



# UNIVERSITY OF CALCUTTA

## Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved 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/ LCCI/ 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 4<sup>th</sup> June, 2018

*S 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.

<b>PART I; SEM I</b>				
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
<b>PART I; SEM II</b>				
CC 3	Non Chordata – II (All Coelomate Phyla)	50	30	20
CC 4	Cell Biology	50	30	20
<b>PART II; SEM III</b>				
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
<b>PART II; SEM IV</b>				
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
<b>PART III; SEM V</b>				
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
<b>PART III; SEM VI</b>				
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

---

### INDEX

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

Code	Paper	Page
<b>Core Course</b>		
ZOOA-CC1-1-TH	Non- Chordates I (Protista to Pseudocoelomate) Theory	5
ZOOA-CC1-1-P	Non- Chordates I Lab	6
ZOOA-CC1-2-TH	Molecular Biology	6
ZOOA-CC1-2-P	Molecular Biology Lab	7
ZOOA-CC2-3-TH	Non-Chordate II (Coelomate Phyla) Theory	7
ZOOA-CC2-3-P	Non-Chordate II Lab	8
ZOOA-CC2-4-TH	Cell Biology Theory	8
ZOOA-CC2-4-P	Cell Biology Lab	9
ZOOA-CC3-5-TH	Chordata Theory	9
ZOOA-CC3-5-P	Chordata Lab	10
ZOOA-CC3-6-TH	Animal Physiology: Controlling & Co-ordinating system Theory	11
ZOOA-CC3-6-P	Animal Physiology: Controlling & Co-ordinating system Lab	11
ZOOA-CC3-7-TH	Fundamental of Biochemistry Theory	12
ZOOA-CC3-7-P	Fundamental of Biochemistry Lab	13
ZOOA-CC4-8-TH	Comparative Anatomy of Vertebrate Theory	13
ZOOA-CC4-8-P	Comparative Anatomy of Vertebrate Lab	14
ZOOA-CC4-9-TH	Animal Physiology: Life Sustaining System Theory	14
ZOOA-CC4-9-P	Animal Physiology: Life Sustaining System Lab	15
ZOOA-CC4-10-TH	Immunology Theory	15
ZOOA-CC4-10-P	Immunology Lab	16
ZOOA-CC5-11-TH	Ecology Theory	16
ZOOA-CC5-11-P	Ecology Lab	17

ZOOA-CC5-12-TH	Principle of Genetics Theory	17
ZOOA-CC5-12-P	Principle of Genetics Lab	18
ZOOA-CC6-13-TH	Developmental Biology Theory	18
ZOOA-CC6-13-P	Developmental Biology Lab	19
ZOOA-CC6-14-TH	Evolutionary Biology Theory	19
ZOOA-CC6-14-P	Evolutionary Biology Practical	20
<b>Discipline Specific Electives</b>		
ZOOA-DSE(A)-5-1-TH	Parasitology Theory	21
ZOOA-DSE(A)-5-1-P	Parasitology Lab	21
ZOOA-DSE(A)-5-2-TH	Biology of Insect Theory	22
ZOOA-DSE(A)-5-2-P	Biology of Insect Lab	23
ZOOA-DSE(B)-5-1-TH	Endocrinology Theory	23
ZOOA-DSE(B)-5-1-P	Endocrinology Lab	24
ZOOA-DSE(B)-5-2-TH	Reproductive Biology Theory	24
ZOOA-DSE(B)-5-2-P	Reproductive Biology Lab	25
ZOOA-DSE(A)-6-1-TH	Animal Cell Biotechnology Theory	25
ZOOA-DSE(A)-6-1-P	Animal Cell Biotechnology Lab	26
ZOOA-DSE(A)-6-2-TH	Animal Biotechnology Theory	26
ZOOA-DSE(A)-6-2-P	Animal Biotechnology Lab	27
ZOOA-DSE(B)-6-1-TH	Animal Behaviour & Chronobiology Theory	27
ZOOA-DSE(B)-6-1-P	Animal Behaviour & Chronobiology Lab	28
ZOOA-DSE(B)-6-2-TH	Fish & Fishery Theory	28
ZOOA-DSE(B)-6-2-P	Fish & Fishery Lab	29
<b>Skill Enhancement Course</b>		
ZOOA-SEC(A)-3-1-TH	Apiculture	29
ZOOA-SEC(A)-3-2-TH	Sericulture	30
ZOOA-SEC(A)-4-1-TH	Aquarium Fishery	31
ZOOA-SEC(A)-4-2-TH	Medical Diagnosis	31

**PART I: SEMESTER 1**  
**CORE COURSE 1. Non-Chordates I**  
**ZOOA-CC1-1-TH**

PART I: SEMESTER 1		
Full Marks 50	4 Credits	50 Hours
<b>Non-Chordates I: Protists to Pseudocoelomates</b>		
<b>Unit 1: Basics of Animal Classification</b>		4
Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types 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		
<b>Unit 2: Protista and Metazoa</b>		15
<b>Protozoa</b> General characteristics and Classification up to phylum (according to Levine <i>et. al.</i> , 1980) Locomotion in <i>Euglena</i> , <i>Paramecium</i> and <i>Amoeba</i> ; Conjugation in <i>Paramecium</i> . Life cycle and pathogenicity of <i>Plasmodium vivax</i> and <i>Entamoeba histolytica</i>		
<b>Metazoa</b> Evolution of symmetry and segmentation of Metazoa		
<b>Unit 3: Porifera</b>		6
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.); Canal system and spicules in sponges		
<b>Unit 4: Cnidaria</b>		10
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.), Metagenesis in <i>Obelia</i> ; Polymorphism in Cnidaria; Corals and coral reef diversity, Role of symbiotic algae in reef formation. Conservation of coral and coral reefs.		
<b>Unit 5: Ctenophora</b>		2
General characteristics		
<b>Unit 6: Platyhelminthes</b>		6
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.) Life cycle and pathogenicity and control measures of <i>Fasciola hepatica</i> and <i>Taenia solium</i>		
<b>Unit 7: Nematoda</b>		7
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.) Life cycle, and pathogenicity and control measures of <i>Ascaris lumbricoides</i> and <i>Wuchereria bancrofti</i> Parasitic adaptations in helminthes		

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

### Non-Chordates I: Protists to Pseudocoelomates

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

## CORE COURSE 2: Molecular Biology

### ZOOA-CC1-2-TH

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

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

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

<b>Full Marks 30</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Demonstration of polytene and lampbrush chromosome from photograph</li> <li>2. Isolation and quantification of genomic DNA from goat liver.</li> <li>3. Agarose gel electrophoresis for DNA.</li> <li>4. Histological staining of DNA and RNA in prepared slides</li> </ol>		

## PART I: SEMESTER 2

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

#### ZOOA-CC2-3-TH

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



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

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

<b>Full Marks 30</b>	<b>2 Credits</b>
<b>List of Practical</b>	
<ol style="list-style-type: none"> <li>1. Study of following specimens: <ol style="list-style-type: none"> <li>a. Annelids - <i>Aphrodite</i>, <i>Nereis</i>, <i>Chaetopterus</i>, Earthworm, <i>Hirudinaria</i></li> <li>b. Arthropods - <i>Limulus</i>, <i>Palaemon</i>, <i>Balanus</i>, <i>Eupagurus</i>, <i>Scolopendra</i>, <i>Peripatus</i>, Silkworm – life history stages, Termite – members of a colony and Honey bee – members of the colony</li> <li>c. Molluscs - <i>Dentalium</i>, <i>Patella</i>, <i>Chiton</i>, <i>Pila</i>, <i>Achatina</i>, <i>Pinctada</i>, <i>Sepia</i>, <i>Octopus</i>, <i>Nautilus</i></li> <li>d. Echinoderms - <i>Asterias</i>, <i>Ophiura</i>, <i>Clypeaster</i>, <i>Echinus</i>, <i>Cucumaria</i> and <i>Antedon</i></li> </ol> </li> <li>2. Anatomy study: Nervous system, Reproductive system (Male &amp; female), Mouth parts &amp; Salivary apparatus in <i>Periplaneta sp.</i></li> </ol>	

### PART I: SEMESTER 2 CORE COURSE 4: Cell Biology ZOOA-CC2-4-TH

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Plasma Membrane</b>		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		
<b>Unit 2: Cytoplasmic organelles I</b>		5
Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes; Protein sorting and mechanisms of vesicular transport		
<b>Unit 3: Cytoplasmic organelles II</b>		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	
<b>Unit 4: Cytoskeleton</b>	5
Type, structure and functions of cytoskeleton; Accessory proteins of microfilament & microtubule	
<b>Unit 5: Nucleus</b>	8
Nuclear envelope, Nuclear pore complex, Nucleolus; Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome),	
<b>Unit 6: Cell Cycle</b>	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	
<b>Unit 7: Cell Signalling</b>	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

<b>Full Marks 30</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Preparation of temporary stained squash of onion/arum root tip to study various stages of mitosis</li> <li>2. Study of various stages of meiosis from grasshopper testis</li> <li>3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.</li> <li>4. Preparation of permanent slide to demonstrate: <ol style="list-style-type: none"> <li>a. DNA by Feulgen reaction</li> <li>b. Cell viability study by Trypan Blue staining</li> </ol> </li> </ol>		

### PART II: SEMESTER 3.

#### CORE COURSE 5 : Chordata

#### ZOOA-CC3-5-TH

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

<b>Unit 3: Agnatha</b>	2
General characteristics and classification of cyclostomes up to order (Young, 1981)	
<b>Unit 4: Pisces</b>	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.	
<b>Unit 5: Amphibia</b>	7
General characteristics and classification up to living Orders (Young, 1981); Metamorphosis, Paedomorphosis, Parental care in Amphibia	
<b>Unit 6: Reptilia</b>	8
General characteristics and classification up to living Orders (Young, 1981); Poison apparatus and Biting mechanism in Snake. Poisonous & Non-Poisonous snake.	
<b>Unit 7: Aves</b>	8
General characteristics and classification up to living Sub-Classes (Young, 1981); Exoskeleton and migration in Birds; Principles and aerodynamics of flight	
<b>Unit 8: Mammals</b>	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

<b>Full Marks 30</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<p>Identification with Reasons</p> <p>a) <b>Protochordata:</b> <i>Balanoglossus, Branchiostoma</i></p> <p>b) <b>Agnatha:</b> <i>Petromyzon</i></p> <p>c) <b>Fishes:</b> <i>Scoliodon, Sphyrna, Pristis, Torpedo, Mystus, Heteropneustes, Labeo rohita, Exocoetus, Hippocampus, Anabas, Flat fish</i></p> <p>d) <b>Amphibia:</b> <i>Necturus, Bufo (Duttaphrynus) melanostictus, Rana (Hoplobatrachus) tigerinus, Hyla, Tylotriton, Axolotl larva</i></p> <p>e) <b>Reptilia:</b> <i>Chelone, Trionyx, Hemidactylus, Varanus, Calotes, Chamaeleon, Draco, Vipera, Naja, Hydrophis,</i></p> <p>f) <b>Mammalia:</b> Bat (Insectivorous and Frugivorous), <i>Funambulus</i> (Indian Palm squirrel)</p> <p>Dissection of brain and pituitary – <i>ex situ</i>, digestive and Urino-genital system of <i>Tilapia</i></p> <p>Pecten from Fowl head</p> <p>Power point presentation on study of habit, habitat or behaviour of any one animal by student – for internal assessment only</p>		

## 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
<b>Unit 1: Tissues</b>		4
Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue		
<b>Unit 2: Bone and Cartilage</b>		4
Structure and types of bones and cartilages, Ossification		
<b>Unit 3: Nervous System</b>		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		
<b>Unit 4: Muscular system</b>		10
Histology of different types of muscle; Ultra-structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle fibre		
<b>Unit 5: Reproductive System</b>		6
Histology of mammalian testis and ovary; physiology of mammalian reproduction – menstrual and oestrous cycle		
<b>Unit 6: Endocrine System</b>		16
Histology and function of thyroid, pancreas and adrenal. Function of pituitary 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
<b>List of Practical</b>		
<ol style="list-style-type: none"><li>1. Recording of cardiac and simple muscle twitch with electrical stimulation</li><li>2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells</li><li>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)</li><li>4. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues</li></ol>		

**PART II: SEMESTER 3**  
**CORE COURSE 7: Fundamentals of Biochemistry**  
**ZOOA-CC3-7-TH**

Full Marks 50	4 Credits	50 Hours
<b>Unit 1: Carbohydrates</b>		8
Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides; Derivatives of Monosaccharides; Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis		
<b>Unit 2: Lipids</b>		7
Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Triacylglycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpenoids. Lipid metabolism: $\beta$ -oxidation of fatty acids - a. Palmitic acid {saturated (C 16:0)}, b. Linoleic acid {unsaturated (C 18:2)}; Fatty acid biosynthesis		
<b>Unit 3: Proteins</b>		10
Amino acids: Structure, Classification, General and Electro chemical properties of $\alpha$ -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		
<b>Unit 4: Nucleic Acids</b>		10
Structure of Purines, Pyrimidines, Nucleosides and Nucleotides; Nucleic Acid Metabolism: Catabolism of adenosine, Guanosine, cytosine and thymine.		
<b>Unit 5: Enzymes</b>		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.		
<b>Unit 5: Oxidative Phosphorylation</b>		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		
<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Qualitative tests for carbohydrates, proteins and lipids</li> <li>2. Qualitative estimation of Urea &amp; Uric acid</li> <li>3. Paper chromatography of amino acids.</li> <li>4. Quantitative estimation of water soluble proteins following Lowry Method</li> </ol>		

### PART II: SEMESTER 4

#### CORE COURSE 8.Comparative Anatomy of Vertebrates

#### ZOOA-CC4-8-TH

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

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

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs</li> <li>2. Study of disarticulated skeleton of toad, Pigeon, Guineapig (limb bones, vertebrae, limb and girdle)</li> <li>3. Comparative study of heart and brain, with the help of model/picture</li> <li>4. Identification of skulls: Pigeon, one herbivore (Guineapig) and one carnivore (Dog) animal</li> </ol>		

### PART II: SEMESTER 4

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

#### ZOOA-CC4-9-TH

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Physiology of Digestion</b>		<b>10</b>
Structural organisation and function of gastro-intestinal tract; Mechanical and chemical digestion of food, absorption of Carbohydrates, Lipids and Proteins in Human		
<b>Unit 2: Physiology of Respiration</b>		<b>10</b>
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		
<b>Unit 3: Physiology of Circulation</b>		<b>8</b>
Structure and functions of haemoglobin; Blood clotting system; Haematopoiesis; Basic steps and its regulation; Blood groups; ABO and Rh factor		
<b>Unit 4: Physiology of Heart</b>		<b>8</b>
Coronary Circulation, Structure and working of conducting myocardial fibres, Origin and conduction of cardiac impulses; Cardiac Cycle and cardiac output		
<b>Unit 5: Thermoregulation &amp; Osmoregulation</b>		<b>6</b>
Thermal regulation in camel and polar bear, Osmoregulation in aquatic vertebrates		
<b>Unit 6: Renal Physiology</b>		<b>8</b>
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

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Determination of ABO Blood group</li> <li>2. Estimation of haemoglobin using Sahli's haemoglobin meter</li> <li>3. Identification of blood cells from human blood</li> <li>4. Preparation of haemin crystals and haemochromogen crystals</li> <li>5. Identification of blood cells from cockroach haemolymph</li> <li>6. Demonstration of blood pressure by digital meter</li> </ol>		

### PART II: SEMESTER 4

#### CORE COURSE 10: Immunology

#### ZOOA-CC4-10-TH

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



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

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

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Demonstration of lymphoid organs (by picture).</li> <li>2. Histological study of Bursa fabricius, spleen, thymus and lymph nodes through slides/ photographs</li> <li>3. Demonstration of ELISA</li> </ol>		

### PART III: SEMESTER 5 CORE COURSE 11.Ecology ZOOA-CC5-11-TH

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Introduction to Ecology</b>	4	
Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere.		
<b>Unit 2: Population</b>	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.		
<b>Unit 3: Community</b>	11	
Community characteristics: species diversity, abundance, dominance, richness, Vertical stratification, Ecotone and edge effect; Ecological succession with one example.		

<b>Unit 4: Ecosystem</b>	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.	
<b>Unit 5: Applied Ecology</b>	7
Types & level of biodiversity Mega-diversity countries, Biodiversity Hot spot, Flagship species, Keystone species, Wildlife Conservation ( <i>in situ</i> and <i>ex situ</i> conservation), concept of protected areas. Red data book, Indian wild life act & Schedule. Concept of corridor, advantages and problem of corridor. 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
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community</li> <li>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<sub>2</sub></li> <li>Report on a visit to National Park/Biodiversity Park/Wild life sanctuary/ any place of ecological interest/ ecological uniqueness/ Zoological garden</li> </ol>		

### PART III: SEMESTER 5

#### CORE COURSE 12.Principle of Genetics

#### ZOOA-CC5-12-TH

Full Marks 50	4 Credits	Class
<b>Unit 1: Mendelian Genetics and its Extension</b>	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		
<b>Unit 2: Linkage, Crossing Over and Linkage Mapping</b>	8	
Linkage and Crossing, Complete & Incomplete Linkage, Measuring Recombination frequency and linkage map construction using three factor crosses, Interference and coincidence Sex linkage in <i>Drosophila</i> (White eye locus) & Human (Haemophilia).		

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

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

<b>Full marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Chi-square analyses for genetic ratio test</li> <li>2. Identification of chromosomal aberration in <i>Drosophila</i> and man from photograph</li> <li>3. Pedigree analysis of some inherited traits in animals</li> </ol>		

### PART III: SEMESTER 6

#### CORE COURSE 13: Developmental Biology

#### ZOOA-CC6-13-TH

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Early Embryonic Development</b>		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 <i>Xenopus</i> (Spemann & Mangold's experiment)		

<b>Unit 2: Late Embryonic Development</b>	10
Extra-embryonic membranes in Chick; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)	
<b>Unit 3: Post Embryonic Development</b>	8
Development of brain and Eye in Chick. Molecular Induction in Brain and Eye development.	
<b>Unit 4: Implications of Developmental Biology</b>	12
<i>In vitro</i> 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**

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of whole mounts of developmental stages of chick embryo through permanent slides: 24, 48, and 96 hours of incubation</li> <li>2. Study of the developmental stages and life cycle of <i>Drosophila</i></li> <li>3. Study of different sections of placenta (photomicrograph/ slides)</li> <li>4. Identification of Invertebrate larva through slides/ photographs of Phylum Annelida, Arthropoda, Mollusca and Echinodermata</li> </ol>		

### **PART III: SEMESTER 6**

#### **CORE COURSE 14.Evolutionary Biology**

#### **ZOOA-CC6-14-TH**

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

<b>Unit 5</b>	10
Species concept, Isolating mechanisms, modes of speciation; Speciation by chromosome rearrangement in <i>Drosophila</i> . Adaptive radiation/macroevolution (exemplified by Galapagos finches).	
<b>Unit 6</b>	2
Origin and Evolution of Man, Unique Hominid characteristics contrasted with primate characteristic	
<b>Unit 7</b>	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.	
<b>Unit 8</b>	3
Extinction, back ground and mass extinctions, detailed example of K-T extinction	
<b>Unit 9</b>	5
Phylogenetic trees, construction and interpretation of Phylogenetic tree using parsimony, convergent and divergent evolution.	

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

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of fossils from models/ pictures: Dickinsonia, Paradoxides (Trilobita), Asteroceas (Ammonoid), Pentremites (Blastoid Echinoderm), Ichthyosaur, Archaeopteryx, Cynodont.</li> <li>2. Study of homology and analogy from suitable specimens.</li> <li>3. Phylogenetic trees, Construction &amp; interpretation of Phylogenetic tree using parsimony, Construction of dendrogram following principles of phenetics &amp; cladistics from a data table.</li> </ol>		

## 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
<b>Unit 1: Introduction to Parasitology</b>		2
Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector); Host parasite relationship		
<b>Unit 2: Parasitic Protists</b>		12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Giardia intestinalis</i> , <i>Trypanosoma gambiense</i> , <i>Leishmania donovani</i>		
<b>Unit 3: Parasitic Platyhelminthes</b>		12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Schistosoma haematobium</i> , <i>Taenia solium</i>		
<b>Unit 4: Parasitic Nematodes</b>		12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Ascaris lumbricoides</i> , <i>Ancylostoma duodenale</i> , <i>Wuchereria bancrofti</i> , Nematode plant interaction.		
<b>Unit 5: Parasitic Arthropods</b>		10
Biology, importance and control of ticks: Soft tick ( <i>Ornithodoros</i> ), Hard tick ( <i>Ixodes</i> ), mites ( <i>Sarcoptes</i> ), Lice ( <i>Pediculus</i> ), Flea ( <i>Xenopsylla</i> ) and Bug ( <i>Cimex</i> ). Parasitoid.		
<b>Unit 6: Parasite Vertebrates</b>		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
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of life stages of <i>Giardia intestinalis</i>, <i>Trypanosoma gambiense</i>, <i>Leishmania donovani</i>, <i>Plasmodium vivax</i>, <i>Plasmodium falciparum</i> through permanent slides/micro photographs</li> <li>2. Study of adult and life stages of <i>Schistosoma haematobium</i>, <i>Taenia solium</i> through permanent slides/micro photographs</li> <li>3. Study of adult and life stages of <i>Ancylostoma duodenale</i> through permanent slides/micro photographs.</li> </ol>		

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**

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

<b>Full Marks 30</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of life cycle of Mosquito</li> <li>2. Study of different kinds of antennae, legs and mouth parts of insects</li> <li>3. Mounting of insect wings any insects</li> <li>4. Methodology of collection, preservation and identification of insects.</li> <li>5. Morphological studies of various castes of <i>Apis</i>, <i>Ant-Camponotus</i>, <i>Termite-Odontotermes</i></li> <li>6. Study of major insect pests of paddy and their damages</li> <li>7. Study of Mulberry silk moth as beneficial insect</li> </ol>		

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

### PART III: SEMESTER 5

#### DSE1. Endocrinology

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

<b>Full Marks 50</b>	4 Credits	50 Hours
<b>Unit 1: Introduction to Endocrinology</b>		<b>6</b>
General idea of Endocrine systems, Classification, Characteristic and Transport of Hormones, Neuro-secretions and Neuro-hormones: Examples and Functions		
<b>Unit 2: Hypothalamo-Hypophyseal Axis</b>		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		
<b>Unit 3: Peripheral Endocrine Glands</b>		12
Structure, Hormones and Functions of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis. Disorders of endocrine glands ( <i>Diabetes mellitus</i> type I & Type II; Graves' Disease).		
<b>Unit 4: Regulation of Hormone Action</b>		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.		



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

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

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Dissect and display of Endocrine glands in laboratory bred rat.</li> <li>2. Study of the permanent slides of all the endocrine glands</li> <li>3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland.</li> <li>4. H-E staining of Histological slides.</li> </ol>		

## **PART III: SEMESTER 5**

### **DSE2. Reproductive Biology**

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

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Reproductive Endocrinology</b>		<b>10</b>
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		
<b>Unit 2: Functional anatomy of male reproduction</b>		<b>14</b>
Histoarchitecture of testis in human; Spermatogenesis and its hormonal regulation; Androgen synthesis and metabolism; Accessory glands functions		
<b>Unit 3: Functional anatomy of female reproduction</b>		<b>18</b>
Histoarchitecture 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, fetomaternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation		
<b>Unit 4: Reproductive Health</b>		<b>8</b>
Infertility in male and female: causes, diagnosis and management, Assisted Reproductive Technology: Sex selection, sperm banks, frozen embryos, <i>in vitro</i> fertilization IVF & IUI Modern contraceptive technologies		

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

<b>Full Marks 50</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals ( only demonstration through chart).</li> <li>2. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland.</li> <li>3. H-E staining of histological slides.</li> <li>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.</li> </ol>		

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

### PART III: SEMESTER 6

#### DSE1. Animal Cell Biotechnology

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

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

<b>Unit 5: Application in Health</b>	8
Hybridoma technology, Production of recombinant Proteins: Insulin and growth hormones.	

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

<b>Full Marks 50</b>	<b>60 Hours</b>	2 Credits
----------------------	-----------------	-----------

<b>List of Practical</b>
<ol style="list-style-type: none"> <li>1. Packing and sterilization of glass and plastic wares for cell culture.</li> <li>2. Preparation of culture media.</li> <li>3. Preparation of genomic DNA from E. coli/animals/ human.</li> <li>4. Plasmid DNA isolation (pUC 18/19) and DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard).</li> <li>5. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting, PCR, DNA Microarrays (By Photograph).</li> </ol>

## **PART III: SEMESTER 6**

### **DSE2. Animal Biotechnology**

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

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

genetic diseases (Cystic fibrosis, Sickle cell anaemia, Thalassaemia). Dolly & Polly cloning Genetically modified economically important animal Gene Therapy	
---	--

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

<b>Full Marks 30</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Genomic DNA isolation from <i>E. coli</i> and Plasmid DNA isolation (pUC 18/19) from <i>E. coli</i></li> <li>2. To study following techniques through photographs - Southern Blotting, Northern Blotting, Western Blotting, PCR, DNA fingerprinting</li> <li>3. Project report on animal cloning &amp; Application &amp; ethical Issues.</li> </ol>		

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

## PART III: SEMESTER 6

### DSE1. Animal Behaviour and Chronobiology

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

<b>Full Marks 50</b>	4 Credits	50 Hours
<b>Unit 1: Patterns of Behaviour</b>		10
Stereotyped Behaviours (Orientation, Reflex); Individual Behavioural patterns; Instinct vs. Learned Behaviour; FAP, Associative learning, classical and operant conditioning, Habituation, Imprinting.		
<b>Unit 2: Social and Sexual Behaviour</b>		20
Social organisation in termites; Communication (dance & pheromones in Bees) Social behaviour: Altruism (Hamilton's rule and concept of haplodiploidy), Cooperation and Selfishness Sexual Behaviour: Sexual dimorphism, Mate choice in peacock, Intra-sexual selection (male rivalry in red deer) Kinship theory: Relatedness & inclusive fitness; parental care in fishes (Nest Building & coast benefit), conflict within families: parent offspring conflict and sibling rivalry		
<b>Unit 3: Chronobiology &amp; Biological Rhythm</b>		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

<b>Full Marks 50</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. To study nests and nesting habits of the birds and social insects.</li> <li>2. To study the behavioural responses of wood lice to dry and humid conditions(demonstration only).</li> <li>3. To study geotaxis behaviour in earthworm.</li> <li>4. To study the phototaxis behaviour in insect larvae.</li> <li>5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.</li> <li>6. Study of circadian functions in humans (daily eating, sleep and temperature patterns).</li> </ol>		

### PART III: SEMESTER 6

#### DSE2. Fish and Fisheries

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

<b>Full Marks 50</b>	4 Credits	50 Hours
<b>Unit 1: Introduction and Classification</b>		<b>4</b>
Feeding habit, habitat and manner of reproduction. Classification of fish (upto Subclasses) (Romar, 1959)		
<b>Unit 2: Morphology and Physiology</b>		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		
<b>Unit 3: Fisheries</b>		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		
<b>Unit 4: Aquaculture</b>		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		
<b>Unit 5: Fish in research</b>		6
Transgenic fish Zebra fish as a model organism in research		

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

<b>Full Marks 30</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Morphometric and meristic characters of fishes</li> <li>2. Identification of <i>Petromyzon</i>, <i>Myxine</i>, <i>Pristis</i>, <i>Exocoetus</i>, <i>Hippocampus</i>, <i>Gambusia</i>, <i>Labeo</i>, <i>Heteropneustes</i>, <i>Anabas</i></li> <li>3. Study of different types of scales (through permanent slides/ photographs).</li> <li>4. Study of crafts and gears used in Fisheries (Photographs)</li> <li>5. Water quality criteria for Aquaculture: Assessment of pH, alkalinity, Salinity.</li> <li>6. Study of air breathing organs in <i>Channa</i>, <i>Heteropneustes</i>, <i>Anabas</i> and <i>Clarias</i></li> <li>7. Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.</li> </ol>		

### 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

<b>Full Marks 80</b>	2 Credits	30 Hours
<b>Unit 1: Biology of Bees</b>		<b>2</b>
<i>Apis</i> and Non- <i>Apis</i> Bee species and their identification. General Morphology of <i>Apis</i> Honey Bees Social Organization of Bee Colony		
<b>Unit 2: Rearing of Bees</b>		<b>14</b>
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth box Bee Pasturage Selection of Bee Species for Apiculture Modern Bee Keeping Equipment Methods of Extraction of Honey (Indigenous and Modern)		
<b>Unit 3: Diseases and Enemies</b>		<b>6</b>
Bee Diseases and Enemies Control and Preventive measures		
<b>Unit 4: Bee Economy</b>		<b>2</b>
Products of Apiculture Industry and its Uses – Honey, Bees Wax, Propolis, Pollen etc.		
<b>Unit 5: Entrepreneurship in Apiculture</b>		<b>6</b>
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
<b>Unit 1: Introduction</b>		<b>6</b>
Sericulture: Definition, history and present status; Silk route Types of silkworms, Distribution and Races Exotic and indigenous races Mulberry and non-mulberry Sericulture		
<b>Unit 2: Biology of Silkworm</b>		<b>4</b>
Life cycle of <i>Bombyx mori</i> Structure of silk gland and secretion of silk		
<b>Unit 3: Rearing of Silkworms</b>		<b>10</b>
Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances. Disinfectants: Formalin, bleaching powder, RKO Silkworm rearing technology: Early age and Late age rearing Types of mountages Spinning, harvesting and storage of cocoons		
<b>Unit 4: Pests and Diseases</b>		<b>7</b>
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		
<b>Unit 5: Entrepreneurship in Sericulture</b>		<b>3</b>
Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture Visit to various sericulture centres.		

[A student has to choose 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
<b>Unit 1: Introduction to Aquarium Fish Keeping</b>		<b>2</b>
The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes		
<b>Unit 2: Biology of Aquarium Fishes</b>		<b>10</b>
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		
<b>Unit 3: Food and feeding of Aquarium fishes</b>		<b>8</b>
Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator		
<b>Unit 4: Fish Transportation</b>		<b>5</b>
Live fish transport - Fish handling, packing and forwarding techniques.		
<b>Unit 5: Maintenance of Aquarium</b>		<b>5</b>
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
<b>Unit 1: Diagnostics Methods Used for Analysis of Blood</b>		<b>8</b>
Blood composition, Differential Leucocyte Count (DLC) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (ESR), Packed Cell Volume (PCV)		
<b>Unit 2: Diagnostic Methods Used for Urine Analysis</b>		<b>4</b>
Urine Analysis: Physical characteristics; Abnormal constituents, Urine culture		
<b>Unit 3: Non-infectious Diseases</b>		<b>6</b>
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	
<b>Unit 4: Infectious Diseases</b>	<b>3</b>
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite (Microscope based and ELISA based)	
<b>Unit 5: Clinical Biochemistry</b>	<b>1</b>
Lipid profiling, Liver function test. PSA test	
<b>Unit 6: Clinical Microbiology</b>	<b>1</b>
Antibiotic Sensitivity Test	
<b>Unit 7: Tumours</b>	<b>2</b>
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).	
<b>Unit 8: Visit to Pathological Laboratory and Submission of Project</b>	<b>6</b>

---

**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.

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

### 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

Code	Paper	Page
<b>Core Course</b>		
ZOOG-CC1-1-TH	Animal diversity Theory	36
ZOOG-CC1-1-P	Animal diversity Lab	37
ZOOG-CC2-2-TH	Comparative Anatomy & Developmental Biology Theory	37
ZOOG-CC2-2-P	Comparative Anatomy & Developmental Biology Lab	38
ZOOG-CC3-3-TH	Physiology and Biochemistry Theory	38
ZOOG-CC3-3-P	Physiology and Biochemistry Lab	39
ZOOG-CC4-4-TH	Genetics and Evolutionary Biology Theory	39
ZOOG-CC4-4-P	Genetics and Evolutionary Biology Lab	40
<b>Discipline Specific Electives</b>		
ZOOG-DSE(A)-5-1-TH	Applied Zoology Theory	40
ZOOG-DSE(A)-5-1-P	Applied Zoology Lab	41
ZOOG-DSE(A)-5-2-TH	Aquatic Biology Theory	42
ZOOG-DSE(A)-5-1-P	Aquatic Biology Lab	42
ZOOA-DSE(B)-6-1-TH	Biology of Insect Theory	43
ZOOA-DSE(B)-6-1-P	Biology of InsectLab	43
ZOOA-DSE(B)-6-2-TH	Ecology & Wild life BiologyTheory	44
ZOOA-DSE(B)-6-2-P	Ecology & Wild life BiologyLab	44
<b>Skill Enhancement Course</b>		
ZOOG-SEC(A)-3-1-TH	Apiculture	45
ZOOA-SEC(B)-4-2-TH	Aquarium Fishery	45
ZOOA-SEC(A)-5-3-TH	Sericulture	46
ZOOA-SEC(B)-6-4-TH	Medical Diagnosis	46

**PART I: SEMESTER 1.**  
**CORE COURSE 1. Animal Diversity**  
**ZOOG-CC1-1-TH**

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

<b>Unit 12: Pisces</b>	4
General features and Classification up to orders (Young, 1981); Osmoregulation in Fishes	
<b>Unit 13: Amphibia</b>	4
General features and Classification up to orders (Young, 1981); Parental care	
<b>Unit 14: Reptiles</b>	4
General features and Classification up to orders (Young, 1981); Poisonous and non-poisonous snakes, Biting mechanism	
<b>Unit 15: Aves</b>	4
General features and Classification up to orders (Young, 1981); Flight adaptations in birds	
<b>Unit 17: Mammals</b>	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		
<p>1. Identification with reasons of the following specimens:</p> <p><i>Amoeba, Euglena, Paramecium, Sycon, Obelia, Aurelia, Metridium, Taenia solium, Ascaris lumbricoides</i> (Male and female), <i>Aphrodite, Nereis, Hirudinaria, Palaemon, Cancer, Limulus, Apis, Chiton, Dentalium, Unio, Sepia, Octopus, Echinus, Cucumaria</i> and <i>Antedon, Balanoglossus, Branchiostoma, Petromyzon, Torpedo, Labeo rohita, Exocoetus, Salamandra, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Bat, Funambulus</i></p> <p>2. Key for Identification of poisonous and non-poisonous snakes</p> <p>3. Study of anatomy of digestive system, salivary gland, mouth parts of <i>Periplaneta</i>, Study of reproductive system of female cockroach</p> <p>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</p>		

### PART I: SEMESTER 2.

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

#### ZOOG-CC2-2-TH

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

Brief account of Gills, lungs, air sacs and swim bladder	
<b>Unit 4: Circulatory System</b>	6
Evolution of heart and aortic arches	
<b>Unit 5: Urino-genital System</b>	6
Succession of kidney, Evolution of urino-genital ducts	
<b>Unit 6: Early Embryonic Development</b>	14
Gametogenesis: Spermatogenesis and oogenesis with respect to mammals. 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	
<b>Unit 7: Late Embryonic Development</b>	10
Placenta types and function; Metamorphic events in frog life cycle and its hormonal regulation	

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

<b>Full marks 30</b>	<b>60 hours</b>	<b>2 Credits</b>
<b>List of Practical:</b>		
1. Osteology: Limb bones, girdle and vertebra of Pigeon & Guineapig, Mammalian skulls: One herbivorous; Guinea pig and one carnivorous; Dog.		
2. Larval stages: Veliger, Nauplius, Trochophore, Mysis.		
3. Study of the different types of placenta- histological sections through photomicrographs.		
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

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Nerve and muscle</b>		<b>8</b>
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		
<b>Unit 2: Digestion</b>		<b>6</b>
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids		
<b>Unit 3: Respiration</b>		<b>6</b>
Pulmonary ventilation, Transport of Oxygen and carbon		
<b>Unit 4: Cardio-vascular system</b>		<b>6</b>

Composition of blood, Structure of Heart, Origin and conduction of the cardiac impulse, cardiac cycle	
<b>Unit 5: Excretion</b>	6
Structure of nephron, Mechanism of Urine formation; Counter-current Mechanism	
<b>Unit 6: Reproduction and Endocrine Glands</b>	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.	
<b>Unit 7: Carbohydrate Metabolism</b>	4
Glycolysis, Krebs's cycle, Glycogenesis, Electron Transport Chain.	
<b>Unit 8: Lipid metabolism</b>	
Beta oxidation of Palmitic acid {saturated (C 16:0)} and Linoleic acid {unsaturated (C 18:2)}	
<b>Unit 9: Protein Metabolism</b>	4
Transamination, Deamination, Urea cycle	
<b>Unit 10. Enzyme</b>	2
Enzyme Classification, factors affecting enzyme action, Inhibition.	

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

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland.</li> <li>2. Study of permanent histological sections of mammalian duodenum, liver, lung, kidney.</li> <li>3. Qualitative test for carbohydrate samples.</li> </ol>		

### **PART II: SEMESTER 4.**

#### **CORE-COURSE 4. Genetics & Evolutionary Biology**

#### **ZOOG-CC4-4-TH**

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



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

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

<b>Full marks 30</b>	<b>2 Credits</b>
<b>List of Practical:</b>	
Verification of Mendelian Ratio using Chi square test. Identification of Human Aneuploidy using photo graph of karyotype. Phylogeny of horse with diagram of limb and skull. Study and identification of Darwin Finches from photographs. 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**

<b>Full Marks 50</b>	<b>Credits 4</b>	<b>50 Hours</b>
<b>Unit I: Host &amp; Parasite Relationship</b>		2
Type of Host, Types of Parasites, Other types of Relations.		
<b>Unit 2: Epidemiology of Diseases</b>		5

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

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

<b>Full marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical:</b>		
<ol style="list-style-type: none"> <li>1. Study of <i>Plasmodium vivax</i>, <i>Entamoeba histolytica</i>, <i>Trypanosoma gambiense</i>, <i>Ancylostoma duodenale</i> and <i>Wuchereria bancrofti</i> and their life stages through permanent slides/photomicrographs or specimens.</li> <li>2. Study of arthropod vectors associated with human diseases: <i>Pediculus</i>, <i>Culex</i>, <i>Anopheles</i>, <i>Aedes</i></li> <li>3. Study of insect damage to different plant parts/stored grains through damaged products/photographs.</li> <li>4. Identifying feature and economic importance of <i>Helicoverpa</i>; <i>Heliothis armigera</i>, <i>Papilio demoleus</i>, <i>Pyrilla perpusilla</i>, <i>Callosobruchus chinensis</i>, <i>Sitophilus oryzae</i> and <i>Tribolium castaneum</i></li> <li>5. Visit to poultry farm or animal breeding centre. Submission of visit report</li> <li>6. Maintenance of freshwater aquarium(demonstration only)</li> </ol>		

# 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
<b>Unit 1: Aquatic Bionics</b>		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.		
<b>Unit 2: Freshwater Biology lakes</b>		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.		
<b>Streams:</b> Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.		
<b>Unit 3: Marine Biology</b>		15
Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.		
<b>Unit 4: Management of Aquatic Resources</b>		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
<ol style="list-style-type: none"> <li>Determine the area of a lake using graphimetric and gravimetric method.</li> <li>Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.</li> <li>Determine the amount of dissolved Oxygen, and free Carbon dioxide, in water collected from a nearby lake / water body.</li> <li>Visit to any aquatic Ecosystem and preparation and submission of report.</li> </ol>		

**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
<b>Unit I: Introduction to Insects</b>		6
General Features of Insects, Morphological features, Head, Eyes, Types of antennae, Mouth parts with respect to feeding habits		
<b>Unit II: Concept of Vectors</b>		6
Brief introduction of Carrier and Vectors; mechanical and biological vector, Reservoirs, Host-vector relationship, Adaptations as vectors, Host Specificity		
<b>Unit III: Insects as Vectors</b>		8
Classification of insects up to orders, detailed features of orders with insects as vectors - Diptera, Siphonaptera, Siphunculata, Hemiptera		
<b>Unit IV: Dipteran as Disease Vectors</b>		14
Dipterans, as important insect vectors - Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases - Dengue, Viral encephalitis, Filariasis; Control of mosquitoes.		
<b>Unit V: Siphonaptera as Disease Vectors</b>		6
Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases - Plague, Typhus fever; Control of fleas		
<b>Unit VI: Siphunculata as Disease Vectors</b>		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		
<b>Unit VII: Hemiptera as Disease Vectors</b>		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
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of different kinds of mouth parts of insects</li> <li>2. Study of following insect vectors through permanent slides/photographs: <i>Aedes</i>, <i>Culex</i>, <i>Anopheles</i>, <i>Pediculus humanuscapitis</i>, <i>Pediculus humanuscorporis</i>, <i>Phlebotomus argentipes</i>, <i>Musca domestica</i>,</li> <li>3. Submission of a project report on any one of the insect vectors and disease transmitted by the insect.</li> </ol>		

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

<b>Full Marks 50</b>	Credits 4	Class 60
<b>Unit 1: Introduction to Ecology</b>		4
Ecosystem, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere.		
<b>Unit 2: Population</b>		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,		
<b>Unit 3: Community</b>		11
Community characteristics: species diversity, abundance, dominance, richness, Vertical stratification, Ecotone and edge effect.		
<b>Unit 4: Ecosystem</b>		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		
<b>Unit 5: Wild Life</b>		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

<b>Full marks 30</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Identification of flora, mammalian fauna, avian fauna</li> <li>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)</li> <li>3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers, etc.</li> <li>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<sub>2</sub></li> </ol>		

## Skill Enhancement Elective Courses (SEC)

### SEMESTER –3

#### SEC-A

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

Full Marks 80	Credits 2	30 Hours
<b>Unit 1: Biology of Bees</b>		2
Classification and Biology of Honey Bees Social Organization of Bee Colony		
<b>Unit 2: Rearing of Bees</b>		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		
<b>Unit 3: Diseases and Enemies</b>		6
Bee Diseases and Enemies Control and Preventive measures		
<b>Unit 4: Bee Economy</b>		2
Products of Apiculture Industry and its Uses ;Honey, Bees Wax, Propolis, Pollen etc		
<b>Unit 5: Entrepreneurship in Apiculture</b>		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
<b>Unit 1: Introduction to Aquarium Fish Keeping</b>		2
The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes		
<b>Unit 2: Biology of Aquarium Fishes</b>		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		
<b>Unit 3: Food and feeding of Aquarium fishes</b>		8
Use of live fish feed organisms. Preparation and composition of formulated fish feeds		
<b>Unit 4: Fish Transportation</b>		5
Live fish transport - Fish handling, packing and forwarding techniques.		
<b>Unit 5: Maintenance of Aquarium</b>		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
<b>Unit 1: Introduction</b>		6
Sericulture: Definition, history and present status; Silk route; Types of silkworms, Distribution and Races Exotic and indigenous races Mulberry and non-mulberry Sericulture		
<b>Unit 2: Biology of Silkworm</b>		4
Life cycle of <i>Bombyx mori</i> ; Structure of silk gland and secretion of silk		
<b>Unit 3: Rearing of Silkworms</b>		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.		
<b>Unit 4: Pests and Diseases</b>		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		
<b>Unit 5: Entrepreneurship in Sericulture</b>		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
<b>Unit 1: Diagnostics Methods Used for Analysis of Blood</b>		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)		
<b>Unit 2: Diagnostic Methods Used for Urine Analysis</b>		4
Urine Analysis: Physical characteristics; Abnormal constituents, Urine culture		
<b>Unit 3: Non-infectious Diseases</b>		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		
<b>Unit 4: Infectious Diseases</b>		3
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite		

(Microscope based and ELISA based)	
<b>Unit 5: Clinical Biochemistry</b>	1
Lipid profiling, Liver function test. PSA test	
<b>Unit 6: Clinical Microbiology</b>	1
Antibiotic Sensitivity Test	
<b>Unit 8: Tumours</b>	2
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture,	
<b>Unit 9: Visit to Pathological Laboratory and Submission of Project</b>	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, Coelenterata, 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. 9<sup>th</sup> 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.  
 Junquera 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. Jones 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 3rd Edition—Johns & Bartlett Publishers  
 Pollard MD, Earnshaw W C, Lippincott-Schwartz. 2007. Cell Biology. 2nd Edn Saunders. Press  
 Robert A. – Biology of Cancer Weinberg. 2<sup>nd</sup> 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; Macmillan  
 Tamarin R. H. – Principles of Genetics; McGraw Hill  
 Weinberg R A. 2014. Biology of Cancer. 2<sup>nd</sup> 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; AcademicExcellence.
- 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; 5<sup>th</sup> 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 ;PLtd.
- 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, 28<sup>th</sup> 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
- Townsend, 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 Jersey 1997.
- 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 Parasitology. 2<sup>nd</sup> 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, Harvard 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. Lippincott 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. Ladsen'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, Hallgrímsson 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)