance & pheromones in Bees)<br>Social behaviour: Altruism (Hamilton's rule and concept of haplodiploidy), Cooperation and Selfishness<br>Sexual Behaviour: Sexual dimorphism, Mate choice in peacock, Intra-sexual selection (male rivalry in red deer)<br>Kinship theory: Relatedness & inclusive fitness; parental care in fishes (Nest Building & coast benefit), conflict within families: parent offspring conflict and sibling rivalry | | |
| **Unit 3: Chronobiology & Biological Rhythm** | | 20 |
| Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms, Circannual rhythms; Photic and non-photic zeitgebers; Role of melatonin. Biological clock and its adaptive significance. Circannual rhythm in bird migration. | | |

## Animal Behaviour and Chronobiology Lab, ZOOA-DSE(B)-6-1-P

| **Full Marks 50** | **60 Hours** | 2 Credits |
|---|---|---|
| **List of Practical** | | |

1. To study nests and nesting habits of the birds and social insects.
2. To study the behavioural responses of wood lice to dry and humid conditions(demonstration only).
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.
5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.
6. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

# PART III: SEMESTER 6

## DSE2. Fish and Fisheries

## ZOOA-DSE(B)-6-2-TH

| **Full Marks 50** | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Introduction and Classification** | | **4** |
| Feeding habit, habitat and manner of reproduction.<br>Classification of fish (upto Subclasses) (Romar, 1959) | | |
| **Unit 2: Morphology and Physiology** | | 14 |
| Types of fins and their modifications; Locomotion in fish; 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; Electric organ, Bioluminescence | | |
| **Unit 3: Fisheries** | | 10 |
| Inland Fisheries; Marine Fisheries; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations | | |
| **Unit 4: Aquaculture** | | 16 |
| 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; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products | | |
| **Unit 5: Fish in research** | | 6 |
| Transgenic fish<br>Zebra fish as a model organism in research | | |

## Fish and Fisheries Lab, ZOOA-DSE(B)-6-2-P

| **Full Marks 30** | **60 Hours** | 2 Credits |
|---|---|---|

**List of Practical**

1. Morphometric and meristic characters of fishes
2. Identification of *Petromyzon, Myxine, Pristis, Exocoetus, Hippocampus, Gambusia, Labeo, Heteropneustes, Anabas*
3. Study of different types of scales (through permanent slides/ photographs).
4. Study of crafts and gears used in Fisheries (Photoghaphs)
5. Water quality criteria for Aquaculture: Assessment of pH, alkalinity, Salinity.
6. Study of air breathing organs in *Channa, Heteropneustes, Anabas* and *Clarias*
7. Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.

# Skill Enhancement courses (SEC)

## [A student will choice either ZOOA-SEC(A)-3-1 or ZOOA-SEC(A)3-2]

## PART II: SEMESTER 3

## SEC-1 Apiculture

## ZOOA-SEC(A)-3-1-TH

| **Full Marks 80** | 2 Credits | 30 Hours |
|---|---|---|
| **Unit 1: Biology of Bees** | | **2** |
| *Apis* and Non-*Apis* Bee species and their identification. General Morphology of *Apis* Honey Bees<br>Social Organization of Bee Colony | | |
| **Unit 2: Rearing of Bees** | | 14 |
| Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth box<br>Bee Pasturage<br>Selection of Bee Species for Apiculture<br>Modern Bee Keeping Equipment<br>Methods of Extraction of Honey (Indigenous and Modern) | | |
| **Unit 3: Diseases and Enemies** | | 6 |
| Bee Diseases and Enemies<br>Control and Preventive measures | | |
| **Unit 4: Bee Economy** | | 2 |
| Products of Apiculture Industry and its Uses – Honey, Bees Wax, Propolis, Pollen etc. | | |
| **Unit 5: Entrepreneurship in Apiculture** | | 6 |
| Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens | | |

## PART II: SEMESTER 3

## SEC-2.Sericulture

## ZOOA-SEC(A)-3-2-TH

| **Full Marks 80** | 2 Credits | 30 Hours |
|---|---|---|
| **Unit 1: Introduction** | | **6** |
| Sericulture: Definition, history and present status; Silk route<br>Types of silkworms, Distribution and Races<br>Exotic and indigenous races<br>Mulberry and non-mulberry Sericulture | | |
| **Unit 2: Biology of Silkworm** | | 4 |
| Life cycle of *Bombyx mori*<br>Structure of silk gland and secretion of silk | | |
| **Unit 3: Rearing of Silkworms** | | 10 |
| Selection of mulberry variety and establishment of mulberry garden<br>Rearing house and rearing appliances.<br>Disinfectants: Formalin, bleaching powder, RKO<br>Silkworm rearing technology: Early age and Late age rearing<br>Types of mountages<br>Spinning, harvesting and storage of cocoons | | |
| **Unit 4: Pests and Diseases** | | 7 |
| Pests of silkworm: Uzi fly, dermestid beetles and vertebrates<br>Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial<br>Control and prevention of pests and diseases | | |
| **Unit 5: Entrepreneurship in Sericulture** | | 3 |
| Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture<br>Visit to various sericulture centres. | | |

**[A student has to choice either ZOOA-SEC(B)-4-1 or ZOOA-SEC(B)4-2]**

## PART II: SEMESTER 4

## SEC-1.Aquarium Fish Keeping

## ZOOA-SEC(B)-4-1-TH

| **Full Marks 80** | 2 Credits | 30 Hours |
|---|---|---|
| **Unit 1: Introduction to Aquarium Fish Keeping** | | **2** |
| The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes | | |
| **Unit 2: Biology of Aquarium Fishes** | | 10 |
| 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** | | 8 |
| Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator | | |
| **Unit 4: Fish Transportation** | | 5 |
| Live fish transport - Fish handling, packing and forwarding techniques. | | |
| **Unit 5: Maintenance of Aquarium** | | 5 |
| General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry | | |

## PART II: SEMESTER 4

## SEC-2.Medical Diagnostic Technique

## ZOOA-SEC(B)-4-2-TH

| **Full Marks 80** | 2 Credits | 30 Hours |
|---|---|---|
| **Unit 1: Diagnostics Methods Used for Analysis of Blood** | | **8** |
| Blood composition, Differential Leucocyte Count (DLC) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (ESR), Packed Cell Volume (PCV) | | |
| **Unit 2: Diagnostic Methods Used for Urine Analysis** | | **4** |
| Urine Analysis: Physical characteristics; Abnormal constituents, Urine culture | | |
| **Unit 3: Non-infectious Diseases** | | **6** |
| Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type | | |

| | |
|---|---|
| II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit | |
| **Unit 4: Infectious Diseases** | **3** |
| Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite (Microscope based and ELISA based) | |
| **Unit 5: Clinical Biochemistry** | **1** |
| Lipid profiling, Liver function test. PSA test | |
| **Unit 6: Clinical Microbiology** | **1** |
| Antibiotic Sensitivity Test | |
| **Unit 7: Tumours** | **2** |
| Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs). | |
| **Unit 8: Visit to Pathological Laboratory and Submission of Project** | **6** |

# UNIVERSITY OF CALCUTTA

## CBCS SYLLABUS FOR ZOOLOGY

**F**

**O**

**R**

**THREE-YEAR GENERAL**
**DEGREE COURSE OF STUDIES**

**ZOOLOGY**

**2018**

# Outline Structure of CBCS Curriculum For Zoology (General), C.U.

| PART I; SEM I | | | | |
|---|---|---|---|---|
| **Subject Code** | **Name of Paper** | **Theory** | **Practical** | **Internal assessment** |
| **CC1/GE1** | **Animal Diversity** | **50** | **30** | **20** |
| **PART I; SEM II** | | | | |
| **CC2/GE2** | **Comparative Anatomy & Developmental Biology** | **50** | **30** | **20** |
| **PART II; SEM III** | | | | |
| **CC 3/GE3** | **Physiology and Biochemistry** | **50** | **30** | **20** |
| **SEC-A (1)** | **Apiculture** | **80** | **NA** | **20** |
| **PART II; SEM IV** | | | | |
| **CC 4/GE4** | **Genetics and Evolutionary Biology** | **50** | **30** | **20** |
| **SEC- B(1)** | **Aquarium Fish Keeping** | **80** | **NA** | **20** |
| **PART III; SEM V** | | | | |
| **DSE A(1)** | **Applied Zoology** | **50** | **30** | **20** |
| **DSE B (1)** | **Aquatic biology** | **50** | **30** | **20** |
| **SEC-A (1)** | **Sericulture** | **80** | **NA** | **20** |
| **PART III; SEM VI** | | | | |
| **DSE A (1)** | **Biology of Insect** | **50** | **30** | **20** |
| **DSE B (2)** | **Ecology & Wild life Biology** | **50** | **30** | **20** |
| **SEC-B (1)** | **Medical diagnosis** | **80** | **NA** | **20** |

**Abbreviations:**

**CC: Core Course; DSE A/B: Discipline Specific Elective A/B; SEC A/B: Skill Enhancement Course.**

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**SUBJECT/PAPER CODE FORMAT**

4. **Subject Code: ZOO**
5. **Honours Code: G**
6. **Course Code: a) Core Course:CC**
   **b) Discipline Specific Elective: DSE-A/DSE-B**
   **c) Skill Enhancement Course: SEC-A/SEC-B**

4. **Semester Code: 1/2/3/4/5/6**
5. **Paper No. Code: 1/2/3…../14**
6. **Paper Component Code: a) Theory:TH, b) Practical: P**

# INDEX

**CBCS ZOOLOGY (GENERAL), Papers & Their Codes**

# PART I: SEMESTER 1.

## CORE COURSE 1.Animal Diversity

## ZOOG-CC1-1-TH

| **Full Marks 50** | 4 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Kingdom Protista** | | 2 |
| General characters and classification up to classes (Levine et. al., 1980); Locomotory Organelles and locomotion in *Amoeba* and *Paramecium* | | |
| **Unit 2: Phylum Porifera** | | 2 |
| General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Canal System in *Sycon* | | |
| **Unit 3: Phylum Cnidaria** | | 2 |
| General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Metagenesis in *Obelia* | | |
| Unit 4: Phylum Platyhelminthes | | 2 |
| General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Life history of *Taenia solium* | | |
| **Unit 5: Phylum Nemathelminthes** | | 2 |
| General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Life history of *Ascaris lumbricoides* and its adaptation | | |
| **Unit 6: Phylum Annelida** | | 4 |
| General characters and classification up to classes (Rupert and Barnes, 1994, 6th Ed.); Metamerism in Annelida | | |
| **Unit 7: Phylum Arthropoda** | | 4 |
| General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Eye in Cockroach, Metamorphosis in Lepidoptera | | |
| **Unit 8: Phylum Mollusca** | | 2 |
| General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Respiration in *Pila* | | |
| **Unit 9: Phylum Echinodermata** | | 4 |
| General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Water-vascular system in Asteroidea | | |
| **Unit 10: Protochordates** | | 2 |
| General Characters ; Pharynx and feeding mechanism in *Amphioxus* | | |
| **Unit 11: Agnatha** | | 2 |
| General features of Agnatha and classification of cyclostomes up to classes (Young, 1981) | | |

| | |
|---|---|
| **Unit 12: Pisces** | 4 |
| General features and Classification up to orders (Young, 1981); Osmoregulation in Fishes | |
| **Unit 13: Amphibia** | 4 |
| General features and Classification up to orders (Young, 1981); Parental care | |
| **Unit 14: Reptiles** | 4 |
| General features and Classification up to orders (Young, 1981); Poisonous and non-poisonous snakes, Biting mechanism | |
| **Unit 15: Aves** | 4 |
| General features and Classification up to orders (Young, 1981); Flight adaptations in birds | |
| **Unit 17: Mammals** | 4 |
| Classification up to orders (Young, 1981); Hair, Horn & Antler, Nail & claw | |

### Animal Diversity, ZOOG-CC1-1-P

| | | |
|---|---|---|
| Full Marks: 30 | 60 Hours | 2 Credits |

List of Practicals

1. Identification with reasons of the following specimens:

   *Amoeba, Euglena, Paramecium, Sycon, Obelia, Aurelia, Metridium, Taenia solium, Ascaris lumbricoides* (Male and female), *Aphrodite, Nereis, Hirudinaria, Palaemon, Cancer, Limulus, Apis, Chiton, Dentalium, Unio, Sepia, Octopus, Echinus, Cucumaria* and *Antedon, Balanoglossus, Branchiostoma, Petromyzon, Torpedo, Labeo rohita, Exocoetus, Salamandra, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja*, Bat, *Funambulus*
2. Key for Identification of poisonous and non-poisonous snakes
3. Study of anatomy of digestive system, salivary gland, mouth parts of *Periplaneta*, Study of reproductive system of female cockroach

   An "animal album" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose

## PART I: SEMESTER 2.

### CORE COURSE 2.Comparative Anatomy & Developmental Biology

## ZOOG-CC2-2-TH

| | | |
|---|---|---|
| **Full Marks 50** | 4 Credits | 50 Hours |
| **Unit 1: Integumentary System** | | 4 |
| Derivatives of integument with respect to glands in Birds & Mammals | | |
| **Unit 2: Digestive System** | | 4 |
| Stomach and Dentition | | |
| **Unit 3: Respiratory System** | | 6 |

| | |
|---|---|
| Brief account of Gills, lungs, air sacs and swim bladder | |
| **Unit 4: Circulatory System** | 6 |
| Evolution of heart and aortic arches | |
| **Unit 5: Urino-genital System** | 6 |
| Succession of kidney, Evolution of urino-genital ducts | |
| **Unit 6: Early Embryonic Development** | 14 |
| Gametogenesis: Spermatogenesis and oogenesis with respect to mammals.<br>Fertilization: Sea-Urchin; Early development of frog; structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula; types of morphogenetic movements; Fate of germ layers | |
| **Unit 7: Late Embryonic Development** | 10 |
| Placenta types and function; Metamorphic events in frog life cycle and its hormonal regulation | |

### Comparative Anatomy & Developmental Biology Lab, ZOOG-CC2-2-P

| | |
|---|---|
| **Full marks 30 60 hours** | **2 Credits** |
| | |
| **List of Practical:** | |
| 1. Osteology: Limb bones, girdle and vertebra of Pigeon & Guineapig, Mammalian skulls: One herbivorous; Guinea pig and one carnivorous; Dog.<br>2. Larval stages: Veliger, Nauplius, Trochophore, Mysis.<br>3. Study of the different types of placenta- histological sections through photomicrographs.<br>4. Developmental stages of chick embryo: 24 Hrs., 48 Hrs, 72 Hrs., 96 Hrs. | |

## PART II: SEMESTER 3.

## CORE COURSE 3. PHYSIOLOGY AND BIOCHEMISTRY

## ZOOG-CC3-3-TH

| | | |
|---|---|---|
| **Full Marks 50** | 4 Credits | 50 Hours |
| **Unit 1: Nerve and muscle** | | **8** |
| Structure of a neuron, resting membrane potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction | | |
| **Unit 2: Digestion** | | 6 |
| Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids | | |
| **Unit 3: Respiration** | | 6 |
| Pulmonary ventilation, Transport of Oxygen and carbon | | |
| **Unit 4: Cardio-vascular system** | | 6 |

| | |
|---|---|
| Composition of blood, Structure of Heart, Origin and conduction of the cardiac impulse, cardiac cycle | |
| **Unit 5: Excretion** | 6 |
| Structure of nephron, Mechanism of Urine formation; Counter-current Mechanism | |
| **Unit 6:Reproduction and Endocrine Glands** | 10 |
| Physiology of male reproduction: Histology of testis, hormonal control of spermatogenesis; Physiology of female, reproduction: Histology of ovary, hormonal control of menstrual cycle. Structure and function of pituitary, thyroid, pancreas and adrenal. | |
| **Unit 7: Carbohydrate Metabolism** | 4 |
| Glycolysis, Kreb's cycle, Glycogenesis, Electron Transport Chain. | |
| **Unit 8: Lipid metabolism** | |
| Beta oxidation of Palmitic acid {saturated (C 16:0)} and Linoleic acid {unsaturated (C 18:2)} | |
| **Unit 9: Protein Metabolism** | 4 |
| Transamination, Deamination, Urea cycle | |
| **Unit 10. Enzyme** | 2 |
| Enzyme Classification, factors affecting enzyme action, Inhibition. | |

## PHYSIOLOGY AND BIOCHEMISTRY Lab; ZOOG-CC3-3-P

| | | |
|---|---|---|
| **Full Marks 30** | **60 Hours** | 2 Credits |
| **List of Practical** | | |
| 1. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland.<br>2. Study of permanent histological sections of mammalian duodenum, liver, lung, kidney.<br>3. Qualitative test for carbohydrate samples. | | |

## PART II: SEMESTER 4.

## CORE-COURSE 4.Genetics & Evolutionary Biology

## ZOOG-CC4-4-TH

| | | |
|---|---|---|
| Full Marks 50 | 4 Credits | 50 Hours |
| **Unit 1:Mendelian Genetics and its Extension** | | 10 |
| Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, lethal alleles, sex linked inheritance in *Drosophila* (White eye locus) & Human (Thalassemia). | | |
| **Unit 2: Linkage, Crossing Over** | | 8 |
| Linkage and crossing over, Complete & Incomplete Linkage, Recombination frequency as a measure of linkage intensity. Holiday Model | | |
| **Unit 3: Mutation** | | |

| | |
|---|---|
| Chromosomal mutation, Deletion, duplication, inversion, translocation, aneuploidy, gene mutation, induced mutation, types & example | 8 |
| **Unit 4: Sex determination** | 8 |
| Genic Balance theory and dosage compensation in *Drosophila*. | |
| **Unit 5: Origin of Life** | 2 |
| Chemical Origin of life | |
| **Unit 6: Evolutionary Theories** | 6 |
| Lamarckism, Darwinism, Neo-Darwinism. | |
| **Unit 7: Process of Evolutionary changes** | 4 |
| Isolating mechanism, Natural Selection. | |
| **Unit 8: Speciation** | 4 |
| Sympatric, Allopatric, Parapatric | |

### Genetics and Evolutionary Biology Lab ZOOG-CC4-4-P

| | |
|---|---|
| **Full marks 30** | **2 Credits** |
| | |
| **List of Practical:** | |
| Verification of Mendelian Ratio using Chi square test.<br>Identification of Human Aneuploidy using photo graph of karyotype.<br>Phylogeny of horse with diagram of limb and skull.<br>Study and identification of Darwin Finches from photographs.<br>Visit to natural history museum and submission of report. | |

# Discipline specific courses

### Elective Course (Any One from DSE-A)

## Semester-5

### DSE-A

## Applied Zoology.ZOOG-DSE-A-5-1-TH

| | | |
|---|---|---|
| **Full Marks 50** | Credits 4 | 50 Hours |
| **Unit I: Host & Parasite Relationship** | | 2 |
| Type of Host, Types of Parasites, Other types of Relations. | | |
| **Unit 2: Epidemiology of Diseases** | | 5 |

| | |
|---|---|
| Transmission, Prevention and Control of Tuberculosis and Typhoid. | |
| **Unit 3: Parasitic Protozoa** | 7 |
| Life History and pathogenicity of *Entamoeba histolytica*, *Plasmodium vivax* and *Trypanosoma gambiense.* | |
| **Unit 4: Parasitic Helminthes** | 8 |
| Life History and pathogenicity of *Alcylostoma duodenale, Wuchereria bancrofti*. | |
| **Unit 5: Insect of Economic Importance** | 8 |
| Biology, Control and Damage caused by *Heliocoverpa armigera, Pyrilla perpusilla, Sytophilus oryzae* and *Tribolium casteneum*. | |
| **Unit 6: Insect of Medical Importance** | 2 |
| Medical Importance and control of *Anopheles* | |
| **Unit 8: Animal Husbandry** | 6 |
| Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle | |
| **Unit 9: Poultry Farming** | 6 |
| Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs | |
| **Unit 10: Fish Technology** | 6 |
| Genetic improvements in aquaculture industry; Induced breeding and transportation of fish seed | |

# Applied Zoology. ZOOG-DSE-A-5-1-P

| | | |
|---|---|---|
| **Full marks 30** | **60 Hours** | 2 Credits |
| **List of Practical:** | | |

1. Study of *Plasmodium vivax, Entamoeba histolytica, Trypanosoma gambiense, Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.
2. Study of arthropod vectors associated with human diseases: *Pediculus, Culex, Anopheles, Aedes*
3. Study of insect damage to different plant parts/stored grains through damaged products/photographs.
4. Identifying feature and economic importance of *Helicoperva; Heliothis armigera,Papilio demoleus, Pyrilla perpusilla*, *Callosobruchus chinensis, Sitophilus oryzae* and *Tribolium castaneum*
5. Visit to poultry farm or animal breeding centre. Submission of visit report
6. Maintenance of freshwater aquarium(demonstration only)

# Discipline specific courses

## Elective Course (Any One from DSE-A)

## Semester-5

## DSE-A

### AQUATIC-BIOLOGY. ZOOG-DSE-A-5-2-TH

| | | |
|---|---|---|
| **Full Marks 50** | **Credits 4** | **Class 60** |
| | | |
| **Unit 1: Aquatic Bionics** | | 15 |
| Brief introduction of the aquatic biomes: Freshwater ecosystem; lakes, wetlands, streams and rivers, estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs. | | |
| **Unit 2: Freshwater Biology lakes** | | 15 |
| Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases; Oxygen, Carbon dioxide. Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.<br>**Streams:** Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes. | | |
| **Unit 3: Marine Biology** | | 15 |
| Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds. | | |
| **Unit 4: Management of Aquatic Resources** | | 15 |
| Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation ;legislations, Sewage treatment Water quality assessment - BOD and COD | | |

## AQUATIC BIOLOGY. ZOOG-DSE-A-5-2-P

| | | |
|---|---|---|
| Full Marks 30 | 60 Hours | 2 Credits |

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of dissolved Oxygen, and free Carbon dioxide, in water collected from a nearby lake / water body.
4. Visit to any aquatic Ecosystem and preparation and submission of report.

# Discipline specific courses

## Elective Course (Any One from DSE-B)

## Semester-6

## DSE-B

# Biology of Insect. ZOOG-DSE-B-6-1-TH

| **Full Marks 50** | Credits 4 | 50 Hours |
|---|---|---|
| **Unit I: Introduction to Insects** | | 6 |
| General Features of Insects, Morphological features, Head, Eyes, Types of antennae, Mouth parts with respect to feeding habits | | |
| **Unit II: Concept of Vectors** | | 6 |
| Brief introduction of Carrier and Vectors; mechanical and biological vector, Reservoirs, Host-vector relationship, Adaptations as vectors, Host Specificity | | |
| **Unit III: Insects as Vectors** | | 8 |
| Classification of insects up to orders, detailed features of orders with insects as vectors - Diptera, Siphonaptera, Siphunculata, Hemiptera | | |
| **Unit IV: Dipteran as Disease Vectors** | | 14 |
| Dipterans, as important insect vectors - Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases - Dengue, Viral encephalitis, Filariasis; Control of mosquitoes. | | |
| **Unit V: Siphonaptera as Disease Vectors** | | 6 |
| Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases - Plague, Typhus fever; Control of fleas | | |
| **Unit VI: Siphunculata as Disease Vectors** | | 4 |
| Human louse; Head, Body and Pubic louse as important insect vectors; Study of louse-borne diseases -Typhus fever, Relapsing fever, Trench fever; Control of human louse | | |
| **Unit VII: Hempitera as Disease Vectors** | | 6 |
| Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors,Control and prevention measures | | |

# Biology of Insect. ZOOG-DSE-B-6-1-P

| **Full marks 25** | **60 Hours** | 2 Credits |
|---|---|---|
| **List of Practical** | | |
| 1. Study of different kinds of mouth parts of insects<br>2. Study of following insect vectors through permanent slides/photographs: *Aedes, Culex, Anopheles, Pediculus humanuscapitis, Pediculus humanuscorporis, Phlebotomus argentipes, Musca domestica,*<br>3. Submission of a project report on any one of the insect vectors and disease transmitted by the insect. | | |

# Ecology& Wild life Biology;ZOOG-DSE-B-6-2-TH

| **Full Marks 50** | Credits 4 | Class 60 |
|---|---|---|
| **Unit 1: Introduction to Ecology** | | 4 |
| Ecosystem, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere. | | |
| **Unit 2: Population** | | 20 |
| Attributes of population: Life tables, fecundity tables, survivorship curves, dispersal and dispersion. Geometric, exponential and logistic growth, equation and patterns, Population regulation: density-dependent and independent factors, | | |
| **Unit 3: Community** | | 11 |
| Community characteristics: species diversity, abundance, dominance, richness, Vertical stratification, Ecotone and edge effect. | | |
| **Unit 4: Ecosystem** | | 10 |
| Types of ecosystem with an example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies | | |
| **Unit 5: Wild Life** | | 5 |
| Wildlife Conservation (in-situ and ex-situ conservation)**:** Necessity for wildlife conservation; National parks & sanctuaries, Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve | | |

# Ecology& Wild life Biology;ZOOG-DSE-B-6-2-P

| **Full marks 30** | **60 Hours** | 2 Credits |
|---|---|---|
| **List of Practical** | | |
| 1. Identification of flora, mammalian fauna, avian fauna<br>2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)<br>3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers, etc.<br>4. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, salinity, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free $CO_2$ | | |

## Skill Enhancement Elective Courses (SEC)

## SEMESTER –3

### SEC-A

### APICULTURE; ZOOG-SEC-A-3-1-TH

| **Full Marks 80** | Credits 2 | 30 Hours |
|---|---|---|
| **Unit 1: Biology of Bees** | | 2 |
| Classification and Biology of Honey Bees Social Organization of Bee Colony | | |
| **Unit 2: Rearing of Bees** | | 14 |
| 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** | | 6 |
| Bee Diseases and Enemies Control and Preventive measures | | |
| **Unit 4: Bee Economy** | | 2 |
| Products of Apiculture Industry and its Uses ;Honey, Bees Wax, Propolis, Pollen etc | | |
| **Unit 5: Entrepreneurship in Apiculture** | | 6 |
| Bee Keeping Industry - Recent Efforts, Modern Methods in employing artificial Beehives for cross | | |

## Skill Enhancement Elective Courses (SEC)

### SEMESTER – 4

### AQUARIUM FISH KEEPING; ZOOG-SEC-B-4-2-TH

| **Full Marks 80** | Credits 2 | 30 Hours |
|---|---|---|
| **Unit l: Introduction to Aquarium Fish Keeping** | | 2 |
| The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes | | |
| **Unit 2: Biology of Aquarium Fishes** | | 10 |
| 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** | | 8 |
| Use of live fish feed organisms. Preparation and composition of formulated fish feeds | | |
| **Unit 4: Fish Transportation** | | 5 |
| Live fish transport - Fish handling, packing and forwarding techniques. | | |
| **Unit 5: Maintenance of Aquarium** | | 5 |
| General Aquarium maintenance - budget for setting up an Aquarium Fish Farm as a Cottage | | |

## Skill Enhancement Elective Courses (SEC)

## SEMESTER –5

### SEC-A

### Sericulture; ZOOG-SEC-A-5-3-TH

| **Full Marks 80** | Credits 2 | 30 Hours |
|---|---|---|
| **Unit 1: Introduction** | | 6 |
| Sericulture: Definition, history and present status; Silk route; Types of silkworms, Distribution and Races Exotic and indigenous races Mulberry and non-mulberry Sericulture | | |
| **Unit 2: Biology of Silkworm** | | 4 |
| Life cycle of *Bombyx mori;* Structure of silk gland and secretion of silk | | |
| **Unit 3: Rearing of Silkworms** | | 10 |
| Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances Disinfectants: Formalin, bleaching powder, RKO Silkworm rearing technology: Early age and Late age rearing Types of mountages; Spinning and harvesting and storage of cocoons. | | |
| **Unit 4: Pests and Diseases** | | 7 |
| Pests of silkworm: Uzi fly, dermestid beetles and vertebrates Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial Control and prevention of pests and diseases | | |
| **Unit 5: Entrepreneurship in Sericulture** | | 3 |
| Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres. | | |

## Skill Enhancement Elective Courses (SEC)

## SEMESTER –6

### SEC-B

### Medical diagnosis; ZOOG-SEC-B-6-4-TH

| Full Marks 80 | Credits 2 | Class 30 |
|---|---|---|
| **Unit 1: Diagnostics Methods Used for Analysis of Blood** | | 8 |
| Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentation Rate (E.S.R) | | |
| **Unit 2: Diagnostic Methods Used for Urine Analysis** | | 4 |
| Urine Analysis: Physical characteristics; Abnormal constituents, Urine culture | | |
| **Unit 3: Non-infectious Diseases** | | 6 |
| Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit | | |
| **Unit 4: Infectious Diseases** | | 3 |
| Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite | | |

| | |
|---|---|
| (Microscope based and ELISA based) | |
| **Unit 5: Clinical Biochemistry** | 1 |
| Lipid profiling, Liver function test. PSA test | |
| **Unit 6: Clinical Microbiology** | 1 |
| Antibiotic Sensitivity Test | |
| **Unit 8: Tumours** | 2 |
| Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, | |
| **Unit 9: Visit to Pathological Laboratory and Submission of Project** | 5 |

**REFERENCE BOOKS**

**Non Chordata**


Anderson DT (Ed.) 2001. Invertebrate Zoology. 2nd Ed. Oxford University Press.
Barnes R. S. K. - The Diversity of Living Organisms; Blackwell Science
Barrington EJW. 1981. Invertebrate Structure and function. 2nd Ed. ELBS & Nelson.
Bernays, E. A., & Chapman, R. F., Host Selection by Phytophagous insects, Chapman & Hall
Blackwelder RE. 1967. Taxonomy- A text and reference book. John Wiley & Sons.
Brusca RC , Brusca GJ. 2002. Invertebrates. 4th Ed. Sinauer Associates
Chaki K C; Kundu G & Sarkar S. - Introduction to General Zoology (Vol. 1), NCBA, Kolkata
Hyman LH. 1951. The Invertebrates (Vol-I). Mc.Graw Hill Book Company.
Jordan EL,Verma PS. 2006. Invertebrate Zoology. S. Chand & Com. New Delhi.
Kapoor VC. 2008. Theory and practice of animal taxonomy. 6th Ed. Oxford & IBH Pub
Kotpal RL. 1988 – 1992. Protozoa, Porifera, Coelentereta, Annelida, Arthropoda, Mollusca, Echinodermata,
Mayr E, Ashlock PD. 1991. Principles of Systematic Zoology. 2nd Ed., McGraw-Hill.
Mayr E. Principle of Systematic Zoology (TATA McGraw Hill)
Meglitsch PA, Schram FR. 1991. Invertebrate Zoology. Oxford University Press.
Moore J. - An introduction to the Invertebrates; Cambridge Univ. Pr.
Nigam H.C. - Biology of non-chordates; Vishal Pub.
Parker TJ, Haswell W. 1972. Text Book of Zoology, Volume I. Macmillan Press, London.
Pechenik JA. 1998. Biology of the Invertebrates, 4th Ed. McGraw Hill.
Rupert E E, Barnes R D. 2006. Invertebrate Zoology, VIII Ed. (Harcourt Asia)
Ruppert E E, Fox R, Barnes R D. 2003. Invertebrate Zoology: a Functional Evolutionary Approach. (Brooks Cole)
Ruppert EE, Fox R, Barnes RD. (1991). Invertebrate Zoology: a Functional Evolutionary Approach. Brooks Cole.
Simpson G. G. - Principles of Animal Taxonomy (Oxford IBH)
Sinha AK, Adhikari S, Ganguly BB. Biology of Animals. Vol. I. NCBA
Villee, C. A., W. F. Walker and R. D. Barnes - General Zoology; Saunders College Pub.
Wilmer P. - Invertebrate inter relationship; Cambridge Univ. Pr.
Wood R. - Reef evolution; Oxford Univ. Pr


**Chordata, Comparative Anatomy**


Arora MP. *Chordata I. Himalaya Pub Hous*
Chaki K C; Kundu G & Sarkar S. - Introduction to General Zoology (Vol. 2), NCBA, Kolkata
Hilderbrand M, Gaslow GE. Analysis of Vertebrate Structure, John Wiley and Sons
Jordan EL, Verma PS. 2003.Chordate Zoology. S.Chand & Company Ltd. New Delhi.
Kardong K V. 2005. Comparative Anatomy of Vertebrates, Function and Evolution; McGraw-Hill
Kardong KV. 2002.Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
Kent GC, Carr RK. 2001.Comparative anatomy of the Vertebrates. 9th Ed. Mc Graw Hill.

Marieb, E. ;1998. Human Anatomy and Physiology, IV Edition, Addison-Wesley.
Norman, J.R. A history of Fishes, Hill and Wang Publishers
Parker TJ, Haswell W. 1972. Text Book of Zoology, Volume II: Marshall and Willam Eds. Macmillan Pr.
Pough H, Christine MJ, Haiser B. 2002. Vertebrate life, VIII Edition, Pearson Internatl.
Romer AS, Parsons TS. 1986. The vertebrate body. 6th Ed. Saunders College Publishing
Sinha KS, Adhikari S, Ganguly BB. 2001. Biology of Animals. Vol. II. NCBA
Young JZ. 2004. The Life of Vertebrates. III Edition. Oxford University press

**Molecular Biology**

Alberts B et al. 2008. Molecular Biology of the Cell. V Edition, Garland publishing Inc.
Allison LA. 2007. Fundamental Molecular Biology. Blackwell Publishing. W.H. Freeman
Bergstorm CT, Dujatkin LA. 2012. Evolution. 1st Edn. W.W. Norton and Co.
Karp G. 2008. Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley.
Lackie JM. 2013. Dictionary of Molecular Biology. Academic Press.
Lodish, B, Matsudaira, K B, Plough, A and Martin ;2016. Molecular Cell Biology. W.H. Freeman
Meyers R.A. – Molecular Biology and Biotechnology; VCH Pub.
Pal A. 2011. Textbook of Cell and Molecular Biology 3rd Edn, Books and Allied, Kolkata.
Russel PJ. 2010. iGenetics: A Molecular Approach, Pearson Benjamin
Strachan T. & A. Read – Human Molecular Genetics; BIOS Scientific
Turner, McLennan, Bales & White ;2005. Instant Notes in Molecular Biology. Taylor Francis
Twyman – Advanced Molecular Biology; Springer
Watson D et al. 2008. Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press
Watson J. D. – Molecular Biology of the gene; Pearson

**Cell Biology, Genetics, Histology**

Banerjee P. K. – Problems on Genetics, Molecular Genetics and evolutionary genetics; NCBS
Becker W. M., L. J. Kleinsmith, J. Hardin – The World of Cell
Cohen N. – Cell Structure, Function and Metabolism; Hodder & Stoughton
Cooper G M – Cell Biology; Sinauer
Cooper G M, Hausman RE. 2009. The Cell: A Molecular Approach. V Ed. ASM Press and Sunderland
Cormack DH. 2003. PDQ Histology. B.C. Decker Ins., London.
Elrod S. and W. Stansfield – Genetics; Schaum
Eroschenko VP. 2008. Atlas of Histology with Functional correlations. Lippincott & Wilkins.
Gillespie J H. 1998. Population Genetics: a Concise Guide. John Hopkins Univ Press.
Hardin J, Bertoni G, Kleinsmith JL. 2012. Becker's World of the Cell, Pearson Benjamin Cummings.
Harvey L. 2004. Molecular Cell Biology. 5th Edn. W.H. Freeman
Hutchison C. & D.M. Glover – Cell cycle control; IRL Oxford Univ.
Junqueria LC, Carneiro J. 2005. Basic histology text and atlas
Klug W S, Cummings MR, Spencer CA. 2012. Concepts of Genetics. Xth Ed. Benjamin Cummings
Lewin B. 2008. Gene IX. Joned and Barlett.
Masters J R W – Animal Cell Culture – a practical approach; Oxford Univ. Pr.
Morgan S. J. & D. C. Darling – Animal cell culture; Oxford
Plopper G D, Sharp, Siroski, E (2015) Lewin's Cell 3rdEdition—Johns & Bartlett Publishers
Pollard MD, Earnshaw W C, Lippincott-Schwartz. 2007. Cell Biology. 2nd Edn Saunders. Press
Robert A. – Biology of Cancer Weinberg. 2nd edition
Ross M H, Pawlina W. 2010. Histology: A Text and Atlas. Lippincott Williams and Wilkins
Roychoudhuri S – A Text Book of Genetics & Molecular Biology; NCBA
Snustad D P, Simmons MJ. 2009. Principles of Genetics. V Edition. John Wiley and Sons Inc
Strickberger M. W – Genetics; Macmillam
Tamarin R. H. – Principles of Genetics; McGraw Hill
Weinberg R A. 2014. Biology of Cancer. 2nd edition. Garland Science, Taylor & Francis
Winter P. C., G. I. Hickey & H. L. Fletcher – Genetics; Viva

**Animal Physiology, Nutrition**


Bamji M S, Rao N P, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing

Fox S I. 2011. Human Physiology. 12th Edn. Mc Graw Hill

Ganong's Review of Medical Physiology; McGraw Hill

Gibney et al. Public Health Nutrition; 2004; Blackwell Publishing

Gunstream SE. 2010. Anatomy and Physiology with integrated study guide. Mc Graw Hill.

Guyton AC, Hall JE. 2006. Textbook of Medical Physiology. Hercourt Asia P Ltd.

Guyton, A.C. and Hall, J.E.; 2011. Textbook of Medical Physiology, XII Edition, Saunders Company

Hall JE. 2015. Guyton and Hall Textbook of Medical Physiology. Saunders publication.

Hill RW, Wyse GA, Anderson M. 2012. Animal Physiology. 3rd Edn. Sineuer Asso

Hoar W. S. – General and Comparative Physiology; PHI

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

Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.

Manay MS, Shadaksharaswamy. Food-Facts and Principles; 1998; New Age International. P Ltd.

McCue, D.–Comparative Physiology of Fasting, Starvation, and Food Limitation; Springer

Metzler DE. 2001. The chemical reactions of living cells – Academic Press.

Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; 5th Ed; New Age International Publishers

Prosser C. L. and F. A. Brown – Comparative Animal Physiology; Saunders

Randall D , Burggren W. 2001. Eckert Animal Physiology by. 4th edition. W. H. Freeman.

Refinetti R. 2000. Circadian Physiology. CRC Press, Boca Raton.

Schmidt-Neilson K – Animal Physiology – Adaptation & Environment, Cambridge University Pr

Sembulingam K, Sembulingam P. 2012. Essentials of Medical Physiology. Jaypee Pub, New Delhi

Sherwood L. 2013. Human Physiology from cells to systems. 8th Edn., Brooks & Cole

Srilakshmi B. Nutrition Science; 2002; New Age International ;P Ltd.

Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.

Tortora, G.J. and Derrickson, B.H.; 2009. Principles of Anatomy and Physiology, XII Ed, Wiley and Sons, Inc.

Vander A, Sherman J, Luciano D. 2014. Vander's Human Physiology: The Mechanism of Body Function. XIII Edn. McGraw Hills

Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.

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


**Biochemistry**


Berg J. & G. Tomaselli – A Clinical Companion to Accompany Biochemistry –; Freeman & Co

Berg JM, Tymoczko JL, Stryer L.2007.Biochemistry, VI Edition, W.H.Freeman and Co., New York.

Campbell MK, Farrell SO. 2012. Biochemistry. 7th Edn. Brooks and Cole.

Chatterjee MN, Shinde R. 2012. A Textbook of Medical Biochemistry. 8th Edn. Jaypee

Conn E. E. & P. K. Stumpf – Outlines of Biochemistry –(Wiley Eastern

Cox MM, Nelson DL. 2008. Lehninger's Principles of Biochemistry, W.H. Freeman & Co., NY

Das D. 2000. Biochemistry. NCBA, Kolkata

Deb A. C. – Fundamentals of Biochemistry; NCBA

Hames BD, Hooper NM. 2000. Instant Notes in Biochemistry, II Edition, BIOS Scientific

Harper's Illustrated Biochemistry; McGraw Hill

Jain JL, Jain N, Jain S. 1979. Fundamentals of Biochemistry. S. Chand Pub. N. Delhi

Lehninger Principle of Biochemistry – D. L. Nelson & M. M. Cox; Maxmillan

Maheswari N. 2008. Clinical Biochemistry. Jaypee Pub., New Delhi

Murray RK et al. 2009. Harper's Illustrated Biochemistry, 28th Edition, McGraw- Hill Co.

Nelson D. L. & M. M. Cox Lehninger Principle of Biochemistry – Maxmillan

Saltsman K., J. Berg & G. Tomaselli – A clinical companion to accompany biochemistry – Freeman

Sathyanarayana U, Chakrapani. 2002. Biochemistry –Books & Allied ;P Ltd, Kolkata

Voet D, Voet JG. 2004. Biochemistry –3rd edition, 2004, John Wiley & Sons, Inc.

Zubay GL. 1998. Biochemistry, 4th edition, Mc Graw-Hill.

**Economic Zoology: Apiculture, Sericulture**

Bisht D.S., Apiculture, ICAR Publication.
Chaudhuri S. 2017. Economic Zoology. Kolkata: New Central Book Agency ;PLtd.
Chun and Chen Da-Chung ;1988 Silkworm Rearing; Pub. By FAO, Rome.
Cramp D. 2012. The Complete Step by Step Book of Beekeeping. Anness Publishing.
Econ Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd.,
Jolly, M. S: Appropriate Sericultural Techniques
Krishnaswamy, Improved Method of Rearing Young age silkworm; 1986 S., Bangalore
Mathews G. 2011. Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell
Narasimhanna MN. 1988. Manual of Silkworm Egg Production;, CSB, Bangalore.
Prost PJ. 1962. Apiculture. Oxford and IBH, New Delhi.
Rangaswami G. 1976. Manual on Sericulture; Food and Agriculture Organisation, Rome
Sarkar S; Kundu G & Chaki K C - Introduction to Economic Zoology; NCBA, Kolkata
Sengupta, K, ;1989 A Guide for Bivoltine Sericulture
Singh S. Beekeeping in India, Indian council of Agricultural Research, New Delhi.
Ullal SR, Narasimhanna MN. Handbook of Practical Sericulture: CSB, Bangalore

**Economic Zoology: Fish & Fisheries, Aquarium Fisheries**

Bone Q and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
Chaudhuri. S, 2017: Economic Zoology, NCBS
Evans D. H. and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK
Khanna S.S. and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House
Nelson JS. 2006. Fishes of the World, 4th Edn. Wiley.
Srivastava, C.B.L. Fish Biology, Narendra Publishing House
von der Emde, R.J. Mogdans and B.G. Kapoor. The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands

**Immunology**

Abbas K A, Lechtman H Andrew. 2003. Cellular and Molecular Immunology. Saunders Publication.
Abbas KA, Andrew, LH. 2011. Basic Immunology: Functions and Disorders of Immune System. Saunders Elsevier
Delves PJ, Martin SJ, Burton DR, Roitt I M. 2006. Roitt's Essential Immunology. Blackwell Pub.
Kindt TJ, Goldsby RA, Osborne BA, Kuby J 2006. Immunology, W.H. Freeman and Company.
Mohanty SK , Leela KS. 2014. Text book of Immunology. 2nd Edn. Jaypee Pub. N. Delhi
Parija SC. 2012. Text book of Microbiology and Immunology. Elsevier.
Playfair, JHL, Chain BM 2001. Immunology at a glance. 7 th Edn. Blackwell Pub.
Reed JC, Green DR. 2011. Apoptosis: Physiology and Pathology. Cambridge University.
Shetty N. 2005. Immunology: Introductory Textbook, New Age International Pub.
Virella G. 2007. Medical Immunology, Informa Healthcare.

**Ecology, Wild life, conservation**

Begon M, Harper J L, Townsend CR. 2006. Ecology: Individuals, Populations & communities. 4th Ed. Blackwell sc.
Bookhout TA. 1996. Research & Management Techniques for Wildlife & Habitats, WLS, Allen
Cain M L, Bowman W D and Hacker S D. 2013. Ecology. 3rd ed. Sinauer associates.
Caughley G, Sinclair ARE. 1994. Wildlife Ecology and Management. Blackwell Science.
Chapman RL, Reiss MJ. 2000. Ecology - Principles & Application. Cambridge University Press.
Colinvaux P. 1993. Ecology 2. John Wiley & Sons, Inc. New York.
Faurie C, Ferra C, Medori P, Devaux J. 2001. Ecology-Science and Practice. Oxford & IBH Pub. Company.
Ghosh, A., S. P. Agarwala & B. Sau Loss of biodiversity and its ethical implications – Sadesh

Hunter ML, Gibbs JB, Sterling EJ. 2008. Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing
Hunter, M. L., J. James & P. Gibbs – Fundamentals of Conservation Biology – John Willey & Sons
Kormondy EJ. 2002. Concepts of Ecology. 4th Indian Reprint, Pearson Education.
Krebs CJ. 2016. Ecology: The Experimental Analysis of Distribution and Abundance. Pearson India Edcn Ltd.
Mackenzie, A, A. S. Ball & S. R. Virdee – Ecology – (Viva)
Majupuria T. C. – Wildlife of India – Techpress, Bangkok
Molles Jr. MC. 2005. Ecology: Concepts and Applications. 3rd Ed. McGraw- Hill.
Mukherjee A. K. – Endangered animals of India – Z.S.I
New T. R. – Invertebrate Surveys for Conservation – Oxford Univ. Pr.
Odum EP, Barret GW. 2017. Fundamentals of Ecology. 15th Indian reprint. Cengage learning India Pltd.
Odum EP. 2008. Fundamentals of Ecology. Brooks/Cole
Ricklefs RE, Miller, GL. 2000. Ecology. 4th Ed. W. H. Freeman & Company.
Russel PJ, Wolfe LS, Hertz PE, Starr C, McMillan B. 2008. Ecology.
Saha G. K. & S. Majumdar – Threatened Mammals of India – Daya Publication House
Saha GK, Mazumdar S. 2017. Wildlife Biology : an Indian Perspective, PHI Learning,
Saharia VB. 1998. Wildlife in India. Natraj Publishers.
Smith TM, Smith R L. 2006. Elements of Ecology. 6th Ed. Pearson Education.
Sodhi NS, Ehlich PR. 2010. Conservation Biology for All. Oxford University Press.
Stiling P. 2009. Ecology- Theories and Applications. 4th Ed. Prentice Hall of India.
Sutherland WJ.2000. The Conservation Handbook: Research, Management & Policy. Blackwell Sc
Townsand, C.; J. L. Harper, M. Bagon – Essentials of Ecology
Van Dyke F. 2008. Conservation Biology: Foundations, Concepts, Application. 2nd Ed. Springer Science
Wild life (Protection) Act 1972 – Wild life Society of India (Nataraj Publication)
Wilson, E. O. – Biodiversity – National Academic Press
Woodroffe R., Thirgood S, Rabinowitz A. 2005. People and Wildlife, Conflict or Co-existence? Cambridge Univ. Pr

**Environmental biology**

Agarwal MP. Solar energy. S Chand and Co. Ltd.
Boyle G. 2004. Renewable Energy, Power for a sustainable future. Oxford University Press
Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
Freedman B. 1989. Environmental Ecology. Academic press, Inc.
Jayakumar P. 2009. Solar Energy: Resource Assessment Handbook.
Joseph F L & B D Louver - Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey1997.
Kasperson, J.X. , Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V.N. Univ Pr, New York, 2003.
Kofi Asante Duah "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998.
Kolluru R, Bartell S, Pitblado R, Risk Assessment and Management Handbook, McGrawHill Inc., New York, 1996.
Park – Environmental Biology
Saha G. K. – Wetland: Crisis and options; (Astral)
Walker, C. H., S. P. Hopkin, R. M. Sibley & D. B. Peakall Principles of Ecotoxicology; Taylor & Francis
Rai GD. 2004. Non-conventional energy sources. Khanna Publishers, New Delhi
Miller T, Spoolma SE. 2013. Environmental Science. Delhi: Cengage learning India Private limited.

**Parasitology**

Ahmed N, Dawson M, Smith C, Wood Ed. 2007. Biology of Disease. Taylor and Francis Group.
Arora D R, Arora B. 2001. Medical Parasitology. II Edition. CBS Publications and Distributors
Bogitsch B J, Carter CE, Oeltmann TN. 2013. Human Parasitology. 4th Edn. Elsevier.
Bose M. 2017. Parasitoses and zoonoses. New Central Book Agency.
Chakraborty P. 2016.. Textbook of Medical parasitology, 3rd edition. New Central Book Agency.
Chatterjee K D. 2009. Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers
Dailey MD. 1996. Meyer, Olsen & Schmidt's Essentials of Parasitology. W.C. Brown Publishers
Gunn A, Pitt SJ. 2012. Parasitology: an Integrated Approach. Wiley Blackwell.

John DT, Petri WA. 2006. Markell and Voge's Medical Parasitology. Elsevier.
Marr JJ, Nilsen TW, Komuniecki RW. 2003. Molecular Medical Parasiology. 2nd Edn. Academic Press.
Muller R, Wakelin D. 2002. Worms and Human Disease. CAB International Publication.
Noble ER, Noble GA. 1982. Parasitology: The biology of animal parasites. Lea & Febiger
Paniker CKJ, Ghosh S. [Ed]; 2013. Paniker's Text Book of Medical Parasitology. Jaypee
Parija SC. 2013. Textbook of medical parasitology, protozoology & helminthology II Edition, All India Publishers and Distributers, Medical Books Publishers, Chennai, Delhi.
Prakash, G.; 2012. Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co Ltd.

**Vector & Biology of Insect**

Chandra G. 2000. Mosquito. Sribhumi Publication Co. Kolkata
Chapman RF. 1998. The Insects: Structure and Function. IV Edition, Cambridge University Press
Klowden, M. J., Physiological system in Insects, Academic Press, USA
Gullan, P. J. and Cranston, P. S., The Insects, An outline of Entomology, Wiley Blackwell, UK
Hati A. K., Medical Entomology, Allied Book Agency, 2010
IMM's AD. 1977. A General Text Book of Entomology. Chapman & Hall, UK
Nation, J. L., Insect Physiology and Biochemistry, CRC Press, USA
Pedigo LP. 2002. Entomology and Pest Management. Prentice Hall Publication
Saunders DS. 2002. Insect Clocks. Elsevier Science.
Snodgrass, R. E., Principles of Insect Morphology, Cornell Univ. Press, USA
Wilson, E. O., The Insect Societies, Harward Univ. Press, UK
Borror, D. J., Triplehorn, C. A., and Johnson, N. F. Introduction to the study of insects, Saunders Pub

**Endocrinology**

Fox T, Brooks A, Baidya B. 2015. Endocrinology. JP Medical, London.
Gardner DG, Shoback D. 2011. Greenspan's Basic and Clinical Endocrinology. McGraw Hill Lange.
Goodendocr man HM. 2000. Basic Medical Endocrinology. Academic Press.
Jameson JL. 2010. Harrison's Endocrinology. McGraw Hill
Melmed S, Conn PM. 2005. Endocrinology: Basic and Clinical Principles. Humana Press.
Melmed S, Polonsky K, Larsen PR, Kronenberg H. 2016. William's Text Book of Endocrinology. Elsevier.
Molina PE. 2013. Endocrine Physiology. McGraw Hill Lange.
Neal JM. 2000. Basic Endocrinology; an Interactive Approach. Blackwell Science.
Norris DO. 2007. Vertebrate Endocrinology. 4th Edn. Elsevier Academic Press
Strauss JF, Barbieri RL. 2014. Yen & Jaffe's Reproductive Endocrinology. Elsevier Sounders

**Reproductive, Developmental Biology**

Carlson BM. 2014. Human Embryology and Developmental Biology. 5th Edn. Elsevier..
Das N. 2012. Fundamental Concept of Developmental Biology. New Central Book Agency
Dudek RW, Fix JD. 2013. BRS Embryology. 3rd Edn. Lippincoat Williams Wilkins
Gardner DK. 2006. In Vitro Fertilization: a Practical Approach. CRC Press.
Gilbert S.F. 2010. Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers,
Schoenwolf GC, Bleyl SB, Brauer PR, Francis-West PH. 2009. Ladesn's Human Embryology. Elsevier
Slack JMW. 2012. Essential Developmental Biology. Wiley-Blackwell.
Wolpert L. 2002. Principles of Development. 2nd Edn. Oxford Univ. Press.

**Evolutionary Biology**

Barton NH, Birggs DEG, Elsen JA, Goldstein DB, Patel NH. 2007. Evolution. CSHL Press
Chattopadhyay S. 2012. Life: Evolution, Adaptation, Ethology. 3rd Edn. Books and Allied, Kolkata.
Darlington PJ. The Geographical Distribution of Animals, R.E. Krieger Pub Co
Dobzhansky T, Ayala FJ, Stebbins JL, Valentine JW. 1977. Evolution. Surajeet Pub., N.Delhi
Freeman S, Herron JC. 2016. Evolutionary Analysis. Pearson Education Limited, Noida, India.
Futuyma DJ. 1997. Evolutionary Biology. Sinauer Associates.

Hall BK, Hallgrimsson B. 2008. Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc
Kardong K. 2004. An Introduction to Biological Evolution. McGraw Hill.
Page RDM, Holmes EC. 1998. Molecular Evolution: A Phylogenetic Approach. Blackwell Sc
Rauchfuss H. 2010. Chemical Evolution and the Origin of Life. Springer.
Ridley M. 1996. Evolution. 2nd Edn. Blackwell Science.
Smith JM. 1998. Evolutionary Genetics. 2nd Edn. Oxford Univ Press.
Volpe EP, Rossenbaum PA. 1999. Evolution. McGraw Hill.

**Animal Biotechnology & Animal Cell Biotechnology**

Atlas R. M. and R. Bartha – Microbial Ecology : Fundamentals and Applications
Thieman W.J. and M.A. Palladino – Introduction to Biotechnology; Pearson

**Animal Behaviour & Chronology**

Alcock J. 2013. Animal Behaviour, Sinauer Associate Inc., USA.
Drickamer LC , Vessey SH . 2001. Animal Behaviour. McGraw-Hill
Dujatkin LA. 2014. Principles of Animal Behaviour. 3rd Edn. W.W.Norton and Co.
Dunlap JC, Loros JJ, DeCoursey PJ. 2004. Chronobiology Biological Timekeeping. Sinauer Assoc.
Krebs J. R. & N. B. Davies – An introduction to Behavioural Ecology – Blackwell Scientific
Kumar V. 2002. Biological Rhythms. Narosa Publishing House, New Delhi.
Mandal F. 2010. A Text Book of Animal Behaviour. Pentice Hall India.
Mathur R. 2005. Animal Behaviour. Rastogi Pub.
Ruhela A, Sinha M. 2010. Recent Trends in Animal Behaviour. Oxford Book Co.
Sherman PW, Alcock J. 2013. Exploring Animal Behaviour, Sinauer Assoc Inc., Massachusetts, USA.

**Practical**

Chatterjee A K, Chakraborty C. – Practical Zoology. (Nirmala Library)
Ghosh K C, Manna B. – Practical Zoology (NCBA)
Gunasegaran JP. 2010. A Text book of Histology and a Practical Guide. Elsevier
Sinha J K, Chatterjee A K. and Chattopadhyay P. – Advanced Practical Zoology (New Central Book Agency)
Poddar T, Mukhopadhyay S, Das S K. An advanced Laboratory Manual of Zoology (Trinity Press)

# UNIVERSITY OF CALCUTTA

## NotificationNo.CSR/13/2023

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in exercise of his powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 11.07.2023 approved the Syllabi of the under mentioned subjects for semester wise Four-year (Honours & Honours with Research) / Three-year (Multidisciplinary) programme of U.G. courses of studies, as applicable under CCF,2022 . under this University, as laid down in the accompanying pamphlet.

**Name of Subject:**

1.Anthropology
2.BBA
3.Bengali
4.BFAD
5.Bio Chemistry
6.Botany
7.Chemistry
8.Commerce
9.Economics
10.Education
11.English
12.Geology
13.Hindi
14.History,Islamic History & Culture
15.Home Science
16.Human Rights
17.Journalism & Mass Communication
18.Mathematics
19.Microbiology (Honours)
20.Molecular Biology
21.Philosophy
22.Physiology
23.Political Science
24.Psychology
25.Social Science
26.Sociology
27.Urdu
28.Women's Studies
29.Zoology

The above shall be effective from the academic session 2023-2024.

12/7/2023

SENATE HOUSE

KOLKATA-700 073

Prof.(Dr.) Debasis Das

Registrar

# Outline Structure of NEP Curriculum for Zoology, C.U.

| Subject Code | Name of Paper | Theory | Practical |
|---|---|---|---|
| **PART I; SEM I** | | | |
| CC 1 | Cell Biology | 75 | 25 |
| SEC-1 | Applied Entomology | 100 | |
| IDC | The University will offer Zoology related IDC as the Paper of Animal Science which will be selected by Students pursuing Major and Minor Courses other than Zoology | 50 | 25 |
| **PART I; SEM II** | | | |
| CC 2 | Biochemistry | 75 | 25 |
| SEC-2 | Aquaculture | 100 | |
| IDC | Anyone to be selected from other Subjects [Except Major and Minor Subject] as provided by the College | 50 | 25 |
| **PART II; SEM III** | | | |
| CC 3 | Genetics | 75 | 25 |
| CC 4 | Cells and Tissue Structure | 75 | 25 |
| SEC-3 | Poultry farming and Animal Husbandry | 100 | |
| IDC | Anyone to be selected from other Subjects [Except Major and Minor Subject] as provided by the College | 50 | 25 |
| **PART II; SEM IV** | | | |
| CC 5 | Non-chordate structure and function | 75 | 25 |
| CC 6 | Parasitology | 75 | 25 |
| CC 7 | Molecular Biology | 75 | 25 |
| CC 8 | Ecology | 75 | 25 |
| **PART III; SEM V** | | | |
| CC 9 | Chordate structure and function | 75 | 25 |
| CC 10 | Endocrinology and Reproductive biology | 75 | 25 |
| CC 11 | Animal Physiology | 75 | 25 |
| CC 12 | Biodiversity and Conservation Biology [Field Visit] | 75 | 25 |
| **PART III; SEM VI** | | | |
| CC 13 | Developmental Biology | 75 | 25 |
| CC 14 | Taxonomy, Evolution and Adaptation | 75 | 25 |
| CC 15 | Animal Behaviour | 75 | 25 |
| Summer Internship | Lab Maintenance, Reagents preparation, instrument handlings | 75 [ 3 credits] | |
| **PART IV; SEM VII** | | | |
| CC 16 | Biotechnology and its Application | 75 | 25 |
| CC 17 | Neurobiology | 75 | 25 |
| CC 18 | Toxicology | 75 | 25 |
| CC 19 | Immunology | 75 | 25 |
| Dissertation/ Research Work | | 100 [4 Credits] | |
| **PART IV; SEM VIII** | | | |
| CC 20 | Scientific Communication and Research Methodology | 75 | 25 |
| CC 21 | Animal Models in Research | 75 | 25 |
| CC 22 | Industrial Microbiology | 75 | 25 |
| Dissertation/ Research Work | | 200 [ 8 credits] | |

**Abbreviations:**

**CC: Core Course; IDC: inter-Disciplinary Course; SEC: Skill Enhancement Course**

**NOTE:Marks = 25 marks per credit**

**Candidates who will not pursue Dissertation/Research have to submit 1 Review paper along with Seminar Presentation at End of Semester-7 and 2 review paper along with Seminar Presentation at end of Semester-8**

# PART I: SEMESTER 1
# CORE COURSE-1: Cell Biology
# Major/Minor/MDC: CC1-TH

| Full Marks 75 | 3 Credits | 50 Hours |
|---|---|---|
| **Unit 1: Plasma Membrane** | | **7** |
| **Structure of the Plasma Membrane:** Lipid Bilayer (Phospholipids and Cholesterol), Peripheral and Integral Membrane proteins, Glycolipids and Glycoproteins (*basicconcept of Glycocalyx*), Fluid Mosaic Model with special reference to Lipid rafts, Mobility of membrane lipids (FRAP assay) and Mobility of Membrane Proteins (Frye-Edidin Experiment); Cell-cell junctions; Transport through plasma membrane. | | |
| **Unit 2: Cytoplasmic organelles I** | | **8** |
| **Basic concepts on Ultrastructure of ER, Golgi and Lysosome; Overview of Protein sorting; ER** Morphology, Targeting proteins to ER, The Signal hypothesis; Insertion of proteins into ER membrane, Protein folding and processing in ER, Export of proteins and lipids from ER; **Golgi Apparatus;** Morphology,Protein glycosylation within Golgi, Protein sorting and export from Golgi apparatus; **Mechanism of Vesicular Transport:** Cargo selection, coat proteins and vesicle budding, Vesicle fusion.;**Lysosome:** Polymorphism**,** Lysosomal acid hydrolases, Endocytosis and lysosome formation. | | |
| **Unit 3: Cytoplasmic organelles II** | | **5** |
| **Mitochondria:** Structure, Semi-autonomous nature, Mitochondrial DNA, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemiosmotic hypothesis and Oxidative Phosphorylation with reference to ATP Synthase and ATP synthesis<br>**Peroxisomes:** Structure and Functions; **Centrosome and its organization** | | |
| **Unit 4: Cytoskeleton** | | **4** |
| Structure and Types: Microtubules, Actin filaments, and Intermediate filaments; Basic composition and function of ECM; Cell matrix Interactions(Integrins) | | |
| **Unit 5: Nucleus** | | **5** |
| Nuclear envelope, nuclear pore complex (transport not included), Kinetochore and centromeric DNA; Chromatin and levels of its packaging. Euchromatin & Heterochromatin, Position effect variegation. Chromatin remodeling complex. | | |
| **Unit 6: Cell Cycle** | | **11** |
| **Cell Cycle:** Phases of the eukaryotic cell cycle, Protein Kinases and Cell cycle regulation, MPF, Growth factors and regulation of G1-Cdks, S phase and regulation of DNA replication, DNA damage checkpoints; **Cell Death:** Caspases, Bcl-2 family, Intrinsic (Death receptors) and Extrinsic Pathway (apoptosome); **Cancer:** Basic Concept of Protooncogene [Ras] & Tumor suppressor genes [Rb and p53] Different ways of activation of a protooncogene to Oncogene. | | |
| **Unit 7: Cell Signalling** | | **5** |
| **Signalling system:** Modes of cell-cell signalling; Types of Signalling molecules **Signalling receptors**: Types and example with special reference to regulation of G protein, Adenyl cyclase-cAMP, Enzyme linked Receptors: RTK (ras-raf) and JAK/STAT | | |
| **Unit 8: Tools and Techniques in Cell Biology** | | **5** |
| • Animal Cell Culture: Primary cell culture and Cell line.<br>• Subcellular fractionation and Ultracentrifugation.<br>• Freeze fracture Replication and Freeze Etching<br>• Principle of Light Microscope: Bright field, Phase contrast microscope, Fluorescence Microscope with reference to FRET, Principle of SEM & TEM.<br>• Cryofixation and use of frozen specimen; Specimen Preparation for Electron Microscopy | | |

## Cell Biology Lab; ZOOA-CC-1-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |
| 1. Cell viability study by Trypan Blue Exclusion method.<br>2. Standardization of Ocular and Stage Micrometer and Measurement of cell or microscopic specimen such as *Paramoecium* sp.<br>3. Preparation of squamous epithelial cell with staining.<br>4. Isolation of Bone Marrow Cells from Rat/Mouse and Giemsa Staining.<br>5. Note book | | |

# PART I: SEMESTER 2
# CORE COURSE-2: Biochemistry
# Major/Minor/MDC; CC2-TH

| **Full Marks 75** | **3 Credits** | **50 Hours** |
|---|---|---|
| **Unit 1: Carbohydrates** | | **9** |
| Structure, classification and properties of Monosaccharides (aldose and ketose), Disaccharides, Polysaccharides; Isomerism of monosaccharides (D and L, optical isomers, furanose and pyranose, α and β anomers, epimers); Reducing and non – reducing sugars.<br>Physiological importance of Monosaccharides, Disaccharides, Polysaccharides | | |
| **Unit 2: Proteins** | | **9** |
| **Amino acids:** Structure, Classification, General and Electro chemical properties of α-amino acids; Essential and non-essential amino acids; **Structures of Protein:** Primary, secondary, tertiary and quaternary) of protein, Classification of proteins. | | |
| **Unit 3: Lipids** | | **4** |
| **Classification of lipids**; Saturated and unsaturated fatty acids, essential and non – essential fatty acids. **Structure and formation of Triglyceride**.; Iodine number and saponification number of fats. | | |
| **Unit 4: Enzymes** | | **9** |
| **Nomenclature, classification and properties**; Cofactors and coenzymes, Effect of Temperature, pH, substrate concentration, enzyme concentration on enzyme action, Isozymes and Proenzyme, Mechanism of enzyme action (Lock and key model, Induced fit model).<br>**Enzyme kinetics**: Derivation of Michaelis-Menten equation with its significance, Lineweaver-Burk plot and its significance. Enzyme inhibition – competitive, non- competitive, allosteric / feedback and its effect on Vmax and Km | | |
| **Unit 5: Carbohydrates Metabolism** | | **7** |
| Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis from lactate and glycerate, Glycogenesis and Glycogenolysis. (Pathways with name of enzymes and significance) | | |
| **Unit 6: Protein Metabolism** | | **4** |
| Transamination, Deamination and its types (Pathways with name of enzymes and significance) Fate of C-skeleton of Glucogenic and Ketogenic amino acids. | | |
| **Unit 7: Lipid Metabolism** | | **4** |
| β-oxidation of fatty acids - a. Palmitic acid {saturated (C 16:0)}, b. Linoleic acid {unsaturated (C 18:2)} Fatty acid biosynthesis | | |
| **Unit 8: Nucleic acid Metabolism** | | **3** |
| Degradation of purine; Purine Salvage pathway and significance. | | |
| **Unit 7: Free radicals and Antioxidants** | | **1** |
| Concepts of free radicals and antioxidants with examples. | | |

## Biochemistry Lab; CC-2-P

| **Full Marks 25** | **1 Credit** | **20 Hours** |
|---|---|---|
| **List of Practical** | | |
| **Group A** **10 Hours** | **15 Marks** | |
| **Qualitative tests for carbohydrates, proteins and lipids**<br>1. For carbohydrate (Glucose, Fructose, Maltose, Sucrose, Starch) – Molisch test, Barfoed test, Benedict test, Fehling test, Seliwanoff test, Hydrolysis test for sucrose, Iodine test<br>2. For Protein (Albumin, Gelatine, Peptone) –Biuret test, Million's test, Xanthoproteic test, Ninhydrin test<br>3. For lipid – Grease spot test | | |
| **Group B** **10 Hours** | **10 Marks** | |
| **Colorimetric estimation of the following**<br>a) Protein by Lowry's method<br>b) To study activity of amylase | | |

# PART I: SEMESTER 1
# SEC-1: Applied Entomology
# Major; SEC-1-TH

| **Full Marks 75** | **3 Credits** | **50 Hours** |
|---|---|---|
| **Unit 1 Basics of Entomology** | | **12** |
| **Insect diversity and adaptation:** Morphological adaptation of insects: Head and antenna; Mouthparts of honey bee and cockroach; Thorax and thoracic appendages- legs and wings [General concept].<br>**Physiological adaptation in cockroach:** Digestive system: Alimentary canal and digestive glands, digestion; Respiratory organs and mechanism of gaseous exchange; Sense organs compound eyes, chemoreceptors.<br>**General Characteristics of Class Insecta and living orders with examples:**Orthoptera, Dictyoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera, Hymenoptera, Anoplura, Siphonaptera(Imms, A.D., 1938);<br>**Ticks and Mites:** General features; difference between ticks and mites; Soft ticks and Hard ticks. | | |
| **Unit 2 Medical Entomology** | | **14** |
| **Concept of Vectors:** Mechanical and biological vectors, modes of transmission; Biological vector and disease cycle.<br>**Biology of *Anopheles, Culex* and *Aedes:***Study of mosquito borne diseases- Malaria, Dengue, and Filariasis; control of mosquitoes.<br>**Biology of *Musca domestica*:**Disease relationship; control of house fly.<br>Biology and systematicsof Bed bug *Cimex lectularius*; disease relationship; Control of Bed Bug.<br>Ticks as Causative agents and Vectors: Rickettsiosis, Tick-borne encephalitis.<br>Forensic Entomology: General perceptions and status of Forensic entomology; Insects and other arthropods of forensic importance; Pattern of insect succession on carcass; Postmortem Interval (PMI) and its estimation process; Applications and limitations of Forensic Entomology | | |
| **Unit 3 Agricultural Entomology** | | **14** |
| Concept of insect pest; Economic Injury Level (EIL), Economic Threshold Level (ETL), Dynamics of EIL;<br>Pests of major crops (Life cycle, Nature of damage and control measures): Pests of Paddy, *Scirpophagaincertulus*; Pests of Jute, *Anomissabulifera;* Pests of brinjal, *Leucinodesorbonalis*; Stored grain pest: *Sitophilusoryzae*; Invasive insect pests of India and their consequences.<br>Insect Pest control: Chemical, Mechanical, Cultural and Biological control measures; Integrated Pest Management (IPM)<br>Study of appliances used in pest control: Dusters; Sprayers- categories of sprayers, agricultural Aircrafts; Granule applicator; soil injectors. | | |
| **Unit 4 Sericulture** | | **5** |
| Types of Silk Moths with special reference to their scientific name, geographical distribution, and host plants.<br>Life cycle of *Bombyx mori*; Structure of Silk Gland; Voltinism,Rearing of mulberry silkworm; Reeling and extraction of silk; Mulberry cocoon management; Mulberry plant types and cultivation; Common diseases and pests of mulberry silkworm and their control measures;Prospects of Sericulture in West Bengal; employment potential in sericulture. | | |
| **Unit 5 Apiculture** | | **5** |
| Various domesticated species of Honeybee; Social organization and life cycle of Honeybee; Modern method of Beekeeping: Newton Box and Langstroth Box; extraction of honey and composition of honey; Pests, Parasites and Diseases and their control measures; Bee-economy: Apiculture products and their uses. | | |

## Applied Entomology Lab: SEC-1-P

| **Full Marks 25** | **1 Credit** | **20 Hours** |
|---|---|---|
| **List of Practical** | | |

1. Dissection and temporary mounting of: - Antennae and mouth parts of Cockroach, House fly and Mosquito
2. Methods of collection, preservation, and identification of economically important insects.
3. Identification of following insect pests (Order, family and specimen characters only): *Scirpophagaincertulus; Sitophilusoryzae*; *Callosobruchuschinensis, Leucinodesorbonalis*; *Anomissabulifera; Pyrillaperpusilla.*
4. Morphological studies of various castes of *Apis* sp.
5. Identification of life stages of *Bombyx mori*; Identification of Bivoltine and multivoltine mulberry cocoon.
6. Identification and medical significance of following insects (adults) through permanent slides/photographs: *Aedes* sp., *Culex* sp., *Anopheles* sp. [for mosquito, larvae and both sexes of adults], *Musca* sp., *Phlebotomus* sp., *Cimex* sp., *Pediculushumanuscapitis*., *Xenopsylla* sp.
7. Visits to **any one place of applied entomological significance** (submission ofa field report):
    a. Agricultural field/ forest for on spot study of pests and damage caused.
    b. Any Sericulture farm for studying grainage and rearing activities
    c. Visit to an apiary to study various activities o Apiculture
    d. Any rural or urban health centre to study various aspects of vector surveillance

# PART I: SEMESTER 2
# SEC-2 Aquaculture
# Major; SEC-2-TH

| **Full Marks 75** | **3 Credits** | **50 Hours** |
|---|---|---|
| **Unit 1 Basics of Idea of Fish Biology** | | **3** |
| Qualities of Cultivable fish, Indigenous and Exotic | | |
| **Unit 2Sustainable Aquaculture System** | | **17** |
| Sustainable Aquaculture Culture System: Extensive, Semi intensive, Extensive<br>Water quality in culture ponds and factors controlling water quality.<br>Preparation and Management of Fish Culture Ponds in Composite Fish Culture<br>Cage Culture, Pen Culture, Raceways. Flow through system. Biofloc. Cold water fishery. Jeol Fishery. Sewage fed fishery. Mariculture with special emphasis on sea weed culture.(Basic concept)<br>Induced Breeding of Carps. Synthetic Hormones in Hypophysation.<br>Management of Fin Fish Hatcheries. Glass Jar Hatchery, Chinese Hatchery. | | |
| **Unit 3Recent Advancement of Aquaculture** | | **20** |
| Aquarium Fisheries.<br>Preparation and Management of Fish Aquarium.<br>Biology of Common Ornamental Fish: Guppy, Swordtail, Angel, Blue morph fish. Anemone fish, Butterfly fish, Molly.<br>**Fish Nutritional Requirements:** Feed Formulations and Preparation of Compound Diets.<br>**Capture Fishery:** Fishing Crafts and Gears, Post harvesting Technology. Fish Transport and Marketing. Fish Preservation and By-products.<br>**Fish Biotechnology:** Transgenic Fish, Sex Reversal in Fish. Aquaponics,Application of GIS and Remote Sensing in Fisheries, Fishery Laws and Regulations. | | |
| **Unit 4 Fin Fish pathology** | | **5** |
| Name of Infective Disease. Causative Agents, Symptoms, Control.Bacteria- Dropsy, Fin and Tail rot. Protozoa- White Spot Disease; Fungal-Saprolegniasis; Ectoparasite-Gyrodactylosis, Dactylogyrosis. Virus- Rhabdovirus | | |
| **Unit 5Applied Aquaculture** | | **5** |
| **Breeding Techniques in Shrimps and Prawns:** Eyestalk Ablation in Shrimp and Salinity shock in Prawns.Techniques of Artificial Pearl Culture. | | |

## Aquaculture Lab: SEC-2-P

| **Full Marks 25** | **1 Credit** | **20 Hours** |
|---|---|---|
| **List of Practical** | | |

1. **Identification of different fish species using Meristic characters. (Systematic position, specimen characters)**
   *Rohu, Catla, Cirhinus, Puntius, Amblyphyngodon, Channapunctatus, Lates, Mystus, Notopterus, Cyprinus, Hypopthalmichthys, Ctenopharyngodon, Oreochromisniloticus, Oreochromismossambicus*
   *Anabas, Clarias, Heteropneustis, Mugil, Macrobrachium, Paneus .*
2. **Field visit to an Aquaculture farm/ Hatchery**

## REFERENCES


**CORE COURSE-1: Cell Biology**

1. **The Cell (8th Edition) G. M. Cooper** and R.E. Hausman
2. **Karp's Cell and Molecular Biology:** Concepts and Experiments **8th edition**
3. **Lewin's CELLS (3rd Edition)** David Sharp, Eric Sikorski, George Plopper
4. **Molecular Biology of the Cell Bruce Alberts** 6th Edition
5. **Lehninger, Principles of Biochemistry** 4th edition
6. **The World of the Cell : Becker**, 6th edition
7. **Cell and Molecular Biology** 8th Edition **De Robertis**
8. **Thrive in Cell Biology, Oxford University Press**, 2013

**CORE COURSE-2: Biochemistry**

1. Cox, M.M and Nelson, D.L. (2008). **Lehninger Principles of Biochemistry**. V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). **Biochemistry. VI** Edition, W.H. Freeman and Co., New York.
3. **D. Das Biochemistry**
4. 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.
5. Hames, B.D. and Hooper, N.M. (2000). **Instant Notes in Biochemistry**, II Edition, BIOS Scientific Publishers Ltd., U.K.

**SEC-1: Applied Entomology**

1. **Chapman, R.F**. (2012). The Insects: Structure and function 5th Edition, Cambridge University Press.
2. Triplehorn, C.A. and Johnson, N.F. (2005). Borror and Delong's Introduction to the study of Insects. 7th Edition, Thompson Brooks/Cole, USA
3. **Atwal, A.S.** (1986). Agricultural Pests of India and South-East Asia. 2nd Edition, Kalyani Publishers, New Delhi.
4. **Pedigo, L.P. and Rice, M.E**. (2009). Entomology and Pest Management. 6th Edition, Pearson Prentice Hall.
5. **Hati, A.K**. (2010). **Medical Entomology**. Allied Book Agency.
6. Shukla, A. (2009) A handbook on Economic Entomology. Daya Publishing House, DelhiEntomology. 3rd Edition, Academic Press, United Kingdom
7. Imms, A.D. (1938). A General Text Book of Entomology. Chapman and Hall

**SEC-2: Aquaculture**

1. Chaudhuri,S.(2017) Economic Zoology, NCBS.
2. Sarkar, S.,Kundu,G. Chaki,K.C. (2017) Introduction to Economic Zoology. NCBA
3. Khanna,S.S. and Singh, H.R.(2017) A Text Book of Fish Biology and Fisheries. Narendra Publishing House.
4. Menon, A.G.K. (1999) the Freshwater Fishes of India, A Handbook. Z.S.I
5. Das, M.K. and Das, R.K. (1997) Fish and Prawn Diseases in India- Diagnosis and Control. Inland Fisheries Society in India, Barrackpore, West Bengal.

6. Jhingran, V.G. (2007) Hindustan Publishing Corporation. 3rd Edition.
7. Pillai, T.V.R. and Kutty. (2007) Fishing News Book. 2nd Edition.
8. Lutz. C.G.( ) Practical Genetics for Aquaculture. Fishing News Book. Oxford.
9. Govindan,T.K.(2008 ) Fish Processing Technology.Oxford and IBH Publishing Co. Pvt. Ltd. Kolkata.
10. Dunham, R.A. (1985) Aquaculture and Fisheries Biotechnology. Genetic Approaches. CABI.
11. Pierre Boundry, Andy Beaumont, Kathryn Hoare. (2010) Biotechnology and Genetics in Fisheries and Aquaculture. Wiley Blackwell.
12. Das,S. (2022) Aquarium Fishery.

**The University will offer Zoology related IDC as the Paper of Animal Science which will be selected by Students pursuing Major and Minor Courses other than Zoology**

## PART I: SEMESTER 1
## IDC-1: Animal Biology
## IDC-1-TH

| **Full Marks 75** | **3 Credits** | **50 Hours** |
|---|---|---|
| **Unit 1: Animal Diversity** | | **10** |
| Phylum Characters and example: [Non-chordates-Porifera, Cnidaria, Ctenophora, Platyhelminthes, Nemathelminthes, Annelida, Arthropoda, Mollusca and Echinodermata]; Chordata | | |
| **Unit 2: Genetics** | | **12** |
| 1. Mendelian Principles and Laws of inheritance<br>2. Linkage and Recombination basic Concepts<br>3. Sex Determination with reference to *Drosophila* [only genic balance theory]<br>4. Chromosomal Aberration [Structural and Numerical] | | |
| **Unit 3: Biodiversity and Wildlife** | | **15** |
| 1. Biodiversity: Definition, typesand value<br>2. Biodiversity: Indices [Shannon & Simpson]<br>3. Conservation: *in situ* and *ex situ* [outline idea]<br>4. Conservation Priority: Hotspot, Megadiversity, Sensitive Ecosystem<br>5. Indigenous Knowledge and PBR: Basic Concepts | | |
| **Unit 4: Insect Vectors** | | **8** |
| 1. Concept of Vector: Biological and Mechanical Vectors with examples<br>2. Disease cycle & Reservoir Concept<br>3. Major Vectors: Mosquito (*Anopheles* sp. &*Aedes* sp.) Life cycle, control, role as vector. | | |
| **Unit 5: Laboratory techniques and Instrumentation** | | **5** |
| 1. Basics of Light Microscopy<br>2. Principles and Application of Colorimetry<br>3. Principles and application of Ultracentrifugation | | |

## Animal Biology Lab: IDC-1-P

| **Full Marks 25** | **1 Credit** | **20 Hours** |
|---|---|---|

| List of Practical |
|---|
| 1. Karyotype analysis of Klinefelter, Down, Turner, Edward & Patau Syndrome<br>2. Identification (Phylum and specimen characters): *Amoeba, Paramoecium, Sycon, Neptune's Cup, Taenia, Ascaris, Nereis, Pheretima, Pila, Lamelledens, Penaeus, Macrobrachium, Musca, Anopheles, Culex, Asterias*.<br>3. One Local-Outdoor Trip for Biodiversity Studies. |

## SEC G For MDC
## Applied Zoology-Theory

| **Full Marks 75** | **3 Credits** | **50 Hours** |
|---|---|---|
| **Unit I: Agricultural Entomology** | | **6** |
| Pest- definition and types (major and minor pests with example); Lifecycle, nature of damage and control of Pests: *Scirpophagaincertulus*of paddy,*Anomissabulifera*of Jute, *Bandicoota*–stored house pest; Insect Pest control: Chemical, Mechanical, Cultural and Biological control measures; Integrated Pest Management (IPM). | | |
| **Unit II: Sericulture** | | **8** |
| Types of Silkworms with special reference to their scientific name, geographical distribution and host plants; *Bombyx mori*: Silk gland, Composition of silk, Uses of silk; Lifecycle; Rearing, Extraction and Reeling of mulberry silk; Silkworm diseases, pests and their control. | | |
| **Unit III: Apiculture** | | **7** |
| Various domesticated species of Honeybee; Social organization of Honeybee; Bee keeping: Langstroth Box for rearing of honey bee, Extraction and processing of honey; Composition of honey, apiculture by products and their uses; Pests and Diseases of bees and their control measures | | |
| **Unit IV: Vermiculture** | | **7** |
| Scope of Vermiculture; Habit categories of earthworms; methodology of vermicomposting: containers for culturing, raw materials required, preparation of bed, environmental pre-requisites, feeding, harvesting and storage of vermicompost; Advantages of vermicomposting; Diseases and pests of earthworms. | | |
| **Unit V: Aquaculture** | | **8** |
| Principles, definition and scope; Prawn culture: Penaeid and Palaemonid features with examples; Semi-intensive method of prawn culture; Application of prawn culture; Difference between major and minor carps with examples; Composite fish farming: General concepts, advantages and disadvantages; Induced breeding: method and advantages; Integrated fish farming. | | |
| **Unit VI: Live Stock Management** | | **8** |
| Dairy: Introduction to common dairy animals: Types of Cattle breeds and their distribution in India; Exotic cattle breeds; Artificial insemination and MOET in breeding; Cattle feed: Roughage and Concentrate; dairy by products, preservation and uses. Dairy pathology and vaccination programme.<br>Poultry: Types of breeds (fowl) with features and examples; Rearing method: Deep litter system; feed formulation for chicks; poultry by products with economic importance; Diseases | | |

| | |
|---|---|
| of poultry and their control measures. | |
| **Unit VII: Lac Culture** | **6** |
| Life cycle, host plants and strains of Lac insect; Lac cultivation: Local practice, improved practice, propagation of Lac insect, inoculation period, harvesting of Lac; Lac composition, processing, products and uses; Natural enemies of lac insect and their management | |

## SEC G For MDC
## Applied Zoology-Practical

| **Full Marks 25** | **1 Credit** | **20 Hours** |
|---|---|---|
| **List of Practical** | | |

1. Identification of various castes of Honey bee, life stages of *Bombyx mori*, various life stages of *Kerrialacca,* various earthworm species used in vermiculture and ectoparasites of Poultry birds
2. Identification of the following fish and prawn specimens (Specimen characters only): *Labeorohita, Catlacatla, Cirrhinusmrigela, Cyprinuscarpio, L. bata, Penaeusmonodon, Macrobrachiumrosenbergi*
3. Collection of any two pests and submission of specimen it along with a small report on its identifying features, life cycle, nature of damage and control: *Sitophilusoryzae, Triboliumcastaneum, Nilaparvatalugens, Anomissabulifera*and*Leucinodesorbonalis*
4. Visit to any one of the following and submission of report on the visit
   a) Apiary
   b) Freshwater fish farm
   c) Any agricultural field
   d) Poultry farm
   e) Sericulture farm
   f) Lac culture farm

# UNIVERSITY OF CALCUTTA

## Notification No. CSR/75/2024

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in the exercise of her powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 12.09.2024 approved the new revised syllabus (Semester- 1 to 6) of Zoology (4-year Honours & Honours with Research and Three-year MDC & Minor) under CCF, under this University, as laid down in the accompanying pamphlet.

The above shall take effect from the Odd Semester Examinations, 2024 and onwards.

19/9/24

Prof.(Dr.) Debasis Das

Registrar

SENATE HOUSE

Kolkata-700073

19.09.2024

# Outline Structure of NEP Curriculum for Zoology Major, C.U.

| SUBJECT CODE | NAME OF PAPER | THEORY | PRACTICAL |
|---|---|---|---|
| **PART I; SEM I** | | | |
| ZOOM CC 1 Th/P | Cell Biology | 75 | 25 |
| ZOOM SEC-1 Th/P | Applied Entomology | 75 | 25 |
| IDC Th/P | The University will offer Zoology related IDC as the Paper of Animal Science which will be selected by Students pursuing Major and Minor Courses other than Zoology | 50 | 25 |
| **PART I; SEM II** | | | |
| ZOOM CC 2 Th/P | Biochemistry | 75 | 25 |
| ZOOM SEC-2 Th/P | Aquaculture | 75 | 25 |
| IDC Th/P | The University will offer Zoology related IDC as the Paper of Animal Science which will be selected by Students pursuing Major and Minor Courses other than Zoology | 50 | 25 |
| **PART II; SEM III** | | | |
| ZOOM CC 3 Th/P | Genetics | 75 | 25 |
| ZOOM CC 4 Th/P | Cells and Tissue Structure | 75 | 25 |
| ZOOM SEC-3 Th/P | Poultry farming and Animal Husbandry | 75 | 25 |
| IDC Th/P | The University will offer Zoology related IDC as the Paper of Animal Science which will be selected by Students pursuing Major and Minor Courses other than Zoology | 50 | 25 |
| **PART II; SEM IV** | | | |
| ZOOM CC 5 Th/P | Non-chordate structure and function | 75 | 25 |
| ZOOM CC 6 Th/P | Parasitology | 75 | 25 |
| ZOOM CC 7 Th/P | Molecular Biology | 75 | 25 |
| ZOOM CC 8 Th/P | Ecology | 75 | 25 |
| **PART III; SEM V** | | | |
| ZOOM CC 9 Th/P | Chordate structure and function | 75 | 25 |
| ZOOM CC 10 Th/P | Endocrinology and Reproductive biology | 75 | 25 |
| ZOOM CC 11 Th/P | Animal Physiology | 75 | 25 |
| ZOOM CC 12 Th/P | Biodiversity and Conservation Biology | 75 | 25 |
| **PART III; SEM VI** | | | |
| ZOOM CC 13Th/P | Developmental Biology | 75 | 25 |
| ZOOM CC 14Th/P | Taxonomy, Evolution and Adaptation | 75 | 25 |
| ZOOM CC 15Th/P | Animal Behaviour | 75 | 25 |
| CU Summer Internship | As per University & UGBoS Instructions | 75 [ 3 credits] | |
| **PART IV; SEM VII** | | | |
| ZOOM CC 16 Th/P | Biotechnology and its Application | 75 | 25 |
| ZOOM CC 17 Th/P | Neurobiology | 75 | 25 |
| ZOOM CC 18 Th/P | Toxicology | 75 | 25 |
| ZOOM CC 19 Th/P | Immunology | 75 | 25 |
| | DISSERTATION/ RESEARCH WORK | 100[4 Credits] | |
| **PART IV; SEM VIII** | | | |
| ZOOM CC 20 Th/P | Scientific Communication and Research Methodology | 75 | 25 |
| ZOOM CC 21 Th/P | Animal Models in Research | 75 | 25 |
| ZOOM CC 22 Th/P | Industrial Microbiology | 75 | 25 |
| | DISSERTATION/RESEARCH WORK | 200[ 8 credits] | |

**ABBREVIATIONS:**

**CC: Core Course (Major ZOOM;Minor ZOOMN) IDC: inter-Disciplinary Course; SEC: Skill Enhancement Course. Multidisciplinary (MZOO)**

**NOTE: Marks = 25 marks per credit. Candidates who will not pursue Dissertation/Research have to submit 1 Review paper along with Seminar Presentation at End of Semester-7 and 2 review paper along with Seminar Presentation at end of Semester-8.**

# Outline Structure of NEP Curriculum for Zoology Minor, C.U.

| PART I; SEM I | | | |
|---|---|---|---|
| **SUBJECT CODE** | **NAME OF PAPER** | **THEORY** | **PRACTICAL** |
| ZOOMN CC1Th/P | Cell Biology | 75 | 25 |
| **PART I; SEM II** | | | |
| ZOOMNCC2 Th/P | Biochemistry | 75 | 25 |
| **PART II; SEM III** | | | |
| ZOOMN CC1Th/P | Cell Biology | 75 | 25 |
| **PART II; SEM IV** | | | |
| ZOOMN CC2Th/P | Biochemistry | 75 | 25 |
| Note: Students who will opt other than Zoology as major in combination with minor Zoology in SEMI and in SEM II will take Cell biology and Biochemistry in SEMI and SEMII, respectively. Students who will opt other than Zoology as major in combination with minor other than Zoology in SEMIII and in SEM IV, they will take Cell biology and Biochemistry as minor Zoology in SEMIII and SEMIV, respectively. | | | |
| **PART III; SEM V** | | | |
| ZOOMN CC3Th/P | Cell and Tissue structure | 75 | 25 |
| **PART III; SEM VI** | | | |
| ZOOMN CC4 Th/P | Non-Chordate structure and function | 75 | 25 |

# Outline Structure of NEP Curriculum for Zoology Multidisciplinary course (MDC), C.U.

| PART I; SEM I | | | | |
|---|---|---|---|---|
| **SUBJECT CODE** | **CC1/CC2** | **Minor** | **THEORY** | **PRACTICAL** |
| MZOO CC1 Th/P | Cell Biology | | 75 | 25 |
| **PART I; SEM II** | | | | |
| MZOOCC2 Th/P | Biochemistry | | 75 | 25 |
| **PART II; SEM III** | | | | |
| MZOOCC3 Th/P | Cells and Tissue Structure | Cells and Tissue Structure | 75 | 25 |
| **PART II; SEM IV** | | | | |
| MZOO CC4Th/P | Non-chordate structure and function | Non-chordate structure and function | 75 | 25 |
| MZOO CC5Th/P | Ecology | | 75 | 25 |
| **PART III; SEM V** | | | | |
| MZOO CC6Th/P | Chordate structure and function | **Chordate structure and function | 75 | 25 |
| MZOO CC7Th/P | *Biodiversity and Conservation Biology | Biodiversity and Conservation Biology | 75 | 25 |
| **PART III; SEM VI** | | | | |
| MZOO CC7Th/P | **Biodiversity and Conservation Biology | Animal Behaviour | 75 | 25 |
| MZOO CC8Th/P | Taxonomy, Evolution and Adaptation | Taxonomy, Evolution and Adaptation | 75 | 25 |
| CU Summer Internship | As per University and college Instructions | As per University and college Instructions | 75 [ 3 credits] | |

**MDC students will take SEC paper SEC-G Applied Zoology in any of SEMI/ SEMII/ SEMIII.**

**Students taking Zoology as major subject will have option to study MZOO CC7Th/P either in SEMV or in SEMVI. Students who will opt Zoology as minor they will study only 6 papers as mentioned in the table.**

# PART I: SEMESTER-I

## CORE COURSE-1: Cell Biology

### CC1 THEORY

| Full Marks 75 | 3 Credits | 46 Hours |
|---|---|---|
| **Unit 1: Plasma Membrane** | | **7** |
| **Structure of the Plasma Membrane:** Lipid Bilayer (Phospholipids and Cholesterol), Peripheral and Integral Membrane proteins, Glycolipids and Glycoproteins (*basic concept of Glycocalyx*), Fluid Mosaic Model with special reference to Lipid rafts, Mobility of membrane lipids (FRAP assay) and Mobility of Membrane Proteins (Frye-Edidin Experiment); Cell-cell junctions; Transport through plasma membrane. | | |
| **Unit 2: Cytoplasmic organelles I** | | **7** |
| **Basic concepts on Ultrastructure of ER, Golgi and Lysosome; Overview of Protein sorting;** ER Morphology, Targeting proteins to ER, The Signal hypothesis; Insertion of proteins into ER membrane, Protein folding and processing in ER, Export of proteins and lipids from ER ; **Golgi Apparatus;** Morphology, Protein glycosylation within Golgi, Protein sorting and export from Golgi apparatus; **Lysosome:** Polymorphism**,** Lysosomal acid hydrolases, Endocytosis and lysosome formation. | | |
| **Unit 3: Cytoplasmic organelles II** | | **4** |
| **Mitochondria:** Structure; Mitochondrial Respiratory Chain, Chemiosmotic hypothesis and Oxidative Phosphorylation with reference to ATP Synthase and ATP synthesis<br>**Centrosome and its organization** | | |
| **Unit 4: Cytoskeleton** | | **4** |
| Structure and Types: Microtubules, Actin filaments, and Intermediate filaments; Composition and function of ECM | | |
| **Unit 5: Nucleus** | | **5** |
| Nuclear envelope, nuclear pore complex (transport not included), Kinetochore and centromeric DNA; Chromatin and levels of its packaging. Euchromatin & Heterochromatin. | | |
| **Unit 6: Cell Cycle** | | **10** |
| **Cell Cycle:** Phases of the eukaryotic cell cycle, Protein Kinases and Cell cycle regulation, MPF, Growth factors and regulation of G1-Cdks, S phase and regulation of DNA replication; **Cell Death:** Extrinsic (Death receptors) and Intrinsic Pathways (apoptosome);<br>**Cancer:** Concept of Protooncogene [Ras] & Tumor suppressor genes [Rb and p53], Different ways of activation of a protooncogene to Oncogene. | | |
| **Unit 7: Cell Signalling** | | **5** |
| **Signalling system:** Modes of cell-cell signalling; Types of Signalling molecules **Signalling receptors**: Types and example with special reference to regulation of G protein, Adenyl cyclase-cAMP, Enzyme linked Receptors: RTK (ras-raf) and JAK/STAT | | |
| **Unit 8: Tools and Techniques in Cell Biology** | | **4** |
| • Animal Cell Culture: Primary cell culture and Cell line.<br>• Subcellular fractionation and Ultracentrifugation.<br>• Freeze fracture Replication and Freeze Etching<br>• Working Principle of Light Microscope: Bright field, Phase contrast microscope, Fluorescence Microscope with reference to FRET; Working Principle of SEM & TEM. | | |

## Cell Biology Lab; ZOOA-CC-1-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |
| **1.** Cell viability study by Trypan Blue Exclusion method.<br>**2.** Standardization of Ocular and Stage Micrometer and Measurement of cell or microscopic specimen such as *Paramoecium* sp.<br>**3.** Preparation of squamous epithelial cell with staining.<br>**4.** Isolation of Bone Marrow Cells from Rat/Mouse and Giemsa Staining.<br>**5. LNB** | | |

# PART I: SEMESTER-I

## SEC-1: Applied Entomology

### SEC-1 THEORY

| Full Marks 75 | 3 Credits | 43 Hours |
|---|---|---|
| **Unit 1 Basics of Entomology** | | **11** |
| **Morphological adaptation of insects**: Head and antenna;—Mouthparts of honey bee and cockroach; Thorax and thoracic appendages- legs and wings [General concept].<br>**Physiological adaptation in cockroach:** Digestive system: Alimentary canal and digestive glands, digestion; Respiratory organs and mechanism of gaseous exchange; Sense organs compound eyes, chemoreceptors.<br>**General Characteristics of Class Insecta and living orders with examples:** Orthoptera, Dictyoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera, Hymenoptera, Anoplura (Imms, A.D., 1938) | | |
| **Unit 2 Medical Entomology** | | **11** |
| **Concept of Vectors:** Carrier and biological vectors, modes of transmission with special reference to Malaria Dengue, and Filaria; Control measures of vectors<br>**Ticks as Causative agents and Vectors**: Rickettsiosis, Tick-borne encephalitis; General outline of Mites and their medical significance.<br>***Phlebotomus* sp:** Characteristics, Biology and mode of transmission of visceral leishmaniasis; control measures. | | |
| **Unit 3 Agricultural Entomology** | | **11** |
| **Insect Pest:** Definition and types; Economic Injury Level (EIL), Economic Threshold Level (ETL), Dynamics of EIL;<br>**Pests of major crops (Life cycle, Nature of damage and control measures):** Pests of Paddy, *Scirpophaga incertulus*; Pests of Jute, *Anomis sabulifera;* Pests of brinjal, *Leucinodes orbonalis*; Stored grain pest: *Sitophilus oryzae*;<br>**Insect Pest control:** Chemical (classification and mode of action) and Biological control measures; Integrated Pest Management (IPM) | | |
| **Unit 4 Sericulture** | | **5** |
| Types of Silk Moths with special reference to their scientific name, geographical distribution, and host plants; Life cycle of *Bombyx mori*; Structure of Silk Gland; Voltinism; Rearing of mulberry silkworm; Reeling and extraction of silk; Mulberry cocoon management; Common diseases and pests of mulberry silkworm and their control measures; Prospects of Sericulture in India. | | |
| **Unit 5 Apiculture** | | **5** |
| Various species of Honeybee; Social organization and life cycle of Honeybee; Modern method of Beekeeping: Newton Box; Apiculture products and their uses; Extraction of honey and composition of honey; Diseases and their control measures. | | |

## Applied Entomology Lab: SEC-1-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |

1. Dissection and temporary mounting of: - Mouth parts of Cockroach and Mosquito
2. Methods of collection, preservation, and identification of economically important insects.
3. Identification (Order and specimen characters only) with economic importance of following insect pests: *Scirpophaga incertulus; Sitophilus oryzae*; *Callosobruchus chinensis; Leucinodes orbonalis*.
4. Life history stages of *Apis* sp and *Bombyx mori*.
5. Identification and medical significance of following insects (adults) through permanent slides: *Aedes aegypti, Aedes albopictus*., *Culex* sp., *Anopheles* sp. [for mosquito, larvae and both sexes of adults], *Musca* sp., *Phlebotomus* sp..
6. Accomplish **any one** from the followings related to applied entomological significance (submission of a report):
   a. Visit to Agricultural field related to damage caused by any pest and pest management. Make a report on it.
   b. Visit to any Sericulture farm to study silkworm rearing, silk reeling, silk processing and make a report on it.
   c. Visit an Apiary and to make a report on it.
   d. Visit to any rural or urban health centre to study various aspects of vector surveillance and vector borne diseases of that locality. Make a report on it.
7. **LNB**

# PART I: SEMESTER-II

## CORE COURSE-2: Biochemistry

### CC2 THEORY

| Full Marks 75 | 3 Credits | 45 Hours |
|---|---|---|
| **Unit 1: Carbohydrates** | | **8** |
| Structure, classification and properties of Monosaccharides (aldose and ketose), Disaccharides, Polysaccharides; Isomerism of monosaccharides (D and L, optical isomers, furanose and pyranose, α and β anomers, epimers); Reducing and non – reducing sugars.<br>Physiological importance of Monosaccharides, Disaccharides, Polysaccharides | | |
| **Unit 2: Proteins** | | **7** |
| **Amino acids:** Structure, Classification, General and Electro chemical properties of α-amino acids; Essential and non-essential amino acids; **Structures of Protein:** Primary, secondary, tertiary and quaternary) of protein, Classification of proteins. | | |
| **Unit 3: Lipids** | | **4** |
| **Classification of lipids**; Saturated and unsaturated fatty acids, essential and non – essential fatty acids. **Structure and formation of Triglyceride**.; Iodine number and saponification number of fats. | | |
| **Unit 4: Enzymes** | | **8** |
| **Nomenclature, classification and properties**; Cofactors and coenzymes, Effect of Temperature, pH, substrate concentration, enzyme concentration on enzyme action, Isozymes and Proenzyme, Mechanism of enzyme action (Lock and key model, Induced fit model).<br>**Enzyme kinetics**: Derivation of Michaelis-Menten equation with its significance, Lineweaver-Burk plot and its significance. Enzyme inhibition – competitive, non- competitive, allosteric / feedback and its effect on Vmax and Km | | |
| **Unit 5: Carbohydrates Metabolism** | | **6** |
| Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis from lactate and glycerate, Glycogenesis and Glycogenolysis. (Pathways with name of enzymes and significance) | | |
| **Unit 6: Protein Metabolism** | | **4** |
| Transamination, Deamination and its types (Pathways with name of enzymes and significance) Fate of C-skeleton of Glucogenic and Ketogenic amino acids. | | |
| **Unit 7: Lipid Metabolism** | | **4** |
| β-oxidation of fatty acids - a. Palmitic acid {saturated (C 16:0)}, b. Linoleic acid {unsaturated (C 18:2)}; Fatty acid biosynthesis | | |
| **Unit 8: Nucleic acid Metabolism** | | **3** |
| Degradation of purine; Purine Salvage pathway and significance. | | |
| **Unit 7: Free radicals and Antioxidants** | | **1** |
| Concept of free radicals and antioxidants with examples. | | |

## Biochemistry Lab; CC-2-P

| Full Marks 25 | | 1 Credit | 20 Hours |
|---|---|---|---|
| **List of Practical** | | | |
| **Group A** | **10 Hours** | **15 Marks** | |
| **Qualitative tests for carbohydrates, proteins and lipids**<br>1. For carbohydrate (Glucose, Fructose, Maltose, Sucrose, Starch) – Molisch test, Barfoed test, Benedict test, Fehling test, Seliwanoff test, Hydrolysis test for sucrose, Iodine test<br>2. For Protein (Albumin, Gelatine, Peptone) –Biuret test, Million's test, Xanthoproteic test, Ninhydrin test<br>3. For lipid – Grease spot test | | | |
| **Group B** | **10 Hours** | **10 Marks** | |
| **Colorimetric estimation of the following**<br>a) Protein by Lowry's method<br>b) Activity of amylase | | | |
| **LNB** | | | |

# PART I: SEMESTER-II

## SEC-2 Aquaculture

### SEC-2-TH

| **Full Marks 75** | **3 Credits** | **43 Hours** |
|---|---|---|
| **Unit 1 Basics of Idea of Fish Biology** | | **3** |
| Qualities of Cultivable fish, Indigenous and Exotic | | |
| **Unit 2 Sustainable Aquaculture System** | | **15** |
| Sustainable Aquaculture Culture System: Extensive, Semi intensive, Extensive<br>Water quality in culture ponds and factors controlling water quality.<br>Preparation and Management of Fish Culture Ponds in Composite Fish Culture<br>Cage Culture, Pen Culture, Raceways. Flow through system. Biofloc. Cold water fishery. Jeol Fishery. Sewage fed fishery. Mariculture with special emphasis on sea weed culture. (Basic concept)<br>Induced Breeding of Carps. Synthetic Hormones in Hypophysation.<br>Management of Fin Fish Hatcheries. Glass Jar Hatchery, Chinese Hatchery. | | |
| **Unit 3 Recent Advancement of Aquaculture** | | **15** |
| Aquarium Fisheries; Preparation and Management of Fish Aquarium; Biology of Common Ornamental Fish: Guppy, Swordtail, Angel, Blue morph fish. Anemone fish, Butterfly fish, Molly.<br>**Fish Nutritional Requirements:** Feed Formulations and Preparation of Compound Diets.<br>**Capture Fishery:** Fishing Crafts and Gears, Post harvesting Technology. Fish Transport and Marketing.<br>Fish Preservation and By-products.<br>**Fish Biotechnology:** Transgenic Fish, Sex Reversal in Fish. Aquaponics, Application of GIS and Remote Sensing in Fisheries, Fishery Laws and Regulations. | | |
| **Unit 4 Fin Fish pathology** | | **5** |
| Name of Infective Disease. Causative Agents, Symptoms, Control. Bacteria- Dropsy, Fin and Tail rot.<br>Protozoa- White Spot Disease; Fungal-Saprolegniasis; Ectoparasite-Gyrodactylosis, Dactylogyrosis. Virus- Rhabdovirus | | |
| **Unit 5 Applied Aquaculture** | | **5** |
| **Breeding Techniques in Shrimps and Prawns:** Eyestalk Ablation in Shrimp and Salinity shock in Prawns. Techniques of Artificial Pearl Culture. | | |

## Aquaculture Lab: SEC-2-P

| **Full Marks 25** | **1 Credit** | **20 Hours** |
|---|---|---|
| **List of Practical** | | |
| 1. **Identification of different fish species using Meristic characters. (Systematic position, specimen characters)** *Rohu, Catla, Cirrhinus, Puntius, Amblypharyngodon, Channa punctatus, Lates, Mystus, Notopterus, Cyprinus, Hypophthalmichthys, Ctenopharyngodon, Oreochromis niloticus, Oreochromis mossambicus*<br>*Anabas, Clarias, Heteropneustes, Mugil, Macrobrachium, Penaeus.*<br>2. **Visit to** nearby fish market and identification of economically important fishes, survey on market economy and preparation of report on it.<br>3. **LNB** | | |

## SUGGESTED REFERENCES

### CORE COURSE-1: CELL BIOLOGY


1. **The Cell (8th Edition) G. M. Cooper** and R.E. Hausman
2. **Karp's Cell and Molecular Biology:** Concepts and Experiments **8th edition**
3. **Lewin's CELLS (3rd Edition)** David Sharp, Eric Sikorski, George Plopper
4. **Molecular Biology of the Cell Bruce Alberts** 6th Edition
5. **Lehninger, Principles of Biochemistry** 4th edition
6. **The World of the Cell : Becker**, 6th edition
7. **Cell and Molecular Biology** 8th Edition **De Robertis**
8. **Thrive in Cell Biology, Oxford University Press**, 2013


### CORE COURSE-2: BIOCHEMISTRY


1. Cox, M.M and Nelson, D.L. (2008). **Lehninger Principles of Biochemistry**. V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). **Biochemistry. VI** Edition, W.H. Freeman and Co., New York.
3. **D. Das Biochemistry**
4. 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.
5. Hames, B.D. and Hooper, N.M. (2000). **Instant Notes in Biochemistry**, II Edition, BIOS Scientific Publishers Ltd., U.K.


### SEC-1: APPLIED ENTOMOLOGY


1. **Chapman, R.F**. (2012). The Insects: Structure and function 5th Edition, Cambridge University Press.
2. Triplehorn, C.A. and Johnson, N.F. (2005). Borror and Delong's Introduction to the study of Insects. 7th Edition, Thompson Brooks/Cole, USA
3. **Atwal, A.S.** (1986). Agricultural Pests of India and South-East Asia. 2nd Edition, Kalyani Publishers, New Delhi.
4. **Pedigo, L.P. and Rice, M.E**. (2009). Entomology and Pest Management. 6th Edition, Pearson Prentice Hall.
5. **Hati, A.K**. (2010). **Medical Entomology**. Allied Book Agency.
6. Shukla, A. (2009) A handbook on Economic Entomology. Daya Publishing House, DelhiEntomology. 3rd Edition, Academic Press, United Kingdom
7. Imms, A.D. (1938). A General Text Book of Entomology. Chapman and Hall


### SEC-2: AQUACULTURE


1. Chaudhuri,S.(2017) Economic Zoology, NCBS.
2. Sarkar, S.,Kundu,G. Chaki,K.C. (2017) Introduction to Economic Zoology. NCBA
3. Khanna,S.S. and Singh, H.R.(2017) A Text Book of Fish Biology and Fisheries. Narendra Publishing House.
4. Menon, A.G.K. (1999) the Freshwater Fishes of India, A Handbook. Z.S.I
5. Das, M.K. and Das, R.K. (1997) Fish and Prawn Diseases in India- Diagnosis and Control. Inland Fisheries Society in India, Barrackpore, West Bengal.
6. Jhingran, V.G. (2007) Hindustan Publishing Corporation. 3rd Edition.
7. Pillai, T.V.R. and Kutty. (2007) Fishing News Book. 2nd Edition.
8. Lutz. C.G.( ) Practical Genetics for Aquaculture. Fishing News Book. Oxford.
9. Govindan,T.K.(2008 ) Fish Processing Technology.Oxford and IBH Publishing Co. Pvt. Ltd. Kolkata.
10. Dunham, R.A. (1985) Aquaculture and Fisheries Biotechnology. Genetic Approaches. CABI.
11. Pierre Boundry, Andy Beaumont, Kathryn Hoare. (2010) Biotechnology and Genetics in Fisheries and Aquaculture. Wiley Blackwell.
12. Das,S. (2022) Aquarium Fishery.


### IDC-1: ANIMAL BIOLOGY


1. Manna, S. , Bhowal, S. K. , Ghosh, R., Ghosh, N., Mukherjee, A. (2024) A Concise Book of Animal Biology. (Ed. S. Manna), Techno World, Kolkata.ISBN 978-81-19777-08-2.

**The University will offer Zoology related IDC as the Paper of Animal Science which will be selected by Students pursuing Major and Minor Courses other than Zoology**

# PART I: SEMESTER-I/II/III

## IDC-1: Animal Biology
## IDC-1-TH

| **Full Marks 50** | **3 Credits** | **45 Hours** |
|---|---|---|
| **Unit 1: Animal Diversity** | | **10** |
| Phylum Characters and example: [Non-chordates-Porifera, Cnidaria, Ctenophora, Platyhelminthes, Nemathelminthes, Annelida, Arthropoda, Mollusca and Echinodermata]; Chordata | | |
| **Unit 2: Genetics** | | **12** |
| 1. Mendelian Principles and Laws of inheritance<br>2. Linkage and Recombination basic Concepts<br>3. Sex Determination with reference to *Drosophila* [only genic balance theory]<br>4. Chromosomal Aberration [Structural and Numerical] | | |
| **Unit 3: Biodiversity and Wildlife** | | **10** |
| 1. Biodiversity: Definition, types and value<br>2. Biodiversity: Indices [Shannon & Simpson]<br>3. Conservation: *in situ* and *ex situ* [outline idea]<br>4. Conservation Priority: Hotspot, Megadiversity, Sensitive Ecosystem<br>5. Indigenous Knowledge and PBR: Basic Concepts | | |
| **Unit 4: Insect Vectors** | | **8** |
| 1. Concept of Vector: Biological and Mechanical Vectors with examples<br>2. Disease cycle & Reservoir Concept<br>3. Major Vectors: Mosquito (*Anopheles* sp. & *Aedes* sp.) and Sand fly [Lifecycle and Control Measures] | | |
| **Unit 5: Laboratory techniques and Instrumentation** | | **5** |
| 1. Basics of Light Microscopy<br>2. Principles and Application of Colorimetry<br>3. Principles and application of Ultracentrifugation | | |

## Animal Biology Lab: IDC-1-P

| **Full Marks 25** | **1 Credit** | **20 Hours** |
|---|---|---|
| **List of Practical** | | |
| **1.** Karyotype analysis of Klinefelter, Down, Turner, Edward & Patau Syndrome<br>**2.** Identification (Phylum and specimen characters): *Amoeba, Paramoecium, Sycon, Neptune's Cup, Taenia, Ascaris, Nereis, Pheretima, Pila, Lamellidens, Penaeus, Macrobrachium, Musca, Anopheles, Culex, Asterias*.<br>**3.** Identification of different ecosystems through photographs: Marine ecosystem, Mangrove ecosystem, Lake ecosystem, Rainforest ecosystem, Desert ecosystem, Grassland ecosystem.<br>**4. LNB** | | |

# SEC G For MDC
# Applied Zoology-Theory

| Full Marks 75 | 3 Credits | 45 Hours |
|---|---|---|
| **Unit I: Agricultural Entomology** | | **5** |
| Pest- definition and types (major and minor pests with example); Lifecycle, nature of damage and control of Pests: *Nilaparvata lugens* of paddy, *Anomis sabulifera* of Jute, *Bandicoota* – stored house pest; Insect Pest control: Chemical, Mechanical, Cultural and Biological control measures; Integrated Pest Management (IPM). | | |
| **Unit II: Sericulture** | | **7** |
| Types of Silkworms with special reference to their scientific name, geographical distribution and host plants; *Bombyx mori*: Silk gland, Composition of silk, Uses of silk; Lifecycle; Rearing, Extraction and Reeling of mulberry silk; Silkworm diseases, pests and their control. | | |
| **Unit III: Apiculture** | | **6** |
| Various domesticated species of Honeybee; Social organization of Honeybee; Bee keeping: Langstroth Box for rearing of honey bee, Extraction and processing of honey; Composition of honey, apiculture by products and their uses; Pests and Diseases of bees and their control measures | | |
| **Unit IV: Vermiculture** | | **6** |
| Scope of Vermiculture; Habit categories of earthworms; methodology of vermicomposting: containers for culturing, raw materials required, preparation of bed, environmental pre-requisites, feeding, harvesting and storage of vermicompost; Advantages of vermicomposting; Diseases and pests of earthworms. | | |
| **Unit V: Aquaculture** | | **8** |
| Principles, definition and scope; Prawn culture: Penaeid and Palaemonid features with examples; Semi-intensive method of prawn culture; Application of prawn culture; Difference between major and minor carps with examples; Composite fish farming: General concepts, advantages and disadvantages; Induced breeding: method and advantages; Integrated fish farming. | | |
| **Unit VI: Live Stock Management** | | **7** |
| Dairy: Introduction to common dairy animals: Types of Cattle breeds and their distribution in India; Exotic cattle breeds; Principles and methods of breeding – inbreeding, outbreeding, crossbreeding; Artificial insemination and MOET; cattle feed: Roughage and Concentrate; dairy by products, preservation and uses. Dairy pathology and vaccination programme.<br>Poultry: Types of breeds (fowl) with features and examples; Rearing method: Deep litter system; feed formulation for chicks; poultry by products with economic importance; Diseases of poultry and their control measures. | | |
| **Unit VII: Lac Culture** | | **6** |
| Life cycle, host plants and strains of Lac insect; Lac cultivation: Local practice, improved practice, propagation of Lac insect, inoculation period, harvesting of Lac; Lac composition, processing, products and uses; Natural enemies of lac insect and their management | | |

# Applied Zoology Lab

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |

1. Identification of various castes of Honey bee, life stages of *Bombyx mori*, various life stages of *Kerria lacca,* various earthworm species used in vermiculture and ectoparasites of Poultry birds
2. Identification of the following fish and prawn specimens (Specimen characters only): *Labeo rohita, Catla catla, Cirrhinus mrigala, Cyprinus carpio, L. bata, Penaeus monodon, Macrobrachium rosenbergii*
3. Collection of any two pests and submission of specimen it along with a small report on its identifying features, life cycle, nature of damage and control: *Sitophilus oryzae, Tribolium castaneum, Nilaparvata lugens, Anomis sabulifera* and *Leucinodes orbonalis*
4. **LNB**

# PART II: SEMESTER-III

## CORE COURSE-3: Genetics

### CC3 THEORY

| Full Marks 75 | 3 Credits | 44 Hours |
|---|---|---|
| **Unit 1: Chromosome** | | **4** |
| Structural organization of Chromosomes; Polytene, Lampbrush and Satellite chromosomes; Human Karyotyping. | | |
| **Unit 2: Allele concept** | | **8** |
| Epistasis, Multiple alleles (ABO blood group in human), Isoallele (White eye mutations in *Drosophila*), Pseudoallele (Lozenge Locus in *Drosophila*) & Cis-trans test for allelism, Lethal alleles, Pleiotropy, Penetrance & Expressivity | | |
| **Unit 3: Genetic Fine Structure** | | **2** |
| Complementation test in Bacteriophage (Benzer's experiment on rII locus) | | |
| **Unit 4: Linkage, Crossing over and linkage mapping** | | **10** |
| Linkage and Crossing over; Complete and Incomplete Linkage; Holliday model of recombination; Linkage map construction using three point crosses;<br>Sex linkage in *Drosophila* (White eye locus) & Human (Haemophilia) | | |
| **Unit 5: Mutations & Chromosomal aberrations** | | **10** |
| Types of gene mutations (Substitution and Frameshift);Types of chromosomal aberrations (Structural and Numerical); Non-disjunction of X chromosome in *Drosophila*, Non-disjunction of human chromosome 21; Molecular basis of mutations induced by UV light and chemical mutagens; mutation detection in *Drosophila* by attached X and CLB method; Biochemical mutation detection in *Neurospora* | | |
| **Unit 6: Extra-chromosomal inheritance** | | **2** |
| Kappa particle in *Paramoecium*, Shell spiralling in snail | | |
| **Unit 7: Transposable Genetic elements** | | **4** |
| IS element in bacteria; Ac-Ds elements in maize; P elements in *Drosophila*; LINE, SINE, Alu elements in human | | |
| **Unit 8: Quantitative Genetics** | | **4** |
| Concept of quantitative traits (Examples – Kernel colour in wheat, Ear length in Corn); Polygenic inheritance; Heritability – Concept and types (Broad sense heritability and Narrow sense heritability) | | |

## Genetics Lab; CC-3-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |

1. **Chi-Square Test** - Test for Goodness of fit – Mendelian monohybrid and di-hybrid ratios, *Epistatic ratios; Contingency Chi-Square Test
2. **Identification of Chromosomal aberration in *Drosophila*** (Deletion, Duplication, Inversion and Translocation) and **Human** (Karyotype of Down Syndrome, Turner Syndrome, Patau Syndrome, Edward Syndrome and Klinefelter Syndrome) from photograph.
3. **Pedigree Analysis** of some inherited traits in Human (Autosomal, X-linked and Y-linked).
4. Temporary squash preparation of Grasshopper testis to study various stages of meiosis.
5. **LNB**

*Only for major course students

# PART II: SEMESTER-III

## CORE COURSE-4: Cells and Tissue Structure

### CC4 THEORY

| Full Marks 75 | 3 Credits | 42 Hours |
|---|---|---|
| **Unit 1: Stain, Dye and Histochemistry** | | **8** |
| Difference between stain and dye.<br>Components and classification of dye.<br>Principle and chemistry of PAS and Feulgen reaction. | | |
| **Unit 2: Epithelial Tissue** | | **8** |
| Salient features; Classification with location and diagram (based on structure and functions)<br>Glandular epithelium in details. Cell polarity-Apical domain and modifications; Lateral domain.<br>**Clinical correlation:** Epithelial metaplasia. | | |
| **Unit 3: Connective Tissue** | | **14** |
| Salient features with respect to cell types and fibers; Classification.<br>Structure and function with diagram of Adipose tissue – brown fat and white fat<br>Areolar tissue (diagram, location, components, and their functions); Bone tissue (cell types, extra cellular matrix and ossification with diagram); Cartilage tissue (structure, types with location and diagram); Blood tissue (composition with function)<br>Brief idea on epithelial membrane: cutaneous membrane, mucous membrane<br>**Clinical correlation** with respect to bone tissue: Osteoarthritis and Osteoporosis | | |
| **Unit 4: Muscle tissue** | | **5** |
| Salient features. Types based on function and striations.<br>Ultrastructure of skeletal muscle.<br>Features of single unit and multiunit smooth muscle, cardiac muscle.<br>Difference between white muscle fiber and red muscle fiber.<br>**Clinical correlation:** Duchene muscular dystrophy. | | |
| **Unit 5: Nervous Tissue** | | **5** |
| Salient features; Structure of neurons and types based on origin, myelin sheath and processes; Neuroglia and functions; **Clinical correlation:** Multiple sclerosis | | |
| **Unit 6: Tissue repair** | | **2** |
| **Steps of tissue (skin as an example) repair:**<br>1. Inflammation 2. Organization 3. Regeneration and/ or Fibrosis.<br>**Factors affecting it:**<br>1. Type of tissue 2. Type of injury. 3. Adequacy of blood supply. 4. State of health. 5. Age. | | |

## Cells and Tissue Structure Lab; CC-4-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |
| **1. Preparation, staining and mounting of the following**<br>a. Epithelial tissue from vaginal smear of rat using methylene blue.<br>b. Connective tissue from blood film of rat using Giemsa.<br>c. Muscle tissue from thigh muscle of cockroach using methylene blue.<br>**2. Identification** with reasons the following mammalian histological sections – lung, liver, stomach, kidney.<br>**3. Tissue preparation**, block making and sectioning of any organ of rat/mice.<br>**4. LNB** | | |

# PART II: SEMESTER-III

## SEC-3: Poultry Farming and Animal Husbandry

### SEC-3 THEORY

| Full Marks 75 | 3 Credits | 42 Hours |
|---|---|---|
| **Unit 1: Common Breeds of Fowl and their Characteristics** | | **6** |
| American Class, Asiatic Class, Mediterranean Class, English Class, Indigenous breeds. Commercial strains of chickens: Broiler, Layer, Grower | | |
| **Unit 2: Rearing methods in Poultry Housing and Equipment** | | **6** |
| Essential of good housing; housing requirements; Poultry equipment (egg collector, incubator, chick cage); Housing systems: Free range system, Semi intensive system, Folding unit system, Deep litter system, Cage system (battery). | | |
| **Unit 3: Poultry nutrition:** | | **4** |
| Nutrition, Feed formulation for chicks | | |
| **Unit 4: Diseases of Poultry and their control measures:** | | **3** |
| Viral disease, Parasitic disease, Fungal disease and their control | | |
| **Unit 5: Poultry market in India**: | | **2** |
| Size, growth and trends; poultry market opportunity and challenges | | |
| **Unit 6: Animal Husbandry: Important cattle breed and their characteristics** | | **5** |
| Cattle breeds in India, Cattle population, Milch breeds, Dual purpose breeds, Draught breed, Cross breed cattle strain | | |
| **Unit 7: Livestock feeds:** | | **4** |
| Cattle feed – Roughage and Concentrate | | |
| **Unit 8: Breeding program:** | | **4** |
| Artificial insemination and MOET in cattle. | | |
| **Unit 9: Dairying:** | | **4** |
| Composition of Milk, Dairy products, National Dairy Development Board and Operation Flood Program. | | |
| **Unit 10: Dairy Pathology** | | **4** |
| Viral disease, bacterial disease, and parasitic disease and control | | |

## Poultry Farming and Animal Husbandry Lab; SEC-3-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |

1. **Identification of following poultry breeds** (only coloured photograph): Plymouth rock, Rhode Island red, New Hampshire, Cochin, Brahma, Leghorn, Cornish, Aseel, Kadaknath, Chittagong.
2. **Identification of following cattle breeds** (only coloured photograph): Sahiwal, Red Sindhi, Gir, Malvi, Hariana, Tharparkar, Jersey.
3. Visit to a poultry farm or animal husbandry and make a report on that study.
4. **LNB**

# PART II: SEMESTER-IV

## CORE COURSE-5: Non-Chordate Structure and Function

### CC5 THEORY

| Full Marks 75 | 3 Credits | 45 Hours |
|---|---|---|
| **Unit 1: Kingdom Protista** | | **4** |
| Subkingdom Protozoa: General characteristics and Classification up to phylum (Levine et. al., 1980); Locomotion in *Euglena, Paramoecium* and *Amoeba*; Asexual reproduction and Conjugation in *Paramoecium* | | |
| **Unit 2: Kingdom Animalia** | | **4** |
| Basic structural organization of animals: Body symmetry; Body cavities with reference to pseudocoelom and coelom, Protostomes and Deuterostomes; Origin of Metazoa. | | |
| **Unit 3: Phylum Porifera** | | **4** |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Canal system in sponge; Spicules in sponges. | | |
| **Unit 4: Phylum Cnidaria** | | **4** |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.), Metagenesis in *Obelia*; Polymorphism in Siphonophora; Coral reef: types, formation, threats and Conservation. | | |
| **Unit 5: Phylum Helminths** | | **4** |
| General characteristics and Classification up to classes of Phyla Platyhelminthes and Nematoda (Ruppert and Barnes, 1994, 6th Ed.); Type study (description of digestive, excretory and reproductive): *Fasciola hepatica, Ascaris lumbricoides* | | |
| **Unit 6: Phylum Annelida** | | **4** |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Excretion in Annelida; Metamerism in Annelida. | | |
| **Unit 7: Phylum Onychophora** | | **2** |
| Affinities and Systematic position of Onychophorans | | |
| **Unit 8: Phylum Arthropoda** | | **6** |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Type study: *Macrobrachium* (respiration and excretion) | | |
| **Unit 9: Phylum Mollusca** | | **5** |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Type study *Pila* sp. (Nervous system and respiratory) and *Octopus* sp. (Nervous system); Torsion in Gastropoda. | | |
| **Unit 10: Phylum Echinodermata** | | **5** |
| General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Water vascular system in Starfish; Echinoderm larva and affinities with chordates. | | |
| **Unit 11: Phylum Hemichordata** | | **3** |
| General characteristics of Phylum Hemichordata; Affinities and systematic position of Hemichordates. | | |

## Non-Chordate Structure and Function Lab; CC-5-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |

1. **Identification with reason & Systematic position of** *Entamoeba, Trypanosoma, Sycon, Obelia, Aurelia, Metridium, Madrepora, Fasciola, Taenia, Ascaris, Nereis, Chaetopterus, Hirudinaria, Peripatus, Limulus, Buthus, Macrobrachium, Balanus, Eupagurus, Julus, Scolopendra, Patella, Chiton, Pila, Sepia, Octopus, Asterias, Ophiura, Echinus, Cucumaria, Antedon* and *Balanoglossus.*
2. **Anatomical study**: **Earthworm**: Mounting of Nerve ring; ***Periplaneta* sp.:** Nervous system, Male and female Reproductive systems.
3. **Laboratory culture and whole mount of** *Paramoecium/Euglena/ Amoeba*
4. **LNB**

# PART II: SEMESTER-IV

## CORE COURSE-6: Parasitology

### CC6 THEORY

| Full Marks 75 | 3 Credits | 42 Hours |
|---|---|---|
| **Unit 1: Introduction to Parasitology** | | **4** |
| Parasitism: parasite, parasitoid, parasitic castration; Vectors and reservoir concept; Zoonosis | | |
| **Unit 2: Parasitic Protists** | | **7** |
| Study of Epidemiology, Morphology, Life Cycle, Pathogenicity, Diagnosis and Control mechanisms of *Entamoeba histolytica, Leishmania donovani, Plasmodium vivax, Plasmodium falciparum* | | |
| **Unit 3: Parasitic Platyhelminthes** | | **8** |
| Study of Epidemiology, Morphology, Life Cycle, Pathogenicity, Diagnosis and Control mechanisms of *Schistosoma haematobium* and *Echinococcus granulosus* | | |
| **Unit 4: Parasitic Nematodes** | | **8** |
| 1. Study of Epidemiology, Morphology, Life Cycle, Pathogenicity, Diagnosis and Control mechanisms of *Ascaris lumbricoides and Ancylostoma duodenale*<br>2. Study of structure, lifecycle and importance of *Meloidogyne incognita* (root-knot nematode) | | |
| **Unit 5: Parasitic Arthropods** | | **8** |
| Biology, importance and control of ticks (*Ixodes* sp.), mites (*Sarcoptes* sp.), Lice (*Pediculus* sp.) | | |
| **Unit 6: Parasitic Vertebrates** | | **3** |
| Brief account of parasitic nature of Cookiecutter Shark, Hood Mocking bird, Vampire bat | | |
| **Unit 7: Parasitic Adaptation and host relation** | | **4** |
| 1. Parasitic adaptation in Helminths<br>2. Host parasitic interactions | | |

## Parasitology Lab; CC-6-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |
| **1. Identification** of *Entamoeba histolytica, Leishmania donovani, Plasmodium vivax* through permanent slides/microphotographs<br>**2. Identification** of *Schistosoma haematobium*, *Echinococcus granulosus* through permanent slides/microphotographs<br>**3. Identification** of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* through permanent slides/photographs<br>**4. Isolation, Fixation, Staining and Mounting** of Protozoa *(Nyctotherus sp/ Balantidium sp.)* and Helminth ( *Leidynema* sp.) from gut of Cockroach *(Periplaneta americana)*<br>**5. LNB** | | |

# PART II: SEMESTER-IV

## CORE COURSE-7: Molecular Biology
## CC7 THEORY

| Full Marks 75 | 3 Credits | 45 Hours |
|---|---|---|
| **Unit 1: Nucleic Acids** | | **3** |
| Structure and composition of DNA: Chargaff's Rule; Hypo and Hyperchromic shift; Watson and Crick Model of the Three-Dimensional Structure of DNA. Different forms of DNA-A, B and Z DNA (comparative overview)<br>RNA as the Genetic Material, Types and Function. | | |
| **Unit 2: DNA Replication** | | **8** |
| Meselson–Stahl Experiment, DNA Replication in Prokaryotes [Bidirectional and discontinuous]; Enzymes/Proteins associated with Replication -Polymerase [I, II & III], Primase, Helicase, SSB, DNA ligase; RNA priming; End replication Problem and Replication of telomeres in eukaryotes. | | |
| **Unit 3: Transcription** | | **6** |
| Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription. | | |
| **Unit 4: Post Transcriptional Modifications and Processing of Eukaryotic RNA** | | **6** |
| Capping and Poly A tail formation in mRNA; Concept of introns and exons and Split genes; Splicing mechanism [Intron Removal by Spliceosome]; RNA editing (gRNA mediated and cytidine deaminase mediated) | | |
| **Unit 4: Translation** | | **6** |
| Genetic code; Characteristics of the Genetic Code; Aminoacylation of a tRNA molecule; Mechanism of protein synthesis in prokaryotes. | | |
| **Unit 6: Gene Regulation** | | **8** |
| Regulation of Transcription in prokaryotes: *lac* operon and *trp* operon (Attenuation control);<br>Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing.<br>Epigenetic Regulation: DNA Methylation (by DNMT), Histone Methylation (by HMT) & Acetylation (by HAT and HDAC). | | |
| **Unit 7: DNA Repair Mechanisms** | | **4** |
| Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair | | |
| **Unit 8: Molecular Techniques** | | **4** |
| • Principle and use of Agarose Gel Electrophoresis<br>• Principle and use of SDS PAGE<br>• Blot Technique: Southern, Northern and Western Blot<br>• PCR: Basic Principle, Reverse Transcriptase-PCR | | |

## Molecular Biology Lab; CC-7-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |
| **1. Isolation of genomic DNA** from Goat Liver by phenol-chloroform method.<br>**2. Quantification of DNA** by diphenylamine (DPA) method.<br>**3. Agarose Gel Electrophoresis**.<br>**4. Concept of buffer preparation** and related calculation and dilution.<br>**5. Instruments and accessories** used to be shown by photographs for the following techniques: PCR, SDS PAGE, Western Blot, Southern Blot.<br>**6. LNB** | | |

# PART II: SEMESTER-IV

## CORE COURSE-8: Ecology

### CC8 THEORY

| Full Marks 75 | 3 Credits | 44 Hours |
|---|---|---|
| **Unit 1: Introduction to Ecology** | | **5** |
| Autecology/Synecology. Laws of Limiting factor. Temperature as limiting factor (effect on plant and animal metabolism, Bergman's rule, Jordan's, rule, Allen's rule, Rensch's rule). Light as limiting factor (photo periodism in plants and animals). | | |
| **Unit 2: Energy Flow in Ecosystem** | | **8** |
| Functional components of Ecosystem: Energy flow (Universal model and Y shaped model, Ten percent law of energy flow); Productivity (Primary and secondary) and ecological efficiencies. Types of Ecological Pyramids with examples; Food chain (Detritus Food Chain and Grazing Food Chain); Food web and types; Bio geochemical cycles (Nitrogen cycle). | | |
| **Unit 3: Population Ecology.** | | **7** |
| Definition and properties (Natality, mortality, Density, Biotic potential, Age structure, survivorship curves, Growth curves with equations); Population regulation (density dependent and independent); r- and k – strategies. | | |
| **Unit 4: Niche and Competition** | | **8** |
| Definition of Habitat and Niche, Types of Niche, N-dimensional niche concept; Niche overlap and resource partitioning, Competition and exclusion principle, Gause's and Connell's Field experiment, niche segregation and character displacement, Lotka Volterra equation for competition. Habitat Ecology – Metabolism and Ecosystem services of Tropical Rain forest and Wetlands. | | |
| **Unit 5: Community Ecology** | | **4** |
| Community; Definition and types; Stratification, species richness and Evenness; Dominance – Diversity Analysis, Interspecific interaction within equilibrial communities (definition and examples). | | |
| **Unit 6: Ecological Succession** | | **4** |
| Definition of succession, Types of succession, Seral stages of succession with special reference to Hydrosere and Lithosere; Models of ecological succession; Resource-Ratio Hypothesis. | | |
| **Unit 7: Pollution Biology** | | **8** |
| Definition, Types of Pollutants (primary and secondary with examples); Causes and effects of acid rain, photochemical smog, ozone layer depletion and eutrophication; Cause and effects of heavy metal pollution in water (Pb, As, Hg); Groundwater Pollution; Concept of Bioconcentration and Biomagnification. | | |

## Ecology Lab; CC-8-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |
| 1. **Quantitative Estimation** of Dissolved $O_2$ (Winkler's method), Free $CO_2$, Alkalinity from the provided water sample and comment on the observation.<br>2. **Estimation** of pH value of the provided water sample.<br>3. **Identification** with reasons of the following zooplanktons: *Daphnia, Cyclops, Cypris*<br>4. **Identification** with reasons of the following soil arthropods: Collembola, termite worker, ant<br>5. **Study of life table and survivorship curve** from a hypothetical data set and comment on the results.<br>6. **LNB** | | |

# SUGGESTED REFERENCES

## CORE COURSE-3: GENETICS


1. Genetics-**Strickberger** 3rd edition
2. iGenetics-**Russell** 3rd edition
3. Genetics-**Benjamin A Pierce** 7th Edition
4. Concepts of Genetics- **Klug and Cummings** 12th Edition
5. Principles of Genetics, 7th Edition, **Snustad and Simmons**.
6. An Introduction to Genetic Analysis, 12th Edition, **Griffith et al.**
7. Schaum's Outlines of Genetics, 5th Edition, **Stansfield**.
8. Problems on Genetics, Molecular Genetics and Evolutionary Genetics, 2nd Revised edition**, P.K. Banerjee**


## CORE COURSE-4: CELLS AND TISSUE STRUCTURE


1. Junqueria LC, Carneiro J. 2005. Basic histology text and atlas
2. Ross M H, Pawlina W. 2010. Histology: A Text and Atlas. Lippincott Williams and Wilkins
3. Don W. Fawcett and William Bloom 1998: a textbook on histology
4. John D. Bancroft 2019: Theory and practice of histology
5. Kiernan J. A. 2001: Histology and histochemical methods 3rd edition


## SEC-3: POULTRY FARMING AND ANIMAL HUSBANDRY


1. J. Prasad (2015) Poultry Production and Management, Kalyani Publisher
2. N. Ghosh (2015) Poultry Science and Practice, CBS Publishers and Distributors
3. I. B. Singh (2000) Poultry, Fisheries, Bee Keeping and Sericulture in India, Pushal Publications and Distributors, Varanasi
4. P.V. Sreenivasaiah (2015) Text Book of Poultry Science, published by Hitesh Mittal for Write and Print Publications, H.13, Balinagar, New Delhi
5. G.C. Banerjee (2000) A Text Book of Animal Husbandry, 8th Edn., Oxford and IBH Publishing Company Pvt. Ltd., New Delhi
6. D.N. Pandey (1995-1996) Animal Husbandry and Veterinary Science, 15th Edn., Published by Jai Prakash Nath and Company, Meerut.
7. P.R. Gupta (2007) Dairy India Yearbook


## CORE COURSE-5: NON-CHORDATE STRUCTURE AND FUNCTION


1. E. E. Ruppert and R.D. Barnes (1994) Invertebrate Zoology, 6th Edition. Harcourt Asia PTE Ltd. Singapore.
2. R. C. Brusca and G.J. Brusca (2003) Invertebrates, 2nd Edition, Sinauer Associates, Inc., Publishers, USA
3. Chapman, R.F. (2012). The Insects: Structure and function 5th Edition, Cambridge University Press. UK
4. L. L. Jordan and P. S. Verma (2002) Invertebrate Zoology. S. Chand and Company Ltd., New Delhi
5. K. K. Chaki, G. Kundu and S. Sarkar (2005) Introduction to General Zoology. New Central book Agency (P) Ltd. Kolkata.
6. R.L. Kotpal (2012) Modern Text Book of Zoology Invertebrates (Animal Diversity I) Rastogi Publications, Meerut 250002, India.


## CORE COURSE-6: PARASITOLOGY


1. Ahmed N, Dawson M, Smith C, Wood Ed. 2007. Biology of Disease. Taylor and Francis Group.
2. Arora D R, Arora B. 2001. Medical Parasitology. II Edition. CBS Publications and Distributors
3. Bogitsch, B J, Carter CE, Oeltmann TN. (2013): Human Parasitology. 4th Edn. Elsevier.
4. Bose M (2017).Parasitoses and zoonoses. New Central Book Agency. 1:3-808
5. Chakraborty, P. (2016): Textbook of Medical parasitology, 3rd edition. New Central Book Agency.
6. Chatterjee K D. 2009. Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers
7. Cheng, T.C., (1986): General Parasitology. Academic Press.
8. Dailey MD. 1996. Meyer, Olsen & Schmidt's Essentials of Parasitology. W.C. Brown Publishers
9. Gunn A, Pitt SJ. 2012. Parasitology: an Integrated Approach. Wiley Blackwell.
10. Hati AK. 1979. Medical Entomology. Allied Book Agency
11. John DT, Petri WA. 2006. Markell and Voge's Medical Parasitology. Elsevier.
12. Roberts, L.S and Janovy, J. (2009). Smith & Robert's Foundation of Parasitology. 8th. Edn. McGraw Hill
13. Smyth JD ( 2012 ): Introduction to animal parasitology. Cambridge Low Priced Edition.

**CORE COURSE-7: MOLECULAR BIOLOGY**


1. Genetics-**Strickberger** 3rd edition
2. iGenetics-**Russell** 3rd edition
3. Genetics-**Benjamin A Pierce** 4th Edition
4. Concepts of Genetics- **Klug and Cummings** 12th Edition
5. Molecular Biology of the Gene-**Watson** 7th Edition
6. Cell Bruce-Alberts 6th Edition
7. Molecular Biology- **Weaver** 5th Edition
8. Principles and techniques of Biochemistry and Molecular Biology- **Walker and Wilson** 8th Edition


**CORE COURSE-8: ECOLOGY**


1. Allen Cain M L, Bowman W D and Hacker S D. 2013. Ecology. 3rd ed. Sinauer associates.
2. Begon M, Harper J L. Townsend CR. 2006. Ecology: Individuals, Populations & communities. 4th Ed.
3. Chapman RL, Reiss MJ. 2000. Ecology-Principles & Application. Cambridge University Press.
4. Colinvaux P. 1993. Ecology 2. John Wiley & Sons, Inc. New York.
5. Faurie C., Ferra C., Medori P., Devaux J. 2001. Ecology-Science and Practice. Oxford & IBH Pub. Company.
6. Kormondy E.J. 2002. Concepts of Ecology. 4th Indian Reprint, Pearson Education.
7. Maiti,P.K. and Maiti,P. 2023. Biodiversity, Perception, Peril and Preservation. PHI, Learning Pvt, Ltd.
8. Molles Jr. MC. 2005. Ecology: Concepts and Applications. 3rd Ed. McGraw-Hill.
9. Odum E.P, Barret GW. 2017. Fundamentals of Ecology. 15th Indian reprint. Cengage learning India Ptd. Odum E.P. 2008. Fundamentals of Ecology. Brooks/Cole
10. Ricklefs . R.E. Miller, G.L. 2000. Ecology. 4th Ed. W. H. Freeman and Company.
11. Russel P.J, Wolfe LS, Hertz PE, Starr C, McMillan B. 2009. Ecology. Cengage Learning,
12. Smith T.M, Smith R L. 2006. Elements of Ecology. 6th Ed. Pearson Education.
13. Stiling P. 2009. Ecology - Theories and Applications. 4th Ed. Prentice Hall of India.
14. Townsend, C.; J. L. Harper, M. Begon – Essentials of Ecology, Blackwell Publishing.


**FOR LABORATORY COURSE.**


1. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
2. Manna, B and Manna, S. (2019): Advanced Laboratory Manual of Parasitology and Immunoparasitology, New Central Book Agency, Kolkata
3. Poddar, T., Mukherjee, S., Das, S.K. (2003) Macmillan Publishers India Limited. An Advanced Laboratory Manual Of Zoology.
4. Mazumder, Bhowal, Chatterjee, Saha (2020) Zoology in Laboratory. Satra Publication.
5. D.K. Som, S. K. Bhowal, N. Ghosh, and A. Mukherjee (2024) A Concise Text Book on Practical Zoology. 1st Edition, Rainbow Publishers, Kolkata 700014, India.
6. S. S. Lal (2012) Practical Zoology. Volume 1 Rastogi Publications, Meerut 250002, India.
7. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
8. Manna, B and Manna, S. (2019): Advanced Laboratory Manual of Parasitology and Immuno-parasitology, New Central Book Agency, Kolkata
9. Sinha J K, Chatterjee A K. and Chattopadhyay P. – Advanced Practical Zoology .New Central Book Agency

# PART III: SEMESTER-V

## CORE COURSE-9: Chordate Structure and Function
### CC 9 THEORY

| Full Marks 75 | 3 Credits | 45 Hours |
|---|---|---|
| **Unit 1: Introduction to Phylum Chordata** | | **4** |
| Theories of Origin of chordates with reference to Dipleurula concept and the Echinoderm theory; General characteristics and outline classification (J.Z. Young, 1981). | | |
| **Unit 2: Protochordata, Agnatha and Pisces** | | **8** |
| Protochordata and Agnatha: General characters and classification up to class (J.Z. Young, 1981); Structure of pharynx and feeding in *Branchiostoma*; Retrogressive metamorphosis in *Ascidia*;<br>Pisces: General characters and classification of Chondrichthyes and Osteichthyes upto class (J.Z. Young, 1981); Swim bladder in fishes; Structure of gills in cartilaginous and bony fishes; Accessory respiratory organs; Olfactory apparatus in *Tilapia*; Electric organ in *Torpedo*. | | |
| **Unit 3: Amphibia and Reptilia** | | **7** |
| Origin of Tetrapods (Evolution of terrestrial ectotherms); General characteristics and classification of Amphibia and Reptilia up to living Orders (J.Z. Young, 1981); Structure, function and derivatives of integument in amphibia; Paedomorphosis in Axolotl; Poisonous and Non-Poisonous snake; Poison apparatus and Biting mechanism in Snake. | | |
| **Unit 4: Aves and Mammalia** | | **8** |
| General characteristics and classification of Aves and Mammalia up to living Sub-Classes (J.Z. Young, 1981); Exoskeleton in Birds; Air-sacs in Pigeon, Aerodynamics of flight in birds; Exoskeleton derivatives of mammals; Dentition in mammals; Ruminant stomach; Echolocation in Micro-chiropterans. | | |
| **Unit 5: Comparative anatomy in chordates** | | **10** |
| Heart and Aortic arches; Brain with reference to cerebrum & cerebellum; kidneys and urino-genital ducts. | | |
| **Unit 6: Skeletal system** | | **8** |
| Jaw suspension in vertebrates; A brief account of axial skeleton and appendicular skeleton: types of skull with reference to temporal vacuities; vertebrae (structure, types based on centrum and regional specialization in mammals); structure of girdles (pectoral and pelvic girdles of Pigeon and Guinea pig) and limb bones (Toad, Pigeon and Guinea pig). | | |

## Chordate Structure and Function Lab; CC-9-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |

1. Identification (upto order) with Reasons (Preserve specimen or Photograph) **Protochordata**: *Herdmania, Branchiostoma*, **Agnatha:** *Petromyzon, Myxine*; **Pisces**: *Scoliodon, Pristis, Hippocampus, Echeneis, Tetradon, Taractes*; *Tenualosa, Wallagu, Ompok*; **Amphibia**: *Necturus, Duttaphrynus, Rhacophorus, Hoplobatrachus, Ambystoma, Tylototriton*, ; **Reptilia**: *Chelone, Hemidactylus, Varanus, Calotes, Chamaeleon, Draco, Vipera, Hydrophis, Bungarus;* **Aves**: *Columba, Psittacula, Passer, Alcedo* **Mammalia**: *Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus, Cavia.*
2. Mounting of Placoid, Cycloid and Ctenoid scales.
3. Osteology: Identification of Limb bones, vertebrae and girdles of *Duttaphrynus, Columba, Cavia*; skull of *Duttaphrynus, Trionyx, Columba, Cavia, Canis.*
4. Comparative study of heart and brain, with the help of model/pictures.
5. Anatomy study: Brain, pituitary, olfactory apparatus (ex situ), digestive and urino-genital system of *Tilapia*
6. Pecten from Fowl head.
7. **LNB**

# PART III: SEMESTER V

## CORE COURSE-10: Endocrinology and Reproductive Biology

### CC 10 THEORY

| Full Marks 75 | 3 Credits | 40 Hours |
|---|---|---|
| **Unit 1: Introduction to Endocrinology** | | **2** |
| General idea of Endocrine system; Classification (with examples) &Transport of Hormones. | | |
| **Unit 2: Hypothalamo-Hypophyseal Axis** | | **5** |
| Hypothalamic nuclei: Name, Secretion and Function; Feedback mechanism with Hypothalamo-hypophyseal – gonadal axes.<br>Chromophobes and chromophils of anterior pituitary with their hormone and functions, Posterior pituitary: hormones and functions in brief, Hypothalamo-hypophyseal portal system. | | |
| **Unit 3: Regulation of Hormone Action** | | **5** |
| Receptors: Steroid hormone receptor, Isoreceptor, Orphan receptor<br>Mechanism of action of steroidal, non-steroidal hormones with receptors (cAMP, IP3-DAG) | | |
| **Unit 4: Thyroid gland and parathyroid gland** | | **5** |
| Histology of thyroid gland (LM and TEM study); Biosynthesis of thyroxine; Role of thyroxin in calorigenesis and metabolism (carbohydrate, protein and fat).<br>Role of thyrocalcitonin and parathormone in calcium homeostasis with special emphasis on vitamin D3. | | |
| **Unit 5: Adrenal gland** | | **5** |
| Histology of adrenal gland (LM study), Corticoid hormones with source, structure and function, Biosynthesis of adrenaline and nor adrenaline, Function of adrenaline; Generalised Adaptation Syndrome. | | |
| **Unit 6: Pancreas** | | **5** |
| Histology of pancreas (LM study) mentioning cell types with their hormone and function, Biosynthesis of insulin, Role of insulin and glucagon on carbohydrate homeostasis. | | |
| **Unit 7: Pineal gland** | | **3** |
| Histology of pineal gland (TEM study), Melatonin: Biosynthesis and its role in vitellogenesis in fish**.** | | |
| **Unit 8: Reproductive endocrinology** | | **5** |
| Histology of testis and ovary (LM study), Biosynthesis of estrogen and testosterone, Effect of testosterone on prostate function, Effect of estrogen on uterus.<br>Lactation and its hormonal control<br>Parturition and its hormonal control | | |
| **Unit 9: Endocrine disorders** | | **2** |
| Cause, Symptoms and Treatment: Graves' disease, Type I and type II diabetes, Cushing Syndrome | | |
| **Unit 10: Endocrine regulation of insect metamorphosis** | | **3** |
| Endocrine glands; hormones and physiology of metamorphosis in insects | | |

## Endocrinology and Reproductive Biology Lab; CC-10-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |

**1.** Demonstration to localize thyroid, pancreas, adrenal, ovary and testis in rat.

**2.** Identification with reasons: Histological section of thyroid, pancreas, adrenal, ovary and testis of rat.

**3.** Analysis and interpretation of clinical condition from the provided blood sample data

a) $T_3$, $T_4$, TSH and TPO

b) Insulin, blood glucose and HbA1C

**4.** Haematoxylin-Eosin (HE) staining of histological section: Mammalian thyroid, adrenal, pancreas, testis and ovary.

**5. LNB**

# PART III: SEMESTER V

## CORE COURSE-11: Animal Physiology

### CC 11 THEORY

| Full Marks 75 | 3 Credits | 45 Hours |
|---|---|---|
| **Unit 1: Physiology of Digestion** | | **6** |
| Anatomy of alimentary system in human; Mechanical digestion and chemical digestion of Carbohydrates, Lipids and Proteins in Human; Absorption of simple sugars, amino acids and fat;<br>Role of GI hormones in digestion: source and function of Gastrin, Secretin, CCK – PZ, Motilin. | | |
| **Unit 2: Physiology of Respiration** | | **6** |
| Anatomy of respiratory system in human; Mechanism of breathing; Pulmonary volumes and capacities; Transport of Oxygen and Carbon dioxide in blood; Oxygen Dissociation curve and the factors influencing it (Bohr effect and Haldane effect); Carbon monoxide poisoning. | | |
| **Unit 3: Physiology of Circulation** | | **8** |
| Structure of hemoglobin, R and T form of hemoglobin; Hemostasis and Mechanism of blood clotting [pathways and clotting factors (I -XIII)]; Hematopoiesis: Basic steps;<br>Blood groups: ABO and Rh factor; Erythroblastosis foetalis, Bombay phenotype;<br>Structure of human heart and conducting system of human heart; Cardiac Cycle and its events: Cardiac output and Strokes volume. | | |
| **Unit 4: Renal Physiology** | | **8** |
| Anatomy of Kidney and histology of nephron with reference to JGA;<br>Ammonotelic, ureotelic and Uricotelic animals with examples; Steps of urea cycle;<br>Mechanism of urine formation: Glomerular filtration, obligatory and facultative water reabsorption and sodium dependent reabsorption, Counter-current mechanism;<br>Role of ADH and RAAS in urine formation; Osmoregulation in marine (elasmobranch and teleost) and freshwater (teleost) fishes; Case study: Osmoregulation in Eel and Salmon. | | |
| **Unit 5: Neurophysiology** | | **5** |
| Structure of neuron; Mechanism of impulse propagation across the myelinated and non-myelinated nerve fibres; Synapse: Chemical and Electrical; Mechanism of Synaptic transmission. | | |
| **Unit 6: Muscular physiology** | | **5** |
| Structure of muscle protein and their role along with calcium and ATP in muscle contraction (excitation-contraction-coupling); Muscle twitch, Muscular fatigue. | | |
| **Unit 7: Thermoregulation** | | **3** |
| Definition and example of Aestivation and hibernation; Thermoregulation in camel, polar bear. | | |
| **Unit 8: Reproductive physiology** | | **4** |
| Menstrual cycle: stages with ovarian, uterine and hormonal changes.<br>Estrous cycle: Stages with ovarian, vaginal and hormonal changes. | | |

### Animal Physiology Lab; CC-11-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|

**List of Practical**

1. Determination of ABO Blood group and Rh factor.
2. Identification of blood cells from human blood film (permanent slide).
3. Staining, mounting and identification of haemocytes from cockroach haemolymph.
4. Preparation of haemin crystals from rat blood.
5. Demonstration of blood pressure by digital meter.
6. Qualitative tests for Ammonia, Urea and Uric acid in given sample.
7. **LNB**

# PART III: SEMESTER V

## CORE COURSE-12: Biodiversity and Conservation Biology

### CC 12 THEORY

| Full Marks 75 | 3 Credits | 45 Hours |
|---|---|---|
| **Unit 1: Introduction to Biodiversity** | | **10** |
| Definition, Biodiversity Values: Direct and Indirect values, Types of Biodiversity, Depicting Species Diversity at alpha diversity, beta diversity and gamma diversity;<br>Biodiversity indices: Shannon diversity index, Simpson's diversity indices; Genetic Diversity: significance in Biodiversity persistence, Consequences of loss of Genetic diversity; Ecosystem diversity: Basic concept of Structural and Functional Diversity with significance;<br>Mega-diversity countries; Concept of endemism and Biodiversity Hot spot; Indicator Species, Flagship species, Keystone species, Umbrella species (definition with examples). | | |
| **Unit 2: Threats to biodiversity** | | **7** |
| Habitat loss, Habitat Degradation, Habitat Fragmentation and Edge effects in Ecotonal communities; Overexploitation of Natural Resource;<br>Concept of Exotic or Invasive Species;<br>Climate change: Cause and effects on Forest and Marine Ecosystems;<br>Climate change effect on Indian Fauna. | | |
| **Unit 3: Wild life conservation. In situ Conservation.** | | **15** |
| Definition of Conservation; Red data book (Extinct, Threatened, Endangered, Rare, and Vulnerable); Indian Wild life Protection Act, 1972 and Schedules I -V (mammalian examples any 2); Concept of Population Viability Analysis.<br>Wildlife Conservation methods: In Situ Conservation; Concept and Design of Protected Areas, National Park, Wildlife Sanctuary, Biosphere reserves (with examples);<br>Tiger Project; Elephant Project; (History, Objective, Implementation, Tiger Crisis); Concept of Corridors; Advantages and disadvantages of Wildlife corridors;<br>Causes and consequences of Human-wildlife conflicts; Mitigation of conflict – an overview;<br>Joint Forest Management; People's Biodiversity Register. | | |
| **Unit 4: Ex situ Conservation.** | | **7** |
| Captive breeding of wild animals: Concept of captive breeding; Advantages and challenges of Captive Breeding; Re-introduction. | | |
| **Unit 5: Wildlife Laws** | | **7** |
| Convention on Biodiversity; Biodiversity Act, 2002 and Rules 2004 (Basic Concept);<br>Wildlife trade and impacts: The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITIES) and Wildlife Trade Monitoring Network (TRAFFIC); IUCN, WWF (Basic concept). | | |

# Biodiversity and Conservation Biology Lab; CC-12-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|

## List of Practical

1. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance: Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various DSLR Camera.[Photographs may be used]
3. Familiarization and study of animal secondary evidences (through photographs); Identification of animals through pug marks of tiger and leopard, hoof marks of deer and elephant, scats of tiger and elephant, antler and horn
4. Biodiversity study of in any one of the ecosystems of West Bengal ( Study A is mandatory and any two studies from the rest)
   A. Check list of fauna should be prepared along with calculation of any diversity index.
   B. Bird Count using line transect.
   C. Tree height measurement,
   D. Measurement of canopy cover.
   E. Butterfly Sampling.
   F. Pitfall sampling
   G. Quadrat Sampling
5. **LNB**

# PART III: SEMESTER-VI

## CORE COURSE-13: Developmental Biology

### CC 13 THEORY

| Full Marks 75 | 3 Credits | 43 Hours |
|---|---|---|
| **Unit 1: Gametogenesis** | | **5** |
| Origin and fate of Primordial Germ Cells; Structure of mammalian sperm and ovum; Spermatogenesis in mammals, Stages of Spermiogenesis, Spermiation; Oogenesis in mammal; Composition of yolk and polarity and types of egg (based on amount of yolk and its distribution). | | |
| **Unit 2: Fertilization** | | **4** |
| Internal and external fertilization; Phases of fertilization in sea urchin and mammal. | | |
| **Unit 3: Post Fertilization events** | | **10** |
| Cleavage: Types based on plane and pattern, Role of yolk in cleavage.<br>Blastula formation in chick.<br>Gastrulation: Definition, Morphogenetic movement (epiboly, emboly, invagination, ingression, involution, delamination) with special reference to Nieuwkoop centre and Koller's sickle; Process of gastrulation in chick; Process of Gastrulation in frog; Fate map in chick embryo, fate mapping using vital dye technique.<br>Extra embryonic membranes in chick and their functions. | | |
| **Unit 4: Organogenesis** | | **8** |
| Induction and its types; Organizer concept, Competence, Spemann and Mangold experiment as Origin of organizer concept; Concept of molecular nature of organizer molecules (signaling/molecular mechanism excluded).<br>Development of eye in chick: retina, optic cup, lens with special reference to induction.<br>Development of Kidney: Different phases and reciprocal induction. | | |
| **Unit 5: Implantation** | | **4** |
| Implantation in humans: Types and hormonal control.<br>Placenta: Structure, types based on histological association and distribution of villi; functions of placenta. | | |
| **Unit 6: Infertility and ART** | | **4** |
| Causes of infertility; Types of ART (ZIFT, GIFT, ICSI, IUI); Cryopreservation of gametes;<br>IVF: method, advantages and disadvantages. | | |
| **Unit 7: Stem cells and its application** | | **4** |
| Definition, Types with examples, concept of potency, applications of stem cell therapy in bone marrow transplantation and cartilage regeneration. | | |
| **Unit 8: Regeneration** | | **4** |
| Regeneration: Morphallaxis and Epimorphosis in *Hydra*; Epimorphic limb regenerations in Salamander. | | |

## Developmental Biology Lab; CC-13-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |

1. Study of whole mounts of developmental stages of chick embryo through permanent slides: 24, 48, 72 and 96 hours of incubation
2. Study of the developmental stages and life cycle of *Drosophila* and frog using photographs
3. Study of different sections of placenta (photograph)
4. Identification of larva through slides – *Nauplius*, Zoea, Veliger, Glochidium, Megalopa, Mysis, Trochophore.
5. Mounting of rat sperm and fish ova
6. **LNB**

# PART III: SEMESTER VI

## CORE COURSE-14: Taxonomy, Evolution and Adaptation

### CC 14 THEORY

| Full Marks 75 | 3 Credits | 45 Hours |
|---|---|---|
| **Unit 1: Taxonomy 1: Basics of Taxonomy and Systematics** | | **5** |
| **Taxonomy and Systematics:** definition and importance; Binomial and Trinomial nomenclature; Law of priority; Homonymy and Synonymy**:** definition with example. **Taxonomic types:** Holotype, Paratype, Allotype, Lectotype, Neotype and Syntype: definition with example; **Linnean Hierarchy**; Biological Species concept and its limitations. | | |
| **Unit 2: Taxonomy 2: Character and Character states** | | **3** |
| **Types of characters with examples:** Primitive, Advance, convergence, parallelisms, reversal of characters; Outgroup and ingroup; Homology versus Analogy; Monophyly, Polyphyly and Paraphyly: definition with examples. | | |
| **Unit 3: Taxonomy 3: Approaches in Classification** | | **6** |
| **Classification**: Definition; **Phenetics:** Definition, OTU, Single linkage clustering and construction of phenogram; **Cladistics:** Definition**,** brief concept on parsimony; DNA Barcoding and application**.** | | |
| **Unit 4: Evolution 1: Gene frequency in a Population and Factors influencing gene frequency** | | **8** |
| Hardy-Weinberg Principle: Assumption, proof of equilibrium, calculation of gene frequency and genotype frequency (for autosomal gene only), testing for equilibrium; Equilibrium destabilizing forces: concept and mathematical expression of Selection (against deleterious recessive allele only); Mutation (changes from dominant to recessive allele only) and Migration. | | |
| **Unit 5: Evolution 2: Concept of Organic Evolution** | | **7** |
| **Biochemical Origin of life**: concept of Protenoids, Microspheres and Protobionts; RNA-world Hypothesis; Darwinism and its limitations; **Modern Synthetic Theory of Evolution**: Sources of variation; Natural selection (types with example); Genetic drift and population bottle neck; Isolation (types with examples); **Speciation**: types and examples. | | |
| **Unit 6: Evolution 3: Evidences** | | **7** |
| **Biogeographical realms**: definition, names of six realms; geographical limit, climate and important vertebrate fauna of Oriental, Palaearctic and Australian realms; **Geological time scale** (only outline idea; detail description not needed); **Fossil**: types and age determination by Carbon dating; **Evolution of horse**; **Evolution of Man.** | | |
| **Unit 7: Adaptation 1: Basics of adaptation** | | **4** |
| Adaptation: definition; adaptive convergence, adaptive divergence: definition with examples; Adaptive radiation in marsupial mammals and Darwin's finches. | | |
| **Unit 8: Adaptation 2: Form of adaptation** | | **5** |
| Cursorial adaptation; Fossorial adaptation; Desert adaptation; Primary and secondary aquatic adaptation, Colouration and Mimicry. | | |

### Taxonomy, Evolution and Adaptation Lab; CC-14-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|
| **List of Practical** | | |

1. Study of fossils from models/ pictures: *Dickinsonia*, *Paradoxides* (Trilobita), *Asteroceras* (Ammonoid), *Pentremites* (Blastoid Echinoderm), Ichthyosaur, *Archaeopteryx*, Cynodont.
2. Study (from preserved specimen or photographs) of features and their adaptive significance : *Labeo rohita*, *Exocoetus* sp.(Flying fish), *Cynoglossus* sp. (Flat fish, Bengal tongue-sole), *Torpedo* sp. (Electric ray), *Himantura* sp. (Sting-ray of Bay of Bengal), *Sphyrna* sp. (hammer-headed shark), *Ichthyophis* sp.,

Axolotl larva of *Ambystoma* sp., *Hyla* sp., *Phrynosoma* sp., *Crocodylus* sp., *Naja* sp., *Pipistrellus* sp. (Indian common Microchiroptera), *Bandicota* sp., *Platinista* sp. (Gangetic dolphin), *Semnopithecus* sp. (Hanuman Langur).

3. *****Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony, Construction of dendrogram following principles of phenetics & cladistics from a data table.
4. *****Calculation of change in gene frequency in population due to Selection (against deleterious recessive trait only), Mutation (changes from dominant to recessive trait only), Migration.
5. **LNB**.

*Only for major course students

# PART III: SEMESTER VI

## CORE COURSE-15: Animal Behaviour

### CC 15 THEORY

| Full Marks 75 | 3 Credits | 44 Hours |
|---|---|---|
| **Unit 1: Introduction to Animal Behaviour** | | **5** |
| Contribution of Konrad Lorenz, Karl Von Frisch and Niko Tinbergen; Three foundations of behaviour study: Natural selection, individuals learning and cultural transmission; Approaches in behaviour study: Conceptual, theoretical and empirical. | | |
| **Unit 2: Patterns of Behaviour** | | **6** |
| Stereotyped Behaviours (Orientation and Reflex): Primary and secondary orientation; Kinesis-orthokinesis, klinokinesis; Taxis: tropotaxis and klinotaxis, menotaxis (light compass orientation).<br>Sign stimulus and Fixed Action pattern in Stickleback; Individual Behavioural patterns;<br>Instinct vs. Learned Behaviour; Associative learning, classical and operant conditioning;<br>Habituation and Sensitisation; Imprinting: Filial and sexual imprinting. | | |
| **Unit 3: Social Behaviour** | | **7** |
| Advantage of group living; Eusociality, Social organisation in termites and Lion pride.<br>Kinship theory: Relatedness & inclusive fitness.<br>Altruism, Selfishness, Hamilton's rule, Reciprocal altruism.<br>Cooperation and co-operative behaviours: Social grooming in Spider monkey, Group Hunting in Hyenas; Aggregations: schooling in fishes, flocking in birds. | | |
| **Unit 4: Sexual Behaviour** | | **7** |
| Sexual dimorphism; Courtship behaviour and Mate choice; Good genes model in sexual selection; Runaway Sexual Selection Hypothesis.<br>Intra-sexual selection (male rivalry in Red Deer); Inter-sexual selection (female choice in peacock);<br>Definition with example: Monogamy, polygamy and Polyandry. | | |
| **Unit 5: Evolutionary Strategies** | | **8** |
| Concept of Parental care and parental investment: Parental care in fishes: oviparity, viviparity and ovoviviparity, nest building behavior of fish and amphibia; Cost and benefit of parental care by male fish;<br>Parent-offspring conflict, Infanticide; sexual conflict in parental care;<br>Territorial behaviour in monkey.<br>Evolutionary Stable strategies (ESS): Hawk–Dove Model. | | |
| **Unit 6: Biological Rhythm** | | **5** |
| Types and characteristics of biological rhythms; Photic and non-photic zeitgebers; Concept of synchronization and masking; Biological oscillation: the concept of Average, amplitude, phase and period; Adaptive significance of biological clocks.<br>Circa annual rhythm: Case Study-Bird migration;<br>Human biological clock (SCN and melatonin); Sleep-wake cycle and its hormonal regulation;<br>Concept of biological cycle disorders in human (brief idea). | | |
| **Unit 7: Communication** | | **6** |
| Adaptive value of Communication: Example of yelling Raven and related hypothesis.<br>Cost-benefits of Signal producer: Singer birds' advantage, coping with illegitimate receiver by frog.<br>Chemical Communication: Pheromones in social insects: (trail, alarm, sexual, home range making and queen pheromones); Pheromones in Big-cat; Definition and examples of kiromones, Synomones, info-chemicals, semio-chemicals; Bruce effect, Lee boot effect and Whitten effect of pheromones.<br>Tactile Communication: Bee dance language. | | |

## Animal Behavior Lab; CC-15-P

| Full Marks 25 | 1 Credit | 20 Hours |
|---|---|---|

**List of Practical**

1. Demonstration of nests and nesting behavior of the bird through photographs (Pigeon, Crow, Tailor bird, Weaver Bird) and social insects through photographs (Termite, Ant and Honey bee).
2. Study of geotaxis behavior in earthworm and phototaxis behavior in insect larvae.
3. Identification of common behavior (by photographs/video) of Fixed Action pattern in Stickleback & Greylag goose, social grooming in spider monkey, group hunting in Hyenas, schooling in fishes, flocking in birds, male rivalry in Red Deer, parental care in Hippocampus, parental care in tree frog, territorial marking in tiger, following response in chicks.
4. To study circadian functions in humans (daily eating, sleep and temperature patterns).
5. **LNB**

# SUGGESTED REFERENCES


## CORE COURSE-9: CHORDATE STRUCTURE AND FUNCTION

1. Gaslow GE. Analysis of Vertebrate Structure, John Wiley and Sons
2. Jordan EL, Verma PS. 2003.Chordate Zoology. S. Chand & Company Ltd. New Delhi.
3. Kardong K V. 2005. Comparative Anatomy of Vertebrates, Function and Evolution; McGraw-Hill
4. Norman, J.R. A history of Fishes, Hill and Wang Publishers
5. Parker TJ, Haswell W. 1972. Text Book of Zoology, Volume II: Marshall and Willam Eds. Macmillan Pr.
6. Pough H, Christine MJ, Haiser B. 2002. Vertebrate life, VIII Edition, Pearson Internatl.
7. Romer AS, Parsons TS. 1986. The vertebrate body. 6th Ed. Saunders College Publishing
8. Som, D.K., Bhowal, S.K., Ghosh, N. and Mukherjee, A (2024) A concise Text Book on Practical Zoology,
9. Rainbow Publisher, Kolkata
10. Ghosh, K.C. and Manna, B. (2009) Practical Zoology, New Central Book Agency(P) Ltd. Kolkata
11. Young JZ. 1981. The Life of Vertebrates. III Edition. Oxford University press

## CORE COURSE-10: ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY

1. Gardner DG, Shoback D. 2011. Greenspan's Basic and Clinical Endocrinology. McGraw Hill Lange.
2. Hadley ME, Levine JE. 2009. 6th Edn. Pearson
3. Melmed S, Polonsky K, Larsen PR, Kronenberg H. 2016. William's Text Book of Endocrinology. Elsevier.
4. Molina PE. 2013. Endocrine Physiology. McGraw Hill Lange.
5. Norris DO. 2007. Vertebrate Endocrinology. 4th Edn. Elsevier Academic Press
6. Strauss JF, Barbieri RL. 2014. Yen & Jaffe's Reproductive Endocrinology. Elsevier Sounders

## CORE COURSE-11: ANIMAL PHYSIOLOGY

1. Ganong's Review of Medical Physiology; McGraw Hill
2. Hall JE. 2015. Guyton and Hall Textbook of Medical Physiology. Saunders publication.
3. Hill RW, Wyse GA, Anderson M. 2012. Animal Physiology. 3rd Edn. Sineuer Asso
4. Randall D, Burggren W. 2001. Eckert Animal Physiology by. 4th edition. W. H. Freeman.
5. Sembulingam K, Sembulingam P. 2012. Essentials of Medical Physiology. Jaypee Pub, New Delhi
6. Sherwood L. 2013. Human Physiology from cells to systems. 8th Edn. Brooks & Cole
7. Tortora, G.J. and Derrickson, B.H.; 2009. Principles of Anatomy and Physiology, XII Ed, Wiley and Sons, Inc.

## CORE COURSE-12: BIODIVERSITY AND CONSERVATION BIOLOGY

1. Caughley G, Sinclair ARE. 1994. Wildlife Ecology and Management. Blackwell Science
2. Hunter ML, Gibbs JB, Sterling EJ. 2008. Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. BlackwellPublishing
3. Hunter, M. L., J. James & P. Gibbs – Fundamentals of Conservation Biology – John Willey & Sons.
4. Maiti, P. K. and P. Maiti (2017) Biodiversity: Perception, Peril and Preservation in the Indian Perspective. PHI. Leaning Pvt. Ltd. New Delhi. *ISBN 978 – 81-203-4380-1, (3nd Eds)*
5. Majupuria T. C. – Wildlife of India – Techpress, Bangkok
6. Mukherjee A. K. – Endangered animals of India – Z.S.I
7. New T. R. – Invertebrate Surveys for Conservation – Oxford Univ. Pr
8. Saha G. K. & S. Majumdar – Threatened Mammals of India – Daya Publication House
9. Saha GK, Mazumdar S. 2017. Wildlife Biology: an Indian Perspective, PHI Learning,
10. Saharia VB. 1998. Wildlife in India. Natraj Publishers.
11. Sutherland WJ.1997. Eclogical Cencus Techniques, A Handbook. Cambridge University Press.
12. Sutherland WJ.2000. The Conservation Handbook: Research, Management & Policy. Blackwell Sc
13. Van Dyke F. 2008. Conservation Biology: Foundations, Concepts, Application. 2nd Ed. Springer Science Wild life (Protection) Act 1972 – Wild life Society of India (Nataraj Publication)
14. Wilson, E. O. – Biodiversity – National Academic Press Woodroffe R., Thirgood S, Rabinowitz A. 2005. People and Wildlife, Conflict or Co-existence? Cambridge Univ. P 2111

## CORE COURSE-13: DEVELOPMENTAL BIOLOGY

1. Carlson BM. 2014. Human Embryology and Developmental Biology. 5th Edn. Elsevier.
2. Gilbert S.F. 2010. Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers,
3. Slack JMW. 2012. Essential Developmental Biology. Wiley-Blackwell.

4. Wolpert L. 2002. Principles of Development. 2nd Edn. Oxford Univ. Press.

**CORE COURSE-14: TAXONOMY, EVOLUTION AND ADAPTATION**

1. Mayr, E. and Ashlock, P.D. (1992) Principles of Systematic Zoology (2ND Edn.). McGraw Hill, New York
2. Quicke, D.L.J. (1997) Principles and Techniques of Contemporary Taxonomy. (1st Edn) Blackie Academic & Professional, an imprint of Chapman & Hall, London
3. Blackwelder, R.E. (1967) Taxonomy, a Text and Reference book. John Wiley and Sons, New York
4. I.C.Z.N. (1985) International Code of Zoological Nomenclature (3rd Edn) University of California Press, Berkley and Los Angeles.
5. Rosenbaum, P.A. (2011) Volpe's Understanding Evolution. McGraw Hill, New York.
6. Som, D.K., Bhowal, S.K., Ghosh, N. and Mukherjee, A. (2024) A concise Text Book on Practical Zoology. (1st Edn). Rainbow Publishers, Kolkata, India
7. Hall, B.K. (2008) Strickberger's evolution (4th Edn.) Jones and Barlett Publishers, USA
8. Futuyma, D.J. (2024) Evolution (5TH Edn.) Oxford University Press.

**CORE COURSE-12: ANIMAL BEHAVIOR**

1. Alcock J. 2013. Animal Behaviour, Sinauer Associate Inc., USA.
2. Drickamer LC , Vessey SH . 2001. Animal Behaviour. McGraw-Hill
3. Dugatkin LA. 2014. Principles of Animal Behaviour. 3rd Edn. W.W. Norton and Co.

# UNIVERSITY OF CALCUTTA

## MODALITIES OF INTERNSHIP IN ZOOLOGY

### Guidelines for the Summer Internship/Apprenticeship Programme (of 3 years Credits) for the students of Zoology

### DURATION OF INTERNSHIP:
### 15 days (60 working hours) from 16th May to 30th May each year

### FULL MARKS: 75 MARKS

Students may undergo internship/apprenticeship in a farm/industry/organization or training in the laboratories under the supervision of any faculty members/researchers in their OWN/other HEIs/research Institutions/ during the summer term. One/two/more of the following activities can be chosen during the training period.

**ACTIVITIES**

1. Biodiversity study of birds/butterfly/insects - campus/local area
2. Laboratory exposure [self/other HEI Institutes] inclusive of
    a. Laboratory reagents Preparation
    b. Handling of Instruments
    c. Museum maintenance [preserving and cataloging specimens]
    d. Data analysis
    e. Report Preparation
3. Field based survey/minor projects to study any branch of Zoology/Allied sciences [like Ecological survey/Epidemiological study/Nutritional assessment of the local area of the candidate.
4. Service-Learning projects involving community on any aspect of Zoology [examples: Water quality assessment of community; Assessment of vectors of a particular locality for any given human diseases etc.]

**FOR EXAMINATION:**

- On completion of the Summer Internship Programme, the students will submit a report with relevant photographs as part of the report and inclusive of an Attendance Document and an **Authenticated Certificate** jointly signed by the **Supervisor/Mentor** and the **Head of the Institution**.
- The report is to be signed by the Supervisor/Mentor with official seal.
- A viva-voce will be conducted by the Department with 1 Faculty acting as Internal Examiner and 1 External Examiner Appointed from Calcutta University
- **The following Marks distribution is to be followed for evaluation**

    1. Submission of report: **50 marks**
    2. Viva Voce: **25 marks**