

# WBSU

## CBCS curricula and syllabi for UG 2018

### Zoology Honours

(Credit values given within brackets)

SEM	COURSES					Total credits
	CORE	DSE	GEC	AEC	SEC	
<b>I</b>	ZOOACOR01T (4) ZOOACOR01P (2)  ZOOACOR02T (4) ZOOACOR02P (2)	-	CEMHGEC01T (4) CEMHGEC01P (2) Or GEC course offered by any other science department	ENVSAECO1T (2)		<b>20</b>
<b>II</b>	ZOOACOR03T (4) ZOOACOR03P (2)  ZOOACOR04T (4) ZOOACOR04P (2)		CEMHGEC02T (4) CEMHGEC02P (2) Or Any other GEC course offered by any other science department	ENGSaec01T (2)		<b>20</b>
<b>III</b>	ZOOACOR05T (4) ZOOACOR05P (2)  ZOOACOR06T (4) ZOOACOR06P (2)  ZOOACOR07T (4) ZOOACOR07P (2)		BOTHGEC01T (4) BOTHGEC01P (2) Or Any other GEC course offered by any other science department		ZOOSSEC0M1 (2)  ANY SEC offered by any other dept,	<b>26</b>
<b>IV</b>	ZOOACOR08T (4) ZOOACOR08P (2)  ZOOACOR09T (4) ZOOACOR09P (2)  ZOOACOR10T (4) ZOOACOR10P (2)		BOTHGEC02T (4) BOTHGEC02P (2) Or Any other GEC course offered by any other science department		ZOOSSEC0M2 (2)  OR ANY SEC offered by any other dept,	<b>26</b>
<b>V</b>	ZOOACOR11T (4) ZOOACOR11P (2)  ZOOACOR12T (4)	ZOOADSE01T (4) ZOOADSE01P (2)				<b>24</b>

	ZOOACOR12P (2)	ZOOADSE02T (4) ZOOADSE02P (2)  ZOOADSE03T (4) ZOOADSE03P (2)  (ANY TWO TO BE CREDITED)				
<b>VI</b>	ZOOACOR13T (4) ZOOACOR13P (2)  ZOOACOR14T (4) ZOOACOR14P (2)	ZOOADSE04T (4) ZOOADSE04P (2)  ZOOADSE05T (4) ZOOADSE05P (2)  ZOOADSE06T (4) ZOOADSE06P (2)  (ANY TWO TO BE CREDITED)				<b>24</b>
	<b>14</b>	<b>4</b>	<b>4</b>	<b>2</b>	<b>2</b>	<b>140</b>

**COURSE DETAILS :**

**Cores**

**Semester I**

**ZOOACOR01T (Theory, 4 credits= 60 classes): Non-Chordates I**

**Unit 1: Protista, Parazoa and Metazoa (19 classes)  
classes**

General characteristics and Classification up to classes

Study of *Euglena*, *Amoeba* and *Paramecium*

Life cycle and pathogenicity of *Giardia intestinalis*, *Leishmania donovani*, *Entamoeba histolytica* and *Plasmodium vivax*

Locomotion and Reproduction in Protista

Evolution of symmetry and segmentation of Metazoa

**Unit 2: Porifera (7 classes)**

General characteristics and Classification up to classes

Canal system and spicules in sponges

**Unit 3: Cnidaria (12 classes)**

General characteristics and Classification up to classes

Metagenesis in *Obelia*

Polymorphism in Cnidaria

Corals and coral reefs: types, formation, distribution, conservation significance

**Unit 4: Ctenophora** 4 Classes

General characteristics

**Unit 5: Platyhelminthes** 10 Classes

General characteristics and Classification up to classes

Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*

**Unit 6: Nematelminthes** 8 Classes

General characteristics and Classification up to classes

Life cycle, and pathogenicity of *Ascaris lumbricoides*, *Ancylostoma duodenale* and *Wuchereria bancrofti*

Parasitic adaptations in helminths

Origin and evolution of parasitic helminths

### **ZOOACOR01P (Practicals, 2 credits = 60 classes): Non-Chordates I Lab**

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramoecium*, Binary fission and Conjugation in *Paramoecium*
2. Examination of freshwater pond water collected from different places for diversity of protists in it.
3. Study of Sycon (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*
4. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*
5. One specimen/slide of any Ctenophore
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/microphotographs)
7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs)
8. To submit a Project Report on any related topic on pond water protozoan or invertebrate diversity/ life cycles of mosquitoes, butterfly/moth etc /coral and coral reefs.

#### **Note:**

1. Only conspicuous characters required to identify the organism to be noted along with the known systematic positions of it (for Protozoans up to Phylum and others up to Class)
2. It is wise to study the coloured photographs of the organisms suggested for the study as available from internet sources along with the preserved specimens, if are there, or otherwise.

#### **Text Book:**

- Biology of the Invertebrates by Jan A Pechenik
- Invertebrates by Brusca and Brusca 2<sup>nd</sup> Ed

#### **References:**

- An introduction to Invertebrates by Janet Moore 2<sup>nd</sup> ed.

- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
- Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
- Bose, Mala. Parasitoses and Zoonoses, New Central Book Agency , 2017.
- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
- Students are encouraged to explore authentic websites (for e.g. wikipedia, different university websites, OCWs) at internet for reading / audio-visual materials on a particular topic if they don't find enough in the text books)

## **ZOOACOR02T (Theory, 4 credits= 60 classes): Ecology**

### **Unit 1: Introduction to Ecology**

**4 classes**

History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere.

### **Unit 2: Population**

**20 classes**

Unitary and Modular populations

Unique and group attributes of population: Demographic factors, life tables, fecundity tables, survivorship curves, dispersal and dispersion.

Geometric, exponential and logistic growth, equation and patterns, r and K strategies Population regulation - density-dependent and independent factors

Population Interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition.

### **Unit 3: Community**

**11 classes**

Community characteristics: species diversity, abundance, dominance, richness, Vertical stratification, Ecotone and edge effect. Ecological succession and one example of it.

### **Unit 4: Ecosystem**

**10 classes**

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 Nutrient and biogeochemical cycle with an example of Nitrogen cycle Human modified ecosystem

### **Unit 5: Applied Ecology**

**5 classes**

Wildlife Conservation (in-situ and ex-situ conservation).

Management strategies for tiger conservation; Wild life protection act (1972)

## **ZOOACOR02P (Practicals, 2 credits = 60 classes): Ecology Lab**

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density of a natural/hypothetical population. Study of species diversity of a community by quadrat or any other suitable sampling method and calculation of Shannon-Weiner diversity index for the same community.

3. Study of an aquatic ecosystem: Sampling of Phytoplankton and zooplankton, Measurements of temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO<sub>2</sub>.

4. Excursion: Visit to a National Park/Wild life sanctuary/ any other Protected Forests within West Bengal. Report (including the actual field diary) on the study of the landscape and habitat features, Types of Forests, Major Flora and Fauna, Man-animal conflicts and other problems, Management and conservation measures.

**Text book:**

1. Campbell's Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece , Published by Pearson Copyright © 2017
2. Ecology: The Experimental Analysis of Distribution and Abundance (Indian Paperback edition) by Charles Krebs (for Unit 5, also read Conservation Biology: A Primer for South Asia by Kamaljit S. Bawa, Meera Anna Oommen, and Richard B. Primack, University Press, India)

**References:**

- Ecology: Theories and Applications by Peter Stiling; Pearson 4<sup>th</sup> Ed. 2001.
- A Primer of Ecology by Gotelli; 3<sup>rd</sup> Ed. Sinauer Associates. 2000.
- Students are encouraged to explore authentic websites (for e.g. different university websites and OCWs) at internet, wikipedia for reading / audio-visual materials on a particular topic if they don't find enough in the text books or otherwise)

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**Semester II**

**ZOOACOR03T (Theory, 4 credits= 60 classes): Non-Chordates II**

**Unit 1: Introduction to Coelomates**

Evolution of coelom and metamerism

**Unit 2: Annelida**

General characteristics and Classification up to classes  
Excretion in Annelida

**Unit 3: Arthropoda**

General characteristics and Classification up to classes  
Vision and Respiration in Arthropoda  
Metamorphosis in Insects  
Social life in bees and termites

**Unit 4: Onychophora**

General characteristics and Evolutionary significance

**Unit 5: Mollusca**

General characteristics and Classification up to classes  
Respiration in Mollusca  
Torsion and detorsion in Gastropoda  
Pearl formation in bivalves  
Evolutionary significance of trochophore larva

**Unit 6: Echinodermata**

General characteristics and Classification up to classes

Water-vascular system in Asteroidea

Larval forms in Echinodermata

Affinities with Chordates

### Unit 7: Hemichordata

General characteristics of phylum Hemichordata. Phylogenetic relationship with non-chordates and chordates (only recent concept)\*

## ZOACOR03P (Practicals, 2 credits = 60 classes): Non-Chordates II Lab

1. Study of following specimens:

Annelids - *Aphrodita*, *Nereis*, *Heteronereis*, *Sabella*, *Serpula*, *Chaetopterus*, *Pheretima*, *Hirudinaria*

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

Onychophora - *Peripatus*

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

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

Hemichordates- *Saccoglossus*

2. Digestive system, septal nephridia and pharyngeal nephridia of earthworm 3. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm

4. Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta*

5. To submit a Project Report (mostly literature review) on any related topic to larval forms (crustacean, mollusc and echinoderm)

#### Note:

1. Only conspicuous characters required to identify the organism to be noted. Along with it, the systematic positions of the organism are to be mentioned (up to Class).
2. It is wise to study the coloured photographs of the whole organisms or its parts suggested for the study as available from internet sources along with the preserved specimens, if are there, and otherwise. Dissections of animals other than common pests are discouraged.

#### Text Book:

- Biology of the Invertebrates by Jan A Pechenik, Mcgrew-Hill, 2014  
Or
- Invertebrates by Brusca and Brusca 2<sup>nd</sup> Ed, Sinauer Associates

#### Reference:

- An introduction to Invertebrates by Janet Moore 2<sup>nd</sup> ed.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
- Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
- Chaudhury, S. (2017). Economic Zoology. New Central Book Agency
- <https://www.nature.com/articles/nature16150> for hemichordate phylogenetic relationship\*

- Students are encouraged to explore authentic websites (for e.g. wikipedia, different university websites and OCWs) at internet for reading / audio-visual materials on a particular topic if they don't find enough in the text books or otherwise)
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## **ZOOACOR04T (Theory, 4 credits= 60 classes): Cell Biology**

### **Unit 1: Overview of Cells**

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions

### **Unit 2: Plasma Membrane**

Various models of plasma membrane structure

Transport across membranes: Active and Passive transport, Facilitated transport

Cell junctions: Tight junctions, Desmosomes, Gap junctions

Extracellular Matrix-Cell Interactions

### **Unit 3: Endomembrane System**

Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

### **Unit 4: Mitochondria and Peroxisomes**

Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis Peroxisomes

### **Unit 5: Cytoskeleton**

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments

### **Unit 6: Nucleus**

Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome)

### **Unit 7: Cell Division**

Mitosis and Meiosis

Cell cycle and its regulation

Cancer (Concept of oncogenes and tumor suppressor genes)

Mechanisms of cell death: brief overview

### **Unit 8: Cell Signaling**

Cell signalling transduction pathways; Types of signaling molecules and receptors

GPCR and Role of second messenger (cAMP)

## **ZOOACOR04P (Practicals, 2 credits = 60 classes): Cell Biology Lab**

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Study of various stages of meiosis (in pre-prepared slides and/or in photographs obtained from websites).
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
  - a. DNA by Feulgen reaction
  - b. Mucopolysaccharides by PAS reaction
  - c. Proteins by Mercurobromophenol blue/Fast Green
5. Cell viability study by Trypan Blue staining

### **Text Book:**

1. Campbell's Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Published by Pearson Copyright © 2017

2. Cell Biology by Gerald Karp; Wiley, 7<sup>th</sup> Ed. 2013  
Or  
Essentials of Cell Biology by Bruce Albert et al.; W.W. Norton Co., 4<sup>th</sup> Ed, 2013  
Or  
Molecular Cell Biology by Hurvey Lodish et al.; W. H. Freeman, 6<sup>th</sup> Ed.2013

**Reference:**

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### **Semester III**

#### **ZOOACOR05T (Theory, 4 credits= 60 classes): Chordates**

##### **Unit 1: Introduction to Chordates**

General characteristics and outline classification of Phylum Chordata

##### **Unit 2: Protochordata**

General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes.

Metamorphosis in Ascidia

Chordate Features and Feeding in Branchiostoma

##### **Unit 3: Origin of Chordata**

Dipleurula concept and the Echinoderm theory of origin of chordates

Advanced features of vertebrates over Protochordata

##### **Unit 4: Agnatha**

General characteristics and classification of cyclostomes up to order

##### **Unit 5: Pisces**

General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses Accessory respiratory organ, migration and parental care in fishes Swim bladder in fishes. Classification up to Sub-Classes

##### **Unit 6: Amphibia**

General characteristics and classification up to living Orders

Metamorphosis and parental care in Amphibia

##### **Unit 7: Reptilia**

General characteristics and classification up to living Orders

Poison apparatus and Biting mechanism in Snake

##### **Unit 8: Aves**

General characteristics and classification up to Sub-Classes

Exoskeleton and migration in Birds

Principles and aerodynamics of flight



## Unit 9: Mammals

General characters and classification up to living orders

Phylogenetic significance of Prototheria

Exoskeleton derivatives of mammals

Adaptive radiation in mammals with reference to locomotory appendages

Echolocation in Microchiropterans and Cetaceans

## Unit 10: Zoogeography

Zoogeographical realms,

Plate tectonic and Continental drift theory,

Distribution of birds and mammals in different realms

**Note:** Classification schemes are to be followed as given in Kardong, 2004. All groups are to be studied up to order, except for Mammals up to class.

## ZOOACOR05P (Practicals, 2 credits= 60 classes): Chordates Lab

Lab/field study of –

### 1. Protochordata

*Herdmania*, *Branchiostoma*,

Colonial Urochordates; Sections of *Balanoglossus* through proboscis and branchiogenital regions,

Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions, *Herdmania* spicules

### 2. Agnatha

*Petromyzon*, *Myxine*

### 3. Fishes

*Scoliodon*, *Sphyrna*, *Pristis*, *Torpedo*, *Chimaera*, *Mystus*, *Heteropneustes*, *Labeo*, *Exocoetus*,  
*Echeneis*, *Anguilla*, *Hippocampus*, *Tetraodon*, *Anabas*, Flat fish

### 4. Amphibia

*Ichthyophis/Ureotyphlus*, *Necturus*, *Bufo*, *Hyla*, *Alytes*, *Salamandra*

### 5. Reptilia

*Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Ophiosaurus*, *Draco*, *Bungarus*,  
*Vipera*, *Naja*, *Hydrophis*, *Zamenis*, *Crocodylus* Key for Identification of poisonous and non-poisonous snakes

### 6. Aves

Study of six common birds from different orders (Stork, Owl/Falcon, Sun Bird, Jacanna, Duck)- types of beaks and claws.

### 7. Mammalia

*Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus*, *Loris*, *Herpestes*, *Erinaceus*.

### 8. Mount of weberian ossicles of *Mystus* or Grass Carp,

*Pecten* from Fowl head, Dissection of Fowl head (Dissections and mounts subject to permission)

Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

### Note:

1. Only conspicuous characters required to identify the animal are to be noted. Along with it, the systematic positions of the animal mentioned (up to Class) and a short note on its habits and habitat are to be noted.
2. It is wise to study the coloured photographs of the whole animal and/or its parts mentioned above for the study, as available from internet sources along with the preserved specimens (if, they are already in the museum). New collection/purchase of animals or their body parts, especially for

those which are protected by conservation laws are to be avoided. Dissections of animals other than common pests are discouraged.

#### **Text Book:**

- Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. McGraw Hill 4<sup>th</sup> Ed. 2005.
- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
- Pough H. Vertebrate life, VIII Edition, Pearson International.

#### **References:**

- Students are encouraged to explore authentic websites (for e.g. wikipedia, different university websites and OCWs) at internet for reading / audio-visual materials on a particular topic if they don't find enough in the text books or otherwise)
- Comparative Anatomy of the Vertebrates 9<sup>th</sup> Ed (2015) by Kent; McGrew-Hill
- Elements of Chordate Anatomy by Weichert and Presch, 2017, Amazon.in

### **ZOOACOR06T (Theory, 4 credits= 60 classes): Physiology: Controlling and Coordinating Systems**

#### **Unit 1: Tissues**

**4 classes**

Structure, locations, classification and functions of epithelial tissues, connective tissues, muscular tissues and nerve tissues

#### **Unit 2: Bone and Cartilage**

**4**

Structure and types of bones and cartilages, Ossification

#### **Unit 3: Nervous System**

**10**

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

#### **Unit 4: Muscular system**

**10**

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle fiber

#### **Unit 5: Reproductive System**

**6**

Histology of testis and ovary; Physiology of Reproduction

#### **Unit 6: Endocrine System**

**16**

Histology and function of pituitary, thyroid, pancreas and adrenal; 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 and endocrine system; Placental hormones

### **ZOOACOR06P (Practicals, 2 credits= 60 classes): Physiology: Controlling and Coordinating Systems) Lab**

1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibers and nerve cells

3. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid
4. Microtomy: Preparation of permanent slide of any five (lung, salivary gland, stomach, small intestine, large intestine only) mammalian (white rat) tissues

#### **Text Book:**

1. Campbell's Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Published by Pearson Copyright © 2017.
2. Sembulingam K, Sembulingam P. 2012. Essentials of Medical Physiology. 6th Edn. Jaypee.  
Or  
Ganong's Review of Medical Physiology by Barret; 25<sup>th</sup> Ed, McGraw-Hill, 2016

#### **Reference Books**

1. Cormack DH. 2003. PDQ Histology. B.C. Decker Ins., London.
2. Gunasegaran JP. 2010. A Text book of Histology and a Practical Guide. Elsevier
3. Junquera LC, Carneiro J. 2005. Basic histology text and atlas.
4. Randall D, Burggren W. 2001. Eckert Animal Physiology by. 4th edition. W. H. Freeman.
5. Ross MH, Pawlina W. 2010. Histology: A Text and Atlas. Sixth Edition. Lippincott Williams & Wilkins.
6. Eroschenko VP. 2008. diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott & Wilkins.

## **ZOOACOR07T (Theory, 4 credits= 60 classes): Biochemistry**

### **Unit 1: Fundamentals of biochemical reactions and metabolism**

Ionization of water, weak acids and bases, buffering and pH changes in living systems

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

### **Unit 2: Carbohydrates**

Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides; Derivatives of Monosachharides

Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis

### **Unit 3: Lipids**

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; Fatty acid biosynthesis

### **Unit 4: Proteins**

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

### **Unit 5: Nucleic Acids**

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids

Types of DNA and RNA, Complementarity of DNA, Hypo- Hyperchromaticity of DNA

Outlines of nucleotide metabolism

### **Unit 6: Enzymes**

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; Allosteric enzymes and their kinetics; Strategy of enzyme action- Catalytic and Regulatory (Basic concept with one example each)

### **Unit 7: Oxidative Phosphorylation**

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

### **ZOOACOR07P (Practicals, 2 credits= 60 classes): Biochemistry Lab**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.
3. Quantitative estimation by Lowry Method
4. Demonstration of proteins separation by SDS-PAGE.
5. Study of the enzymatic activity of Trypsin and Lipase.
6. Performing the Acid and Alkaline phosphatase assay from serum/ tissue.

### **Text Book**

1. Campbell's Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Published by Pearson Copyright © 2017.
2. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.

### **References:**

1. Principles of Biochemistry by Voet, Pratt and Voet; Wiley International Student Ed. 2012
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
4. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.



## Semester IV

### **ZOOACOR08T (Theory, 4 credits= 60 classes): Comparative Anatomy**

<b>Unit 1: Integumentary System</b>	<b>6 Classes</b>
Structure, function and derivatives of integument in amphibian, birds and mammals	
<b>Unit 2: Skeletal System</b>	<b>6</b>
Overview of axial and appendicular skeleton; Jaw suspension; Visceral arches.	
<b>Unit 3: Digestive System</b>	<b>8</b>
Comparative anatomy of stomach; dentition in mammals	
<b>Unit 4: Respiratory System</b>	<b>6</b>
Respiratory organs in fish, amphibian, birds and mammals	
<b>Unit 5: Circulatory System</b>	<b>8</b>
General plan of circulation, Comparative account of heart and aortic arches	
<b>Unit 6: Urinogenital System</b>	<b>6</b>
Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	
<b>Unit 7: Nervous System</b>	<b>6</b>
Comparative account of brain, Cranial nerves in mammals	
<b>Unit 8: Sense Organs</b>	<b>4</b>
Classification of receptors, Brief account of auditory receptors in vertebrate	

### **ZOOACOR08P (Practicals, 2 credits= 60 classes): Comparative Anatomy Lab**

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Study of disarticulated skeleton of Toad, Pigeon and Guineapig
3. Demonstration of Carapace and plastron of turtle
4. Identification of mammalian skulls: One herbivorous (Guineapig) and one carnivorous (Dog) animal
5. Dissection of Tilapia: Circulatory system, Brain, pituitary, urinogenital system

#### **Text Book:**

1. Comparative Anatomy of the Vertebrates 9th Ed (2015) by Kent; McGrew-Hill
2. Elements of Chordate Anatomy by Weichert and Presch, 2017, Amazon.in

#### **References:**

- Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons
- Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. McGraw Hill 4<sup>th</sup> Ed. 2005.

## **ZOOACOR09T (Theory, 4 credits= 60 classes): Physiology: Life Sustaining system**

### **Unit 1: Physiology of Digestion**

**12**

Structural organisation and functions of Gastrointestinal tract and Associated glands; Mechanical and chemical digestion of food, absorption of Carbohydrates, Lipids, Proteins and Nucleic Acids; Digestive enzymes

### **Unit 2: Physiology of Respiration**

**10**

Mechanism of Respiration, Respiratory volumes and capacities, transport of Oxygen and Carbon dioxide in blood, Dissociation curves and the factors influencing it, respiratory pigments; Carbon monoxide poisoning

### **Unit 3: Physiology of Circulation**

**12**

Components of Blood and their functions; Structure and functions of haemoglobin; Haemostasis; Blood clotting system, Fibrinolytic system; Haemopoiesis: Basic steps and its regulation; Blood groups; ABO and Rh factor

### **Unit 4: Physiology of Heart**

**8**

Structure of mammalian heart, Coronary Circulation, Structure and working of conducting myocardial fibers, Origin and conduction of cardiac impulses; Cardiac Cycle and cardiac output; Blood pressure and its regulation

### **Unit 5: Thermoregulation & Osmoregulation**

Physiological classification based on thermal biology. Thermal biology of endotherms; Osmoregulation in aquatic vertebrates; Extra-renal osmo-regulatory organs in vertebrates

### **Unit 6: Renal Physiology**

**8**

Structure of Kidney and its functional unit, Mechanism of urine formation, Regulation of acid-base balance

## **ZOOACOR09P (Practicals, 2 credits= 60 classes): Animal Physiology: Life Sustaining system Lab**

### **List of Practical**

1. Determination of ABO Blood group
2. Enumeration of red blood cells and white blood cells using haemocytometer
3. Estimation of haemoglobin using Sahli's haemoglobinometer
4. Preparation of haemin and haemochromogen crystals
5. Recording of blood pressure using a sphygmomanometer/digital meter

### **Text Book:**

1. Campbell's Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Published by Pearson Copyright © 2017.
2. Ganong's Review of Medical Physiology by Barret; 25<sup>th</sup> Ed, McGraw-Hill, 2016

### **Reference Books**

1. Elaine N. Marieb, 2006. Human Anatomy & Physiology, Pearson Education.

2. Eroschenko VP. 2008. diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott & Wilkins.
3. Fox SI. 2011. Human Physiology. 12th Edn. Mc Graw Hill
4. Gunstream SE. 2010. Anatomy and Physiology with integrated study guide. 4th Edn., Mc Graw Hill.
5. Guyton AC, Hall JE. 2006. Textbook of Medical Physiology. XI Edn. Hercourt Asia PTE Ltd. W.B. Saunders Company.
6. Hill RW, Wyse GA, Anderson M. 2012. Animal Physiology. 3rd Edn. Sineuer Associaes.
7. Sembulingam K, Sembulingam P. 2012. Essentials of Medical Physiology. 6th Edn. Jaypee Pub, New Delhi
8. Sherwood L. 2013. Human Physiology from cells to systems. 8th Edn., Brooks & Cole
9. Tortora GJ, Grabowski S. 2006. Principles of Anatomy & Physiology. XI Edition John Wiley & son
10. Vander A, Sherman J, Luciano D. 2014. Vander's Human Physiology: The Mechanism of Body Function. XIII Edn. McGraw Hills

## **ZOOACOR10T (Theory, 4 credits= 60 classes): Immunology**

### **Unit 1: Overview of Immune System** 4

Basic concepts of health and diseases, Historical perspective of Immunology, Organs (Primary & Secondary lymphoid organs and its importance) and Cells of the Immune system, Concept of Haematopoiesis and development of progenitor cells of the Immune system (Brief idea)

### **Unit 2: Innate and Adaptive Immunity** 6

Principle of Innate and Adaptive Immunity.

- Components of innate immunity
  - Epithelial barriers (skin and mucosal membranes [concept])
  - Cellular mechanisms (phagocytes, NK cells, mast cells, eosinophils, inflammation [concept])
  - Humoral mechanisms (complement, cytokines, chemokines etc. [concept])
- Components of adaptive immunity
  - Cellular mechanisms (Cell-Mediated Immune System (CMIS) or T-Cell Immunity [concept])
  - Humoral mechanisms (Formation of Plasma B cells and Memory B cells [concept])

6

### **Unit 3: Antigen, Antigen presentation & MHC**

Concept of Antigen, Immunogen, Allergen & Pathogen. Adjuvants and haptens, Factors influencing immunogenicity, Epitope. Types of Antigen Presenting Cells (APC), Structure of Major Histocompatibility Complex (MHC) molecules. Mechanism of antigen presentation and involvement of MHC molecules (both MHC-I & MHC-II) in details. Co-stimulatory molecules on APC.

6

### **Unit 3: T Cell development**

Structure of T cell receptors, Co-stimulatory molecules on T cells Concept of synapse between APC & T cells (between MHC~TCR & between Co-stimulatory molecules) in details. Central differentiation of T cells; T cell selection in thymus

Peripheral differentiation of T cells; Th1 & Th2	6
<b>Unit 4: Immunoglobulins</b>	
Structure and functions of different classes of immunoglobulins, Antigen- antibody interactions, Immunoassays (ELISA and RIA), Hybridoma technology, Monoclonal antibody production	
<b>Unit 6: Cytokines &amp; Chemokines</b>	4
Brief concept on types of Cytokines & Chemokines	
Cytokines (source & function of IL-1, IL-2, IL-4, IL-5, IL-6, IL-8, IL-10, IL-12, Interferons, Tumor Necrosis Factors, Tumor Growth Factors, GM-CSF, M-CSF).	
Chemokines (source & function of CCL2, CCL3, CCL4, CCL5, CxCL8, CxCL10)	4
<b>Unit 7: Complement System</b>	
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: Immunology of diseases</b>	6
Malaria, Visceral Leishmaniasis, Filariasis, Dengue and Tuberculosis	
<b>Unit 10: Vaccines</b>	4
Various types of vaccines. Active & passive immunization (Artificial and natural).	

## **ZOOACOR10P (Practicals, 2 credits= 60 classes): Immunology Lab**

### **List of Practical**

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

*(The experiments can be performed on white rats).*

### **Text Book**

1. Campbell's Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Published by Pearson Copyright © 2017.
2. Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication

### **Reference Books**

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). Immunology, VI Edition. W.H. Freeman and Company.
- Abbas, K. Abul and Lechtman H. Andrew (2003.) Basic Immunology E-Book: Functions and Disorders of the Immune System; 2012 Saunders Publication



## Semester V

### **ZOOACOR11T (Practicals, 2 credits= 60 classes): Molecular Biology Lab**

#### **Unit 1: Nucleic Acids**

Salient features of DNA and RNA Watson and Crick Model of DNA

#### **Unit 2: DNA Replication**

Mechanism of DNA Replication in Prokaryotes, Semi-conservative, bidirectional and discontinuous Replication, RNA priming, Replication of telomeres

#### **Unit 3: Transcription**

Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.

#### **Unit 4: Translation**

Mechanism of protein synthesis in prokaryotes, Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

#### **Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA**

Capping and Poly A tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA

#### **Unit 6: Gene Regulation**

Regulation of Transcription in prokaryotes: lac operon and trp operon; Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing, Genetic imprinting

#### **Unit 7: DNA Repair Mechanisms**

Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair

#### **Unit 8: Molecular Lab Techniques**

PCR, Western and Southern blot, Northern Blot, Sanger DNA sequencing , cDNA technology

### **ZOOACOR11P (Practicals, 2 credits= 60 classes): Molecular Biology Lab**

#### **List of Practicals**

1. Demonstration of polytene Chromosome from Drosophila /Chironomid larvae
2. Isolation and quantification of genomic DNA using spectrophotometer (A260 measurement)
3. Agarose gel electrophoresis for DNA

#### **Text Book:**

1. Campbell's Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece , Published by Pearson Copyright © 2017.
2. Molecular Biology of The Gene by Watson. 7th Edition. Pearson.

#### **References:**

- Molecular Cell Biology by Harvey Lodish. 7th Edition. W.H. Freeman.
- iGenetics: A Molecular Approach by Peter. J. Russell. 3rd edition. Pearson Benjamin Cummings.

- Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, Cambridge Univ. Press, Paperback

## **ZOOACOR12T (Theory, 4 credits= 60 classes): Genetics**

### **Unit 1: Mendelian Genetics and its Extension**

Background of Mendel's experiments

Principles of Mendelian inheritance,

Incomplete dominance and co-dominance, Epistasis, Multiple alleles, Lethal alleles,

Pleiotropy, Sex-linked, sex- influenced and sex-limited inheritance, Polygenic Inheritance.

### **Unit 2: Linkage, Crossing Over and Chromosomal Mapping**

Linkage and Crossing Over, molecular basis of crossing over, Measuring Recombination frequency and linkage intensity using three factor crosses, Interference and coincidence

### **Unit 3: Mutations**

1. Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example of each), Chromosomal aberrations, gene mutations and human diseases (Down's, Klienfelter's, Turner's, Cri du Chat, Sickle cell, Haemophilia, Thallassimia, Albinism – only genetical aspects here, details of physiological consequences not required), Sex chromosomes and sex-linked inheritance

2. Non-disjunction and variation in chromosome number; Molecular basis of mutations in relation to UV light and chemical mutagens

### **Unit 4: Sex Determination**

Mechanisms of sex determination in Drosophila with reference to alternative splicing

Sex determination in mammals

Dosage compensation in Drosophila & Human

### **Unit 5: Extra-chromosomal Inheritance**

Criteria for extra chromosomal inheritance, Antibiotic resistance in Chlamydomonas, Kappa particle in Paramoecium Shell spiralling in snail

### **Unit 6: Recombination in Bacteria and Viruses**

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

### **Unit 7: Transposable Genetic Elements**

Transposons in bacteria,

Ac-Ds elements in maize and P elements in Drosophila,

LINE, SINE, Alu elements in humans

## **ZOOACOR12P (Practicals, 2 credits= 60 classes): Genetics**

### **List of Practical**

1. Chi-square analyses

Statistical tests of data and decision making

Chi square test for goodness of fit and student t test for comparing means of two small samples from normal populations (paired/unpaired)

2. Pedigree analysis of some inherited traits in human

3. Identification of chromosomal aberration in Drosophila from photographs

### Text Book

1. Campbell's Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Published by Pearson Copyright © 2017.
2. Principles of Genetics by Robert Tamarin; McGraw Hill, 7<sup>th</sup> Ed. 2017  
Or  
Principles of Genetics by Snustad, D.P., Simmons, M.J. (2009). 5<sup>th</sup> Ed. John Wiley and Sons Inc

### Reference Books

- Developmental biology by Scott. F. Gilbert, 9th edition.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings
- Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings

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## Semester VI

### **ZOOACOR13T (Theory, 4 credits= 60 classes): Developmental Biology**

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

2 Classes

Basic concepts: Phases of Development, Cell-cell interaction, Differentiation and growth, Differential gene expression

#### **Unit 2: Early Embryonic Development**

20

Gametogenesis, Spermatogenesis, Oogenesis;

Types of eggs, Egg membranes;

Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula;

Fate maps (including Techniques);

Early development of frog and chick up to gastrulation; Embryonic induction and organizers

#### **Unit 3: Late Embryonic Development**

8

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

#### **Unit 4: Post Embryonic Development**

12

Development of brain and Eye in Vertebrate Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each)

#### **Unit 5: Implications of Developmental Biology**

8

Teratogenesis: Teratogenic agents and their effects on embryonic development;

In vitro fertilization, Stem cell (ESC), Amniocentesis

## **ZOOACOR13P (Practicals, 2 credits= 60 classes): Developmental Biology Lab**

### **List of Practical**

1. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
2. Study of the developmental stages and life cycle of *Drosophila* from stock culture
3. Study of different sections of placenta (microphotographs/ slides)
4. Project report on *Drosophila* culture/chick embryo development

### **Text Book:**

1. Campbell's Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Published by Pearson Copyright © 2017.
2. Developmental Biology by Gilbert, S. F. (2010), IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA

### **References:**

- Principles of Development by Wolpert and Beddington; OUP Oxford, 2<sup>nd</sup> Ed., 2001
- Essential Developmental Biology by Slack JMW; 3<sup>rd</sup> Ed., Wiley

## **ZOOACOR14T (Theory, 4 credits= 60 classes): Evolutionary Biology**

### **Unit 1: Oigin of earliest life**

5 classes

Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes, three domains of life

### **Unit 2: Historical review of evolutionary concept**

7

Pre-Darwinian Concepts and theories including Lamarckism, Darwinian Theory, Neo-Darwinian Synthesis, Anti-evolutionary ideas of Creationism and their scientific refusal

### **Unit 3: Evidences in favour of Evolution**

4

Fossil records: types of fossils, geological time scale, transitional forms: examples of fossils depicting the evolutionary stages of the modern horses  
Molecular (universality of genetic code and protein synthesis machinery) evidences

### **Unit 4: Sources of variations**

3

Heritable variations present in natural populations (classical study of Lewontin and Hubby, 1966 in *Drosophila*, as example)

### **Unit 5: Population genetics:**

16

Concept of Populations and calculation of allele frequencies in a population  
Hardy-Weinberg Law and equilibrium (derivations, applications of law to find gene and genotype frequencies in human Populations)  
Evolutionary forces disrupting H-W equilibrium-

Natural selection: Definition as the non-differential rate of reproductions and survivals of competing alleles, concept of fitness, selection coefficient, Types of natural selection with examples- Disrupting, Stabilizing, Directional.

Genetic Drift- outline of its mechanism, basic concepts and examples of founder's effect, bottleneck phenomenon;

Role of Gene flow and Mutation rates in changing allele frequencies in a population (No mathematical models)

### **Unit 6: Products of evolution**

10

Inter-population variations: clines, races, Species concepts and modes of speciation (just outlines of Allopatric, Sympatric and Parapatric speciation models with examples ), Isolating mechanisms Adaptive radiations/ macroevolution as exemplified by Galapagos finches

### **Unit 7: Extinctions**

2

Major mass extinctions in the history of life and their impacts on biodiversity on earth (brief descriptions)

### **Unit 8: Origin and evolution of man**

6

Unique hominin characteristics contrasted with primate characteristics (including social and cultural ones), Primate phylogeny: from Dryopithecus leading to Homo sapiens, Molecular evidences of human origin and migrations (brief outline)

### **Unit 8: Molecular Phylogeny**

7

The basic concept of molecular phylogeny, Neutral theory of molecular evolution, molecular clock (brief introductions)

Example of evolution in vertebrate globin genes

## **ZOOACOR14P (Practicals, 2 credits= 60 classes): Evolutionary Biology Lab**

### **List of Practical**

1. Study of fossils from models/ photographs- Direct ancestors of horses, Archaeopteryx
2. Study of homology and analogy from suitable specimens (from Photographs/models)
3. Verification of Hardy-Weinberg equilibrium in a population by chi square analysis
5. Collection of a sample of height, weight, age, sex data from at least 100 individuals and applying of different statistical analyses (frequency distribution, mean, mode, standard deviations, correlations, etc) and graphical representations.

### **Text Book:**

1. Campbell's Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece , Published by Pearson Copyright © 2017.
2. Evolution by Ridley, M. 3<sup>rd</sup> Ed.(2004) Blackwell publishing  
Or  
Evolutionary Biology Douglas, J. Futuyma (1997); Sinauer Associates

### **Reference:**

- Evolution by Barton et al, 1<sup>st</sup> Ed. 2007 Cold Spring Harbor Lab Press
- Why Evolution is True by Jerry Coyne; 2010, Penguin India
- Strickberger's Evolution by Hall and Halgrimmson; 5<sup>th</sup> Revised Ed., 2013, Jones and Bartlett,

## **DSE: DISCIPLINE SPECIFIC ELECTIVE Courses**

**(Semester V: any two courses to be credited for honours)**

### **ZOADSE01T (Theory 4 Credits = 60 classes): Animal Behaviour and Chronobiology**

#### **Unit 1: Introduction to Animal Behaviour**

1. A brief history of animal behaviour studies including the works of Fabre, Darwin, Von Frisch, Lorenz, Tinbergen, Jane Goodal, Biruté Galdikas, Dian Fossey, Salim Ali, Gopal Bhattacharyya, M. K. Chandrashekar, Raghavendra Gadagkar.
2. The objectives of modern animal behaviour studies: Tinbergen's four questions.
3. Methods of studying behaviours: observation vs Watching, Ad libitum observations, Focal animal studies, Instantaneous scan, etc.
4. Branches of Animal Behaviour Studies

#### **Unit 2: Behaviours of Individuals**

1. Reflexes and Orientations
2. Instinct
3. Learning: Imprinting and other Programmed Learning, Habituation, Innovations and Cultural Transmission / Social Learning

#### **Unit 3: Social and Sexual Behaviour**

1. Social Behaviour: Concept of Society; Communication and the senses Altruism;
2. Insects' society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance.
3. Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care. Pheromones.

#### **Unit 4: Introduction to Chronobiology**

1. Historical developments in chronobiology;
2. Biological oscillation: the concept of Average, amplitude, phase and period
3. Adaptive significance of biological clocks

#### **Unit 5: Biological Rhythm**

1. Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms;
2. Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms;
3. Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.

### **ZOADSE01P (Practical, 2 Credits=60 Classes): Animal Behaviour and Chronobiology Lab**

#### **List of Practical**

1. To study nests and nesting habits of the birds and social insects (e.g. Social Wasps, .
2. To study the behavioural responses of wood lice to dry and humid conditions.
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.

5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.
6. Study and actogram construction of locomotor activity of suitable animal models.
7. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

**Text Book:**

1. Animal Behaviour: Mechanisms. Ecology. Evolution by Drickamar, Vessey, 5<sup>th</sup> Ed. Jakob; McGraw Hill.
2. Survival Strategies by Raghavendra Gadagkar, University Press

**Reference:**

- An Introduction to Animal Behaviour by Manning and Dawkins; 5<sup>th</sup> Ed. Cambridge Univ. Press
- Measuring Behaviour: An Introductory Guide by Martin and Bateson; 3<sup>rd</sup> Ed. Cambridge Univ. Press
- Introduction to Behavioural Ecology by Krebs and Davies; Wiley-Blackwell

**ZOOADSE02T (Theory 4 Credits = 60 classes): Entomology: Insects and their Biology**

**Unit 1: Introduction** 2

General Features of Insects  
Distribution and Success of Insects on the Earth

**Unit 2: Insect Diversity and Classifications** 12

Classifications of Arthropods with special reference to Insects (Insects are to be classified up to order with estimated species richness of the orders globally, in India and in West Bengal. Conspicuous/important families/Genera/species of each order have to be noted with their peculiar habits and habitats)

**Unit 3: General Morphology of Insects**

External Features; Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits  
Thorax: Wings and wing types, Types of Legs adapted to diverse habitats, Abdominal appendages and genitalia- only brief introduction.

**Unit 4: Physiology of Insects** 14

Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system (brief outlines)  
Photoreceptors: Types, Structure and Function (brief introductions)  
Metamorphosis: Types and Neuroendocrine control of metamorphosis (introductory)

6

**Unit 5: Insect Society**

Social insects: different types of social insects with brief outlines of their social systems  
Trophallaxis in social insects such as ants, termites and bees

4

**Unit 6: Insect Plant Interaction**

Outline of the concept of co-evolution, role of allelochemicals in host plant mediation, Host-plant selection by phytophagous insects, Major insect pests in paddy

8

**Unit 7: Insects as Vectors**

Insects as mechanical and biological vectors, Brief discussion on houseflies and mosquitoes as important vectors

## **ZOADSE02P (Practical, 2 Credit=60 Classes): Biology of Insects Lab**

### **List of Practical**

1. Study of life cycle of Mosquito
2. Study of different kinds of antennae, legs and mouth parts of insects (any three)
3. Mounting of insect wings, spiracles and genitalia of any insects
4. Methodology of collection, preservation and identification of insects.
5. Morphological studies of various castes of *Apis*, *Camponotus* *Odontotermes*
6. Study of major insect pests of paddy and their damages
7. Study of Mulberry silk moth as beneficial insect

### **Text Book:**

1. The Insects: Structure and function, Chapman, R. F., Cambridge University Press,
2. A general text book of entomology, Imms , A. D., Chapman & Hall,

### **References**

- Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA
- Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication, USA
- The Insect Societies, Wilson, E. O., Harward Univ. Press, UK
- Host Selection by Phytophagous insects, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
- Physiological system in Insects, Klowden, M. J., Academic Press, USA
- Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA
- Medical Entomology, Hati A. K., Allied Book Agency, 2010

## **ZOADSE03T (Theory, 4 Credit=60 Classes): Endocrinology**

### **Unit 1: Introduction to Endocrinology**

**4**

General idea of Endocrine systems, Classification, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones

### **Unit 2: Epiphysis, Hypothalamo-hypophysial Axis**

**16**

Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction; Structure and functions of hypothalamus and Hypothalamic nuclei, Regulation of neuroendocrine glands, Feedback mechanisms; Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophysial portal system, Disorders of pituitary gland.

### **Unit 3: Peripheral Endocrine Glands**

**16**

Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis; Hormones in homeostasis, Disorders of endocrine glands

### **Unit 4: Regulation of Hormone Action**

**14**

Mechanism of action of steroidal, non-steroidal hormones with receptors Bioassays of hormones using RIA & ELISA; Estrous cycle in rat and menstrual cycle in human; Multifaceted role of Vasopressin & Oxytocin; Hormonal regulation of parturition



## ZOADSE03T (Practical, 2 Credit=60 Classes): Endocrinology Lab

### List of Practical

1. Dissect and display of Endocrine glands in rat.
2. Study of the permanent slides of all the endocrine glands
3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland
4. Estimation of plasma level of any hormone using ELISA
5. Designing of primers of any hormone

### Text Book:

1. Hall JE. 2015. Guyton and Hall Textbook of Medical Physiology. 13th Edition. Saunders publication.
2. Ross MH, Pawlina W. 2010. Histology: A Text and Atlas. Sixth Edition. Lippincott Williams and Wilkins.
3. Norris DO, Carr JA. 2013. Vertebrate Endocrinology. 5 editions Academic Press;

### References:

4. Fox T, Brooks A, Baidya B. 2015. Endocrinology. JP Medical, London.
5. Gardner DG, Shoback D. 2011. Greenspan's Basic and Clinical Endocrinology. 9<sup>th</sup> Edn. McGraw Hill Lange.
6. Goodman HM. 2000. Basic Medical Endocrinology. 4th Edn. Academic Press.
7. Jameson JL. 2010. Harrison's Endocrinology. 2nd Edn. McGraw Hill.
8. Melmed S, Conn PM. 2005. Endocrinology: Basic and Clinical Principles. 2nd Edn. Humana Press.
9. Melmed S, Polonsky K, Larsen PR, Kronenberg H. 2016. William's Text Book of Endocrinology. 13<sup>th</sup> Edn. Elsevier.
10. Molina PE. 2013. Endocrine Physiology. 4th Edn. McGraw Hill Lange.
11. Neal JM. 2000. Basic Endocrinology; An Interactive Approach. Blackwell Science.
12. Norris DO. 2007. Vertebrate Endocrinology. 4th Edn. Elsevier Academic Press.
13. Strauss JF, Barbieri RL. 2014. Yen & Jaffe's Reproductive Endocrinology. Elsevier Saunders

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**(Semester VI: any two courses to be credited for honours)**

## ZOADSE04T (Theory 4 Credits = 60 classes): Fish and Fishery

### Unit 1: Introduction and Classification

4

General description of fish

Feeding habit, habitat and manner of reproduction

Classification of fish (up to Subclasses) with important examples

14

### Unit 2: Morphology and Physiology

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; Osmoregulation in Elasmobranchs; Reproductive strategies (special reference to Indian fish); Electric organ, Bioluminescence

10

### Unit 3: Fisheries

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

16

#### **Unit 4: Aquaculture**

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products

#### **Unit 5: Fish in research**

6

Transgenic fish, Zebra fish as a model organism in research

### **ZOOADSE04P (Practical, 2 Credits = 60 classes): Fish and Fishery**

#### **List of Practical**

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

#### **Text Book:**

Q. Bone and R. Moore, *Biology of Fishes*, Talyor and Francis Group, CRC Press, U.K.

#### **Reference**

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

## ZOADSE05T (Theory, 4 Credits = 60 classes): Parasitology

### Unit 1: Introduction to Parasitology

3

Brief introduction of Parasitism and other animal associations, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship and zoonosis

### Unit 2: Parasitic Protists 15

15 Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*, *Plasmodium vivax*, *Plasmodium falciparum* and *Toxoplasma gondii*

### Unit 3: Parasitic Platyhelminthes 15

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciola hepatica*, *Paragonimus westermani*, *Schistosoma haematobium*, *Taenia solium*, *Echinococcus granulosus* and *Hymenolepis nana*

### Unit 3: Parasitic Nematodes 15

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis*. Study of structure, life cycle and importance of Meloidogyne (root knot nematode), Pratylenus (lesion nematode)

### Unit 4: Parasitic Arthropoda 3

Mosquitoes and flies as vectors of human pathogen

Biology, importance and control of myiasis causing diptera

Biology, importance and control of ticks, mites, *Pediculus humanus* (head and body louse), *Xenopsylla cheopis* and *Cimex lectularius*

### Unit 6: Parasitic Vertebrates

2

A brief account of parasitic vertebrates; Cookiecutter Shark, Candiru, Hood Mockingbird and Vampire bat

## ZOADSE05P (Practical, 2 Credits = 60 classes): Fish and Fishery

### List of Practicals

- Study of life stages of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* and *Plasmodium vivax* through permanent slides/micro photographs
- Study of adult and life stages of *Fasciola hepatica*, *Schistosoma haematobium*, *Taenia solium* and *Hymenolepis nana* through permanent slides/micro photographs
- Study of adult and life stages of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis* through permanent slides/micro photographs .
- Study of plant parasitic root knot nematode, Meloidogyne from the soil sample
- Study of *Pediculus humanus* (Head louse and Body louse), *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/ photographs
- Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry]
- Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a by product]

**Text Book:**

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

**References:**

- Bose, M.(2017). Parasitoses and Zoonoses. New Central Book Agency(P) Ltd
- Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors
- Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers
- Noble, E.R. and Noble G.A. (1982) Parasitology: The biology of animal parasites. V Edition, Lea & Febiger
- Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi
- Rattan Lal, Ichhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi

**ZOADSE06T (Theory, 4 Credits = 60 classes): Wildlife and Conservation**

<b>Unit 1: Introduction to Wild Life</b>	<b>5</b>
Values of wild life; Importance of conservation; Causes of depletion of Wildlife in India;	
<b>Unit 2: Evaluation and management of wild life</b>	<b>12</b>
Forest habitats: major forest types of India and West Bengal Forest covers estimation: remote sensing and GIS	
<b>Unit 3: Management of habitats</b>	<b>8</b>
Management of Successional wild habitats Forest fire Restoration of degraded wild habitats (The above topics should be learnt in reference to the protected areas in West Bengal)	
<b>Unit 4: Population estimation</b>	<b>10</b>
Population and population density estimations: different methods in practice Sex Ratio computation and Fertility status	
<b>Unit 5: Wildlife conservation practices in India</b>	<b>5</b>
Traditional Conservation ethics and practices in India Conservation strategies and Practices: Wildlife Acts (IUCN, WPA of India, CITES etc)	
<b>Unit 6: Management planning of wild life in protected areas</b>	<b>5</b>
Estimation of carrying capacity; Eco tourism / wild life tourism in forests; Concept of climax persistence; Ecology of perturbation.	
<b>Unit 7: Man and Wildlife</b>	<b>5</b>
Causes and consequences of human-wildlife conflicts; Mitigation of conflict – an overview; Wildlife/Ecotourism advantages and disadvantages	

## **Unit 8: Protected areas**

**10**

Major wildlife areas in India (all from West Bengal): Sanctuaries, National Parks, Tiger and other Wildlife Reserves, Biosphere reserves, etc.

Community reserve: concepts and examples

Management challenges in Tiger reserve

## **ZOADSE06P (Practical, 2 Credits = 60 classes): Wildlife and Conservation**

### **List of Practicals**

1. Identification of common local flora, mammalian fauna, avian fauna, herpeto-fauna
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Range Finders, Global Positioning System, Various types of Cameras and lenses)
3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers, etc.
4. Demonstration of different field techniques for flora and fauna
5. Quadrat and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment.
6. Trail / transect monitoring for abundance and diversity estimation of mammals and birds, butterflies (direct and indirect evidences)

### **Text Book:**

1. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
2. Conservation Biology: A Primer for South Asia by Kamaljit S. Bawa, Meera Anna Oommen, and Richard B. Primack, Atree and University Press

### **References:**

1. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Coexistence? Cambridge University.
2. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5 th edition. The Wildlife Society, Allen Press.
3. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
4. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

## General Electives

**(GEC offered by the Dep. Of Zoology for students studying with honours level core courses other than offered by the Dep. Of Zoology)**

*Same as offered as core courses for the BSc general students*

<b>ZOOHGEC01T: Animal Diversity</b>	
<b>Theory (Credits 4)</b>	<b>Class</b>
<b>Unit-1 Kingdom Protista</b>	
General characters and classification of Subkingdom Protozoa up to Phylum (Levine et al., 1980); Locomotory Organelles and locomotion in Protozoa	<b>3</b>
<b>Unit-2 Phylum Porifera</b>	
General characters and classification up to classes; Canal System in <i>Sycon</i>	<b>3</b>
<b>Unit-3 Phylum Cnidaria</b>	
General characters and classification up to classes; Polymorphism in Hydrozoa	<b>3</b>
<b>Unit-4 Phylum Platyhelminthes</b>	
General characters and classification up to classes; Life history of <i>Taenia solium</i>	<b>3</b>
<b>Unit-5 Phylum Nematoda</b>	
General characters and classification up to classes; Life history of <i>Ascaris lumbricoides</i> and its parasitic adaptations	<b>3</b>
<b>Unit-6 Phylum Annelida</b>	
General characters and classification up to classes; Nephridia in Annelida	<b>3</b>
<b>Unit 7 Phylum Arthropoda</b>	
General characters and classification up to classes; Vision in insect, Metamorphosis in Insects	<b>5</b>
<b>Unit-8 Phylum Mollusca</b>	
General characters and classification up to classes; Respiration in <i>Pila</i>	<b>3</b>
<b>Unit-9 Phylum Echinodermata</b>	
General characters and classification up to classes; Water-vascular system in <i>Asterias</i>	<b>4</b>
<b>Unit-10 Protochordates</b>	
General features; Feeding in <i>Branchiostoma</i>	<b>2</b>
<b>Unit-11 Agnatha</b>	
General features and classification up to classes (Young, 1981)	<b>2</b>
<b>Unit-12 Pisces</b>	
General features and Classification up to Subclasses (Romer, 1959); Osmoregulation in Fishes	<b>3</b>
<b>Unit-13 Amphibia</b>	
General features and Classification up to living orders (Duellman & Trueb, 1986); Metamorphosis in Toad	<b>3</b>
<b>Unit-14 Reptiles</b>	
General features and Classification up to living Subclass (Young, 1981); Poisonous and non-poisonous snakes, Biting mechanism in snakes	<b>4</b>
<b>Unit-15 Aves</b>	
General features and Classification up to orders (Young, 1981); Flight adaptations in birds	<b>3</b>
<b>Unit-16 Mammals</b>	
Classification up to Subclasses (Young, 1981); Origin & distribution of Cranial nerves in <i>Cavia</i>	<b>3</b>
<b>Suggested Readings [Consult Latest Editions]</b>	
1. Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6thEd. Brooks Cole.	
2. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates.	
3. Kardong, K.V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.	
4. Kent, G.C. & Carr, R.K. (2001). Comparative anatomy of theVertebrates. 9thEd. McGraw Hill.	
5. Romer, A.S. & Parsons, T.S.(1986).The vertebrate body. 6thEd. Saunders College Pub.	
6. Ruppert E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: a Functional Evolutionary Approach. 7th Ed. Brooks Cole.	
7. Young, J. Z.(2004).The Life of Vertebrates. III Edition. Oxford university press.	

**ZOOHGEC01P: Animal Diversity Lab (Credits 2)****1. Spot identification of the following specimens:**

*Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Euspongia,, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria and Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Passer, Psittacula, Alcedo, Sorex, Pteropus, Funambulus, Suncus*

2. Study of the following permanent slides: Transverse section of male and female *Ascaris*

3. Identification of poisonous and non-poisonous snakes

4. 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.

**Suggested Readings:**

1. Chatterjee and Chatterjee: Practical Zoology

2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata

**ZOOHGEC02T, Physiology and Biochemistry**

<b>Theory (Credits 4)</b>	<b>Class</b>
<b>Unit-1 Nerve and muscle</b>	<b>8</b>
1. Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres.	
2. Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction.	
<b>Unit-2 Digestion</b>	<b>5</b>
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids	
<b>Unit-3 Respiration</b>	<b>5</b>
Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood	
<b>Unit-4 Excretion</b>	<b>5</b>
Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism	
<b>Unit-5 Cardiovascular system</b>	<b>6</b>
Composition of blood, Homeostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle	
<b>Unit-6 Reproduction and Endocrine Glands</b>	<b>7</b>
Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle. Structure and function of pituitary, thyroid, pancreas and adrenal	
<b>Unit 7 Carbohydrate: Structure and Metabolism</b>	<b>8</b>
Introduction to Carbohydrates, Structure & Types of Carbohydrates, Isomerism, Introduction to Intermediary metabolism: Glycolysis, Krebs cycle, Pentose phosphate pathway, Gluconeogenesis, Electron transport chain	
<b>Unit-8 Lipid: Structure and Metabolism</b>	<b>5</b>
Introduction to Lipids: Definitions; fats and oils; classes of lipids; Lipoproteins; Biosynthesis and $\beta$ oxidation of palmitic acid	
<b>Unit-9 Protein: Structure and metabolism</b>	<b>5</b>
Proteins and their biological functions, functions of amino acids, physicochemical properties of amino acids. Peptides – structure and properties; primary structure of protein, secondary, tertiary and quaternary structures. Transamination, Deamination and Urea Cycle.	
<b>Unit-10 Enzymes</b>	<b>4</b>
Introduction, Classification of Enzymes, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation	

**Suggested Readings**

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edn. W.H Freeman & Co.

2. Chatterjea, MN and Shinde, R (2012) . A Textbook of Medical Biochemistry. 8th Edn. Jaypee Pub., N.Delhi

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

4. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper's Illustrated Biochemistry.

- XXVIII Edition. Lange Medical Books/Mc Graw3Hill.
- Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
  - Sherwood, L. (2013). Human Physiology from cells to systems. 8th Edn., Brooks & Cole
  - Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.
  - Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology, XI Edition., McGraw Hill
  - Elaine N. Marieb, 2006. Human Anatomy & Physiology, Pearson Education.

### ZOOHGEC02P: Physiology and Biochemistry Lab (Credits 2)

- Preparation of haemin crystals
- Identification of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland, small intestine, liver, lung, kidney
- Qualitative tests to identify functional groups of carbohydrates in given solutions: Glucose (Benedict's test), Sucrose (Iodine test)
- Quantitative estimation of total protein in given solutions by Lowry's method.
- Study of activity of salivary amylase under optimum conditions.

### ZOOHGEC03T: Insect, Vectors and Diseases

Theory (Credits 4)	Class
<b>Unit-1 Introduction to Insects</b>	<b>6</b>
General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts with respect to feeding habit	
<b>Unit-2 Concept of Vectors</b>	<b>6</b>
Brief introduction to Vectors (mechanical and biological), Reservoirs, Host-vector relationship, Adaptations as vectors, Host specificity	
<b>Unit-3 Insects as Vectors</b>	<b>8</b>
Detailed features of insect orders as vectors – Diptera, Siphonoptera, Siphunculata, Hemiptera	
<b>Unit-4 Dipteran as Disease Vectors</b>	<b>14</b>
Study of important Dipteran vectors – Mosquitoes, Sand fly, Houseflies Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis Control of mosquitoes	
<b>Unit-5 Siphonaptera as Disease Vectors</b>	<b>6</b>
Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas	
<b>Unit-6 Siphunculata as Disease Vectors</b>	<b>4</b>
Human louse (Head, Body and Pubic louse) as important insect vectors; Control of human louse	
<b>Unit-7 Hemiptera as Disease Vectors</b>	<b>6</b>
Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures	

### ZOOHGEC03P: Insect Vectors and Diseases Lab (Credits 2)

#### List of Practical

- Mounting and Study of different kinds of mouth parts of insects
- Spot identification of following insect vectors through permanent slides/photographs: *Aedes*, *Culex*, *Anopheles*, *Pediculus humanuscapitis*, *Pediculus humanuscorporis*, *Phthiruspubis*, *Xenopsylla cheopis*, *Cimex lectularius*, *Phlebotomus argentipes*, *Musca domestica*
- Study of different diseases transmitted by above insect vectors
- Submission of a project report on any one of the insect vectors and disease transmitted

#### Suggested Readings

- Anathakrishnan : Bio resources Ecology 3rdEdition
- Goldman : Limnology, 2ndEdition
- Odum and Barrett : Fundamentals of Ecology, 5thEdition
- Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1stEdition



5. Trivedi and Goyal : Chemical and biological methods for water pollution studies
6. Welch : Limnology Vols. I-II
7. Wetzel : Limnology, 3rd edition

### **ZOOHGEC04T , Environment and Public Health**

<b>Theory (Credits 4)</b>	Class
<b>Unit 1: Introduction</b>	
Sources of Environmental hazards, Hazard identification and accounting, Fate of toxic and persistent substances in the environment, Dose response evaluation, Exposure assessment	10
<b>Unit 2: Climate Change</b>	
Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health	10
<b>Unit 3: Pollution</b>	
Air, water, noise pollution sources and effects, Pollution control	5
<b>Unit 4: Waste Management Technologies</b>	
Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants.	15
<b>Unit 5: Diseases</b>	
Causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid, filariasis	10

### **Suggested Readings [Consult Latest Editions]**

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

### **ZOOHGEC03P: Environment and Public Health Lab (Credits 2)**

1. To determine pH, Cl, SO<sub>4</sub>, NO<sub>3</sub> in soil and water samples from different locations.

## Skill Enhancement Course (SEC): Offered by the Department of Zoology

### **ZOOSSEC01M (2 credits = 60 classes/hours): Aquarium fish keeping**

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

4 Classes

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

#### **Unit 2: Diversity of Aquarium fishes and their Biology**

20

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

Indigenous fishes suitable for aquaria, problems of natural population depletion

Problem with exotic fishes

#### **Unit 3: Food and feeding of Aquarium fishes**

10

Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator

#### **Unit 4: Fish Transportation**

15

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

#### **Unit 5: Maintenance of Aquarium**

11

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

### **ZOOSSEC02M ( 2 credits = 30 classes/hours ): VERMICOMPOST PRODUCTION**

1. Natural role of earthworms in soil fertility
2. Concept of Vermicompost- the need for it
3. Productions:
  - a. Suitable worm species and their availability– for Large scale/small scale, Climate and Temperature
4. Feedstock – for small scale or home farming / large scale or commercial
5. Operations and maintenance
  - a. Smells
  - b. Moisture
  - c. Pest species
  - d. Worms escaping
  - e. Nutrient levels
6. Harvesting
7. Properties of the vermicompost
8. Benefits of vermicompost
9. Use as soil conditioner
10. Applications

## Reference and contacts:

- The Complete Technology Book on Vermiculture and Vermicompost by NPCS Board of Consultants and Engineers; Asia Pacific Business Press, 2004
- Audio-visual training material:  
[https://www.google.co.in/search?rlz=1C1CHZL\\_enIN766IN766&ei=2Kz2Wr6yDoPIvgTLw6aYDQ&q=vermicompost+preparation&oq=vermicompost&gs\\_l=psy-ab.1.0.0i71k118.0.0.0.8499.0.0.0.0.0.0.0.0.0.0.0.0...0...1c..64.psy-ab..0.0.0....0.RNrPR98LJOg#kpvalbx=1](https://www.google.co.in/search?rlz=1C1CHZL_enIN766IN766&ei=2Kz2Wr6yDoPIvgTLw6aYDQ&q=vermicompost+preparation&oq=vermicompost&gs_l=psy-ab.1.0.0i71k118.0.0.0.8499.0.0.0.0.0.0.0.0.0.0.0.0...0...1c..64.psy-ab..0.0.0....0.RNrPR98LJOg#kpvalbx=1)
- <https://www.youtube.com/watch?v=sQKI0Y7fj24>
- <https://www.youtube.com/watch?v=oGf7Oe7oP4Y>
- <http://www.ivri.nic.in/services/vermi.aspx>
- Vermicompost production training in 24 Parganas- North: <http://www.swanirvar.in/help.php>

## References and Contacts:

- Ecological Methods by Henderson and Southwood; 4<sup>th</sup> Ed., Wiley-Blackwell
- WEST BENGAL BIODIVERSITY BOARD  
**Address:** Prani Sampad Bhawan, 5th Floor, LB - 2, Sector - III, Salt Lake City, Kolkata, West Bengal 700106  
<https://www.google.co.in/search?q=west+bengal+biodiversity+board>  
**NATIONAL BIODIVERSITY AUTHORITY**  
<http://nbaindia.org/>

## **ZOOSSEC0M2** (2 credits = 60 classes/hours) : **Aquarium fish keeping**

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

4 Classes

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

### **Unit 2: Diversity of Aquarium fishes and their Biology**

20

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

Indigenous fishes suitable for aquaria, problems of natural population depletion

Problem with exotic fishes

### **Unit 3: Food and feeding of Aquarium fishes**

10

Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator

**Unit 4: Fish Transportation**

15

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

**Unit 5: Maintenance of Aquarium**

11

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