

**SYLLABUS FOR UNDERGRADUATE  
COURSE IN ZOOLOGY  
(Bachelor of Science Examination)**

**UNDER  
CHOICE BASED CREDIT SYSTEM**

<b>Course Structure of U.G. Zoology Honours</b>				
<b>Semester</b>	<b>Course</b>	<b>Course Name</b>	<b>Credit</b>	<b>Total marks</b>
Semester-I	AECC I	AECC I	4	100
	Core I (Theory)	Non-chordates I: Protista to Pseudocoelomates	4	75
	Core I (Practical)	Non-chordates I: Protista to Pseudocoelomates	2	25
	Core II (Theory)	Principles of Ecology	4	75
	Core II (Practical)	Principles of Ecology	2	25
	GE 1 (Theory)	GE 1 (Theory)	4	75
	GE I (Practical)	GE I (Practical)	2	25
Semester-II	AECC 2	AECC 2	4	100
	Core III (Theory)	Non chordates II: Coelomates	4	75
	Core III (Practical)	Non chordates II: Coelomates	2	25
	Core IV (Theory)	Cell biology	4	75
	Core IV (Practical)	Cell biology	2	25
	GE II (Theory)	GE II (Theory)	4	75
	GE II (Practical)	GE II (Practical)	2	25
Semester-III	Core V (Theory)	Diversity of Chordates	4	75
	Core V (Practical)	Diversity of Chordates	2	25
	Core VI (Theory)	Physiology: Controlling and Coordinating systems	4	75
	Core VI (Practical)	Physiology: Controlling and Coordinating systems	2	25
	Core VII (Theory)	Fundamentals of Biochemistry	4	75
	Core VII (Practical)	Fundamentals of Biochemistry	2	25
	SEC 1	SEC 1	4	100
	GE III (Theory)	GE III (Theory)	4	75
	GE III (Practical)	GE III (Practical)	2	25
Semester-IV	Core VIII (Theory)	Comparative anatomy of Vertebrates	4	75
	Core VIII	Comparative anatomy of	2	25

	(Practical)	Vertebrates		
	Core IX (Theory)	Physiology: Life Sustaining Systems	4	75
	Core IX (Practical)	Physiology: Life Sustaining Systems	2	25
	Core X (Theory)	Biochemistry of Metabolic Processes	4	75
	Core X (Practical)	Biochemistry of Metabolic Processes	2	25
	SEC 2	SEC 2	4	100
	GE IV (Theory)	GE IV (Theory)	4	75
	GE IV (Practical)	GE IV (Practical)	2	25
Semester-V	Core XI (Theory)	Molecular Biology	4	75
	Core XI (Practical)	Molecular Biology	2	25
	Core XII (Theory)	Principles of Genetics	4	75
	Core XII (Practical)	Principles of Genetics	2	25
	DSE I (Theory)	DSE 1	4	75
	DSE I (Practical)	DSE 1	2	25
	DSE II (Theory)	DSE II	4	75
	DSE II (Practical)	DSE II	2	25
Semester-VI	Core XIII (Theory)	Developmental Biology	4	75
	Core XIII (Practical)	Developmental Biology	2	25
	Core XIV (Theory)	Evolutionary Biology	4	75
	Core XIV (Practical)	Evolutionary Biology	2	25
	DSE III (Theory)	DSE III	4	75
	DSE III (Practical)	DSE III	2	25
	DSE IV (Theory with Practical /Project)	Project/ Economic Zoology	6	100
Total			<b>148</b>	<b>2600</b>

## ZOOLOGY

### HONOURS PAPERS:

Core course – 14 papers

Discipline Specific Elective – 4 papers (Out of 9 suggested papers)

Generic Elective for Non Zoology students – 4 papers. In case University offers 2 subjects as GE, then papers 1 and 2 will be the GE paper.

Marks per paper - Midterm: 15 marks, End term: 60 marks (Theory) + 25 marks (Practical),

Total – 100 marks

Credit per paper – 6

Teaching hours per paper – 40 hours (theory) + 10 hours (practical)

### Core Paper I

#### Non-Chordates I: Protista to Pseudocoelomates

##### Unit 1: Protista, Parazoa, Metazoa and Porifera

General characteristics and Classification up to classes. Study of Euglena, Amoeba. Life cycle and pathogenicity of Plasmodium vivax and Entamoeba histolytica. Locomotion and Reproduction in Protista. General characteristics and Classification up to classes, Canal system and spicules in sponges.

##### Unit 2: Cnidaria & Ctenophora

General characteristics and Classification up to classes, Metagenesis in Obelia, Polymorphism in Cnidaria, Corals and coral reefs. General characteristics and Evolutionary significance of Ctenophora.

##### Unit 3: Platyhelminthes

General characteristics and Classification up to classes. Life cycle and pathogenicity of Fasciola hepatica and Taeniasolium.

##### Unit 4: Nematelminthes

General characteristics and Classification up to classes. Life cycle, and pathogenicity of Ascaris lumbricoides and Wuchereria bancrofti. Parasitic adaptations in helminthes

**Note:** Classification to be followed from “Barnes, R.D. (1982). Invertebrate Zoology, V Edition”

### PRACTICAL

1. Study of whole mount of Euglena, Amoeba and Paramecium, Binary fission and Conjugation in Paramecium.
2. Examination of pond water collected from different places for diversity in protista.
3. Study of Sycon (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*, *Taeniasolium* and their life cycles (Slides/microphotographs).

7. Study of adult *Ascarislumbricoides* and its life stages (Slides/micro-photographs).

8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

**Note:** Classification to be followed from “Ruppert and Barnes (2006) *Invertebrate Zoology*, 8th edition, Holt Saunders International Edition”

#### **TEXT BOOKS**

1. Kotpal RL; *Modern Textbook of Zoology – Invertebrates*; Rastogi Publications - Meerut; 2016 edition

2. Richard Busca, W. Moore, Stephen M. Shuster. *Invertebrates*; OUP USA; 3 edition (19 January 2016)

#### **SUGGESTED READINGS**

1. Richard Fox , Robert D. Barnes, Edward E. Ruppert, *Invertebrate Zoology: A Functional Evolutionary Approach*, Brooks/Cole; 7th edition edition2003

2. Barrington, E.J.W. *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson.

3. Hyman, L.H. *Invertebrate Series* (Recent edition)

4. Verma P. S. *A Manual of Practical Zoology: Invertebrates*. S Chand Publication

5. Parker JJ and WA Haswel *Textbook of Zoology*. Vol I and II

## **Core Paper II**

### **Principles of Ecology**

#### **Unit 1: Ecosystem and Applied Ecology**

Ecology: Autecology and synecology, Types of ecosystems with one 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 Nutrient and biogeochemical cycle with one example of Nitrogen cycle. Ecology in Wildlife Conservation and Management. Laws of limiting factors, Study of physical factors- (Light, temperature).

#### **Unit 2: Population**

Attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion 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.

#### **Unit 3: Community**

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

#### **Unit – 4: Biometry**

Biological data, graphical representation of data (frequency polygon and histogram), sampling techniques, measures of central tendency (Mean, median and mode), Measures of dispersion (range, quartile deviation, mean deviation and standard deviation), Hypothesis and hypothesis testing (Chi-square test, t- test)

#### **PRACTICAL**

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton collection, preservation and mounting, Measurement of temperature, turbidity/penetration of light, determination of pH, Dissolved Oxygen content (Winkler's method), BOD, COD, Free CO<sub>2</sub>, Hardness, TDS.
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary.
5. Chi-square analysis using seeds/beads/Drosophila.
6. Problems on standard deviation.
7. Graphical representation of data (Frequency polygon and Histogram).

#### **Text Book**

1. Odum, E.P. and Barrett, G.W., (2018). Fundamentals of Ecology, 5<sup>th</sup> Edition
2. Smith and Smith, Elements of Ecology, Global Edition; Pearson Education India; ninth edition (14 May 2015)
3. Myra Samuels, J. Witmer, A. Schaffner, Statistics for the life sciences, Prentice Halls, Boston, 4<sup>th</sup> edition, 2012

#### **Suggested Readings**

1. Kormondy, (2017). Concepts of Ecology, Updated 4/e, Pearson
2. Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
3. Ricklefs, R.E., (2000). Ecology. 5<sup>th</sup> Edition. Chiron Press
4. Dash M.C., Fundamentals of Ecology. Mc GrawHill
5. Smith TM and Smith RL, Elements of Ecology, 8th Edition, Pearson education INC, USA
6. Miller, G.T. and Spoolman, S.E. (2017) Environmental Science, 14<sup>th</sup> Edition. Cengage Publication, New Delhi.
7. Odum, E.P. and Barrett, G.W., (2018). Fundamentals of Ecology, 5<sup>th</sup> Edition.
8. Cengage Publication, New Delhi
9. Web site: <https://www.cbd.int/>
10. Baneerjee Pranab Kumar, Introduction to biostatistics, S Chand & Company; 3rd Rev. Edn. 2006 edition
11. Chainy GBN, Mishra G, Mohanty PK, 2004, Basic Biostatistics, Kalyani Publisher

## Core Paper III

### Non- Chordates II: Coelomates

#### Unit 1: Coelomates and Annelids

Evolution of coelom and metamerism. General characteristics and Classification up to classes; Excretion in Annelida.

#### Unit 2: Arthropoda and Onychophora

General characteristics and Classification up to classes. Vision and Respiration in Arthropoda. Metamorphosis in Insects. Social life in bees and termites. Onychophora: General characteristics and Evolutionary significance.

#### Unit 3: Mollusca

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

#### Unit 4: Echinodermata

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

**Note:** Classification to be followed from “Ruppert and Barnes (2006) Invertebrate Zoology, 8th edition, Holt Saunders International Edition”

### PRACTICAL

1. Study of following specimens:
2. Annelids - Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria
3. Arthropods – Tachypleus, Carcinoscorpious, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta, termites and honey bees
4. Onychophora – Peripatus
5. Molluscs - Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus
6. Echinodermates - Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon
7. Study of digestive system, nephridia of earthworm (Virtual).
8. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
9. Mount of mouth parts and dissection of digestive system and nervous system of Periplaneta.
10. To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)

### Text Books

1. Kotpal RL (2014) Text book of Zoology, Invertebrate, Rastogi Publication
2. Jordan and Verma PS (2009) Invertebrate Zoology. S Chand publication.

### **Suggested Readings**

1. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.
2. 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
3. Verma P S. (2010) A Manual of Practical Zoology: Non-chordates. S Chand Publication

## **Core Paper IV**

### **Cell biology**

#### **Unit 1: Overview of cells and plasma membrane**

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions, Various models of plasma membranestructure. Transport across membranes: Active and Passive transport, Facilitated transport. Cell junctions: Tight junctions, Desmosomes, Gap junctions.

#### **Unit 2: Cytoskeleton & Endomembrane System**

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments; Structure and Functions: Endoplasmic Reticulum, Golgi apparatus, Lysosomes.

#### **Unit 3: Mitochondria and Peroxisomes**

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

#### **Unit 4: Nucleus, Cell Division and Cell signalling**

Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus; Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome); Mitosis, Meiosis, Cell cycle and its regulation; GPCR and Role of second messenger (cAMP)

### **Practical**

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
  - i. DNA by Feulgen reaction
  - ii. DNA and RNA by MGP
  - iii. Mucopolysaccharides by PAS reaction
  - iv. Proteins by Mercuric bromophenol blue/Fast Green
5. Demonstration of osmosis (RBC/ Egg etc.).

### **Text Books**

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. S Harisha (2007) Biotechnology procedures and experiments handbook., Infinity Science Press, Hingham



### **Suggested Readings**

1. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York and London.
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
3. Suvarna S, Lyton C, Bancroft JD (2013) *Theory and practice of histological techniques*, Churchill Livingstone, Elsevier, UK
4. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.

## **Core Paper V**

### **Diversity and distribution of Chordates**

#### **Unit 1: Protochordates and Origin of Chordates**

Protochordata: General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata. General characteristics and outline classification Chordata. Dipleurula concept and the Echinoderm theory of origin of chordates.

#### **Unit 2: Agnatha, Pisces & Amphibia**

General characteristics of Agnatha: General characteristics and classification of cyclostomes up to class Chondrichthyes and Osteichthyes: classification up to order, Migration, Parental care in fishes, Accessory respiratory organs in pisces, Evolutionary significance of Dipnoi. Amphibian: Origin of Tetrapoda (Evolution of terrestrial ectotherms); General characteristics and classification up to order. Parental care in Amphibia.

#### **Unit 3: Reptilia & Aves**

General characteristics and classification up to order in reptiles; Affinities of Sphenodon; Poison apparatus and Biting mechanism in snakes. General characteristics and classification up to order in Aves Archaeopteryx - a connecting link; Flight adaptations and Migration in birds.

#### **Unit 4: Mammals & Zoogeography**

General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages. Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms.

### **PRACTICAL**

1. Protochordata: *Balanoglossus*, *Herdmania*, *Branchiostoma*, Colonial Urochordata, Sections of *Balanoglossus* through proboscis and branchio-genital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions. Permanent slides of *Herdmania* spicules.
2. Agnatha: *Petromyzon* and *Myxine*.
3. Fishes: *Scoliodon*, *Sphyrna*, *Pristis*, *Torpedo*, *Chimaera*, *Mystus*, *Heteropneustes*, *Labeo*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon*/ *Diodon*, *Anabas*, Flat fish.
4. Amphibia: *Ichthyophis*/*Ureotyphlus*, *Necturus*, *Bufo*, *Hyla*, *Alytes*, Salamander.

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. Types of beaks and claws. Study of feathers.
7. Mammalia: Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes, Erinaceus.
8. Power point presentation on study of any two animals from two different classes by students. Submission of album of local species.

#### **TEXT BOOKS**

1. Kotpal RL; Modern Textbook of Zoology –Vertebrates; Rastogi Publications - Meerut; 2016 edition
2. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford University Press.
3. Tiwari SK (2006) Fundamentals of World Zoogeography, Sarup & Sons

#### **SUGGESTED READINGS**

1. Pough H. Vertebrate life, VIII Edition, 2007 Pearson International.
2. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
3. Hickman CP, Roberts LS, Keen S, Larson A, I'Anson H, Isenhour DJ Integrated Principle of Zoology, 14th edition, 2008, McGrawHill publication
4. Verma PS and Srivastava PC. (2011) Advanced Practical Zoology. S Chand Publication.

### **Core Paper VI**

#### **Physiology: Controlling and Coordinating Systems**

##### **Unit 1: Tissues & Tissue system**

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue. Structure and types of bones and cartilages, Ossification, bone growth and resorption.

##### **Unit 2: Muscle & Nervous System**

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction. 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 - reflex arc; Physiology of hearing and vision.

##### **Unit 3: Reproductive System**

Histology of testis and ovary; Physiology of male and female reproduction; Hypothalamus-Pituitary & Gonadal axis. Puberty, Ovarian Cycle, Methods of contraception in male and female, Placental hormones.

##### **Unit 4: Endocrine System**

Histology of endocrine glands – Hypothalamus (Neuroendocrine gland) pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones and mechanism of hormone action, (steroidal and non-steroidal hormones).

## **PRACTICAL**

1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
2. Study of permanent slides- Squamous epithelium, Striated muscle fibres and nerve cells.
3. Study of permanent slides-Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid.
4. Microtomy: Preparation of permanent slides/photographs/computer models of any five types of mammalian (Goat/rat,etc) tissues

## **TEXT BOOKS**

1. Marieb EN and Hoehn K, Human Physiology,(2013), 9th edition, Pearson Education, USA.
2. Endocrinology, Hadley ME and Levine JE (2009), Pearson Education India; 6 edition
3. Textbook of Medical Physiology, Guyton & Hall, Elsevier, 12<sup>th</sup> edition, 2016

## **SUGGESTED BOOKS**

1. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition., Lippincott W. & Wilkins
2. Martini F H, Nath J L and Bartholomew E F.(2015) Fundamentals of Anatomy and Physiology. Pearson Education Publication,
3. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B.Saunders Company.
4. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons.

## **Core Paper VII**

### **Fundamentals of Biochemistry**

#### **Unit 1: Carbohydrates & Lipids**

Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates; Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids.

#### **Unit 2: Proteins**

Amino acids: Structure, Classification and General properties of  $\alpha$ -amino acids; Physiological importance of essential and non-essential  $\alpha$ -amino acids.

Proteins: Bonds stabilizing protein structure; Levels of organization in proteins; Renaturation, Denaturation; Introduction to simple and conjugate proteins

Immunoglobulins: Basic Structure, Classes and Function, Antigenic Determinants.

#### **Unit 3: Nucleic Acids**

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids Cot Curves: Base pairing, Denaturation and Renaturation of DNA, Types of DNA and RNA, Complementarity of DNA, Hypo-Hyperchromaticity of DNA.

#### **Unit 4: Enzymes**

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of  $K_m$  and  $V_{max}$ , Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action.

#### **PRACTICAL**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH, temperature and inhibitors on the action of salivary amylase./Urease/acid or alkaline phosphatase
5. Demonstration of proteins separation by SDS-PAGE.

#### **TEXT BOOKS**

1. Satyanarayan and Chakrapani , (2017) Biochemistry, Elsevier; Fifth edition
2. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
3. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto, Biochemistry, 8<sup>th</sup> edition, 2015.
4. Victor W., Rodwell, David A., Bender, Kathleen M., Botham, Peter J., Kennelly, P. Anthony, Harper's Illustrated Biochemistry, 31<sup>st</sup> edition.

#### **SUGGESTED READING**

1. 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.
2. 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 Publication.
3. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
4. Devasena T. (2010). Enzymology Oxford University Press; 1 edition
5. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.

### **Core Paper VIII**

#### **Comparative Anatomy of Vertebrates**

##### **Unit 1: Integumentary & Skeletal System**

Structure, functions and derivatives of integument (Scale, claw, nail, hair, feather and dentition). Axial and appendicular skeleton, Jaw suspensorium, Visceral arches.

##### **Unit 2: Digestive & Respiratory System**

Alimentary canal and associated glands; Respiration through Skin, gills, lungs and air sacs; Accessory respiratory organs.

### **Unit 3: Circulatory and Urinogenital system**

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

### **Unit 4: Nervous System & Sense Organs**

Comparative account of brain; Nervous system, Spinal cord, Cranial nerves in mammals. Classification of receptors: Brief account of visual and auditory receptors in man. Chemo and mechano receptors

### **PRACTICAL**

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, Varanus, Fowl, Rabbit.
3. Carapace and plastron of turtle /tortoise (Photographs, charts etc).
4. Mammalian skulls: One herbivorous and one carnivorous animal.
5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted).
6. Project on skeletal modifications in vertebrates (may be included if dissection not permitted).

### **TEXT BOOKS**

1. Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education
2. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies
3. R. K. Saxena and Sumitra Saxena (2016). Comparative Anatomy of Vertebrates 2nd edition.

### **SUGGESTED READINGS**

1. Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate tructure, John Wiley and Sons
2. Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House

## **Core Paper IX**

### **Physiology: Life Sustaining Systems**

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

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

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

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

### **Unit 3: Renal Physiology and Blood**

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance. Components of blood and their functions; Structure and functions of haemoglobin haemostasis: Haemopoiesis, Blood clotting system, Blood groups: Rh factor, ABO and MN.

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

Structure of mammalian heart; Coronary circulation; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses Cardiac cycle; Cardiac output and its regulation, Frank-Starling Law of the heart, nervous and chemical regulation of heart rate. Electrocardiogram, Blood pressure and its regulation.

### **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
6. Examination of sections of mammalian slides: oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney.

### **TEXT BOOKS**

1. Marieb E.N. and Hoehn K.N. (2009) Human Physiology. Pearson Education Publication, 9<sup>th</sup> edition
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons.
3. Guyton & Hall, (2016) Textbook of Medical Physiology. Elsevier, 12<sup>th</sup> edition,

### **SUGGESTED READINGS**

1. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
2. Vander A Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills.
3. Moyes C.D., Schulte PM (2016), Principles of physiology, 2nd edition, Pearson education, 3rd.
4. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Herculat Asia PTE Ltd. W.B. Saunders Company.

## Core Paper X

### Biochemistry of Metabolic Processes

#### Unit 1: Overview of Metabolism

Catabolism vs Anabolism, Stages of catabolism, 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: Carbohydrate Metabolism

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

#### Unit 3: Lipid and protein Metabolism

$\beta$ -oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis  
Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids.

#### Unit 4: Oxidative Phosphorylation

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

#### PRACTICAL

1. Estimation of total protein in given solutions
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
3. To study the enzymatic activity of Trypsin/ Lipase.
4. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.
5. Dry Lab (Virtual): To trace the labelled C atoms of Acetyl-CoA till they evolve as CO<sub>2</sub> in the TCA cycle.

#### TEXT BOOKS

1. Satyanarayan and Chakrapani , (2017) Biochemistry, Elsevier; Fifth edition.
2. Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.

#### SUGGESTED READINGS

1. 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.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

## Core Paper XI

### Molecular Biology

#### Unit 1: Nucleic Acids, DNA Replication & Repair

Salient features of DNA and RNA. Watson and Crick model of DNA. DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear ds-DNA, replication of telomeres. Pyrimidine dimerization and mismatch repair.

#### Unit 2: Transcription & Translation

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

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

#### Unit 3: Post Transcriptional Modifications and Processing of Eukaryotic RNA

Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA.

#### Unit 4: Gene Regulation & Regulatory RNAs

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon and trp operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, RNA interference, miRNA, siRNA.

#### PRACTICAL

1. Study of Polytene chromosomes from Chironomous / Drosophila larvae
2. Preparation of liquid culture medium (LB) and raise culture of E. coli
3. Estimation of the growth kinetics of E. coli by turbidity method
4. Preparation of solid culture medium (LB) and growth of E. coli by spreading and streaking
5. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer ( $A_{260\text{nm}}$  measurement)
6. Quantitative estimation of RNA using Orcinol reaction
7. Study and interpretation of electron micrographs/ photograph showing (a) DNA replication, (b) Transcription and (c) Split genes.

#### TEXT BOOKS

1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
2. Lewin B. (2013). Gene XI, Jones and Bartlett.
3. De Robertis E.D.P. (2017) Cell and Molecular Biology 8Ed.
4. Arnold Berk, Chris A. Kaiser, Harvey Lodish, Angelika Amon, Hidde Ploegh, Anthony Bretscher, Monty Krieger Kelsey C. Martin (2016) Molecular Cell Biology. 8<sup>th</sup> edition.



## **SUGGESTED READINGS**

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: Molecular Biology of the Cell, IV Edition.
3. Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, V Edition, ASM Press and Sinauer Associates.
4. McLennan A., Bates A., Turner, P. and White M. (2015). Molecular Biology IV Edition. GS, Taylor and Francis Group, New York and London.

## **Core Paper XII**

### **Principles of Genetics**

#### **Unit 1: Mendelian Genetics, Linkage, Crossing Over and Chromosomal Mapping**

Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex-influenced and sex-limited characters inheritance. Polygenic inheritance with suitable examples; simple numericals based on it. Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.

#### **Unit 2: Mutations**

Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method.

#### **Unit 3: Sex Determination & Extra-chromosomal Inheritance**

Chromosomal mechanisms of sex determination in Drosophila and Man; Criteria for extra-chromosomal inheritance, Antibiotic resistance in Chlamydomonas, Mitochondrial mutations in Saccharomyces, Infective heredity in Paramecium and Maternal effects.

#### **Unit 4: Recombination in Bacteria and Viruses & Transposable Genetic Elements**

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage. Transposons in bacteria, Ac-Ds elements in maize and P elements in Drosophila, Transposons in human.

## **PRACTICAL**

1. Study of Mendelian laws and gene interactions.
2. Linkage maps based on data from conjugation, transformation and transduction.
3. Linkage maps based on data from Drosophila crosses.
4. Study of human karyotype (normal and abnormal).
5. Pedigree analysis of some human inherited traits.

## **TEXT BOOKS**

1. Benjamin Pierce, (2015) Genetics- A Conceptual Approach, 5th edition, WH Freeman publication
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition.

## **SUGGESTED READINGS**

1. Benjamin Cummings. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B.Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.
4. Fletcher H. and Hickey I. (2015). Genetics. IV Edition. GS, Taylor and Francis Group, New York and London.

## **Core Paper XIII**

### **Developmental Biology**

#### **Unit 1: Introduction to Developmental Biology, Gametogenesis & Fertilization**

Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division. Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy.

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

Cleavage: Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers.

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

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

#### **Unit 4: Post Embryonic Development & Implications of Developmental Biology**

Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories. Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis.

## **PRACTICAL**

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages).
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages).
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture.
4. Study of different sections of placenta (photomicrograph/ slides).

5. Project report on Drosophila culture/chick embryo development.
6. Study of developmental stages by raising chick embryo in the laboratory

### **TEXT BOOKS**

1. Lewis Wolpert (2010). Principles of Development. II Edition, Oxford University Press.
2. Gilbert, S. F. (2017). Developmental Biology, XI Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.

### **SUGGESTED READINGS**

1. Carlson, R. F. Patten's Foundations of Embryology.
2. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers.
3. Verma PS and Agrawal VK, Chordata Embryology (2010) (S Chand Publication).

## **Core Paper XIV**

### **Evolutionary Biology**

#### **Unit 1: Theories, Evidences of Evolution and Extinction**

Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes. Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism. Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Sources of variations: Heritable variations and their role in evolution. Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction.

#### **Unit 2: Process of Evolutionary changes**

Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection). Genetic Drift (mechanism, founder's effect, bottleneck phenomenon); Role of Migration and Mutation in changing allele frequencies.

#### **Unit 3: Species concept and Speciation**

Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Parapatric. Adaptive radiation / macroevolution (exemplified by Galapagos finches);

#### **Unit 4: Concept of Origin and Evolution of man**

Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homo sapiens, molecular analysis of human origin. Phylogenetic trees, Multiple sequence alignment, construction and interpretation of phylogenetic trees.

## **PRACTICAL**

1. Study of fossils from models/ pictures
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.
6. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation.

## **TEXT BOOKS**

1. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
2. Rastogi B.B., (2018). Organic Evolution, MedTech; 3<sup>rd</sup> edition

## **SUGGESTED READINGS**

1. B.K. and Hallgrimson, B. (2008). Evolution IV Edition. Jones and Barlett Publishers.
2. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates. Snustad. S Principles of Genetics.
3. Ridley, M (2004) Evolution III Edition Blackwell publishing Hall.

## **Discipline Specific Elective Paper-1**

### **Animal Behaviour and Chronobiology**

#### **Unit 1: Animal Behaviour**

Origin and history of Ethology; Brief profiles of Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen; Proximate and ultimate behavior; Objective of behaviour, Behaviour as a basis of evolution; Behaviour as a discipline of science; Innate behaviour, Instinct, Stimulus filtering, Sign stimuli and Code breakers.

#### **Unit 2: Patterns of Behaviour**

Stereotyped Behaviours (Orientation, Reflexes); Individual behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.

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

Social Behaviour: Concept of Society; Communication and the senses; Altruism; Insects' society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.

#### **Unit 4: Chronobiology**

Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks, Relevance of biological clocks, Types and characteristics of biological rhythms: Short- and Long-term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation seasonal reproduction of vertebrates; Role of melatonin.

#### **PRACTICAL**

1. To study nests and nesting habits of the birds and social insects.
2. To study the behavioural responses of wood lice in dry and humid condition.
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxisbehaviour in insect larvae.
5. Study and actogram construction of locomotor activity of suitable animal models.
6. Study of circadian functions in humans (daily eating, sleep and temperature patterns).
7. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioral activities of animals and prepare a short report.

#### **TEXT BOOKS**

1. John A (2009) Animal Behaviour.9<sup>th</sup> edition, Sinauer Associate Inc., USA.
2. Vinod Kumar (2002) Biological Rhythms: Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

#### **SUGGESTED READINGS**

1. AK Pati. Chronobiology: The Dimension of Time in Biology and Medicine. PINSA (Biological Sciences). Part B 67 (6). 323-372, Dec., 2001.
2. David McF. Animal Behaviour. Pitman Publishing Limited, London, UK.
3. Manning A and Dawkins MS. An Introduction to Animal Behaviour. Cambridge University Press, USA.
4. Paul WS and John A (2013) Exploring Animal Behaviour. 6<sup>th</sup> Edition. Sinauer Associate Inc., Massachusetts, USA.
5. Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Chronobiology Biological Timekeeping: J, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.

**OR**

#### **Animal Biotechnology**

##### **Unit 1. Introduction to Animal Biotechnology**

Concept and scope of biotechnology,Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC and Expression vectors (characteristics).

Restriction enzymes: Nomenclature, detailed study of Type II,Construction of genomic and cDNA libraries and screening by colony and plaque hybridization Transformation techniques: Calcium chloride method and electroporation

##### **Unit 2. Molecular Techniques**

Southern, Northern and Western blotting,DNA sequencing: Sanger method Polymerase Chain Reaction, DNA Finger Printing and DNA microarray

### **Unit 3. Genetically Modified Organisms**

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.

### **Unit 4. Culture Techniques and Applications**

Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Thalassemia, Haemophilia and Sickle cell anemia), Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy.

### **PRACTICAL**

1. Genomic DNA isolation from E. coli / Animal tissue
2. Plasmid DNA isolation (pUC 18/19) from E. coli
3. Restriction digestion of plasmid DNA / Lambda Phage DNA
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided.
6. To study following techniques through photographs
  - a. Southern Blotting
  - b. Northern Blotting
  - c. Western Blotting
  - d. DNA Sequencing (Sanger's Method)
  - e. PCR
  - f. DNA fingerprinting

### **TEXT BOOKS**

1. BD Singh, (2014) Biotechnology: Expanding Horizons, Kalyani Publishers
2. U. Satyanarayan and U Chakrapani, (2014) Biotechnology, Books & Allied Ltd

### **SUGGESTED READINGS**

1. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An Introduction to Genetic Analysis. IX Edition. Freeman and Co., N.Y., USA.
2. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA- Genes and Genomes- A Short Course. III Edition, Freeman and Co., N.Y., USA.
3. Brown, T.A. (2015). Gene Cloning and DNA Analysis. 7th Edition, Academic Press, California, USA.
4. California, USA.

**OR**

## **ENDOCRINOLOGY**

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

History of endocrinology, Types of endocrine glands and hormones, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones.

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

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

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

Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Adrenal, Pancreas. Structure, Hormones, Functions and Regulation of Ovary and Testis.

Hormones in homeostasis, Disorders of endocrine glands.

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

Hormone action at Cellular level: Hormone receptors, transduction and regulation Hormone action at Molecular level: Molecular mediators, Genetic control of hormone action.

### **PRACTICAL**

1. Dissect and display of Endocrine glands in laboratory bred rat\*
2. Study of the permanent slides of all the endocrine glands
3. Compensatory ovarian/ adrenal hypertrophy in vivo bioassay in laboratory bred rat\*
4. Demonstration of Castration/ ovariectomy in laboratory bred rat\*
5. Estimation of plasma level of any hormone using ELISA
6. Designing of primers of any hormone
7. Report on endocrine disorders in human

(\*Subject to UGC guidelines)

### **TEXT BOOKS**

1. C. Donnell Turner (2012) General Endocrinology Pub- Affiliated East-West press Pvt. Ltd.-New Delhi; 6th Edition
2. Hadley, M.E. and Levine J.E. (2007). Endocrinology, 6th Edition. Pearson Prentice-Hall, Pearson Education Inc., New Jersey

### **SUGGESTED READINGS**

1. Stephen Nussey and Saffron Whitehead (2001). Endocrinology: An Integrated Approach; Oxford: BIOS Scientific Publishers

## **Discipline Specific Elective Paper-11**

### **Basics of Neuroscience**

#### **Unit 1: Introduction to Neuroscience & Nervous System**

Origins of Neuroscience; Neuroanatomy, Neurophysiology, and Systems Neurobiology. Introduction to the structure and function of the nervous system: Cellular components: Neurons; Neuroglia; Neuron doctrine; The prototypical neuron – axons and dendrites as unique structural components of neurons.

#### **UNIT 2: Cellular and Molecular Neurobiology**

Molecular and cellular approaches used to study the CNS at the level of single molecules, The ionic bases of resting membrane potential; The action potential- its generation and properties; The action potential conduction. Synapse: Synaptic transmission, Types of synapses; synaptic function; Principles of chemical synaptic transmission; Principles of synaptic integration; EPSPs and IPSPs. Ion channels, Neural transmission.

#### **Unit 3. Neurotransmitters**

Different types of neurotransmitters– catecholamines, amino acidergic and peptidergic neurotransmitters; Transmitter gated channels; G-protein coupled receptors and effectors, neurotransmitter receptors; Ionotropic and metabotropic receptors.

#### **UNIT 4: Neurobiology and Neuropharmacology of Behaviour**

The principles of signal transduction and information processing in the vertebrate central nervous system, and the relationship of functional properties of neural systems with perception and behavior; sensory systems, molecular basis of behavior including learning and memory. Molecular pathogenesis of pain and neurodegenerative diseases such as Parkinson's, Alzheimer's, psychological disorders, Addiction.

#### **PRACTICAL**

1. Dissection and study of Drosophila nervous system using GFP reporter.
2. Observation and quantitation of Drosophila photoreceptor neurons in healthy and diseased condition.
3. Nerve Cell preparation from the spinal cord.
4. Study of neurons and/ or myelin by Nissl, Giemsa or Luxol Fast Blue staining.
5. Study of olfaction in Drosophila.
6. Study of novelty, anxiety and spatial learning in mice.

#### **TEXT BOOKS**

1. Kandel, Schwartz and Jessell (2000) Principles of Neural Science-4th Edn-Eds. - McGraw- Hill Companies
2. Mark F. Baer; Barry W. Connors,(2015) Neuroscience: Exploring the brain . Lippincott Williams and Wilkins

#### **SUGGESTED READINGS**

1. From Molecules to Networks: An Introduction to Cellular and Molecular Neuroscience by John H. Byrne. Ruth Heidelberg and M. Neal Waxham.
2. Neuroscience-Eds. Dale Purves (3rd Edn)-Sinauer Associates, Inc.-2004.
3. Nerve Cells and Animal Behaviour-2nd Edn-Peter J Simmons and David Young-CUP-2003.
4. Essential Psychopharmacology- Neuroscientific Basis and Practical Applications-2nd Edn.-Stephan M. Stahl-CUP-2000.
5. Phantoms in the Brain - Vilayanur S. Ramachandran and Sandra Blakeslee-1998 The Human Brain Book - Rita Carter-2009

**OR**

#### **Reproductive Biology**

##### **Unit 1: Reproductive System and Endocrinology**

Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation.

Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in male and female.

##### **Unit 2: Functional anatomy of male reproduction**

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



### **Unit 3: Functional anatomy of female reproduction**

Outline and histology of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization, prevention of polyspermy; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto- maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation

### **Unit 4: Reproductive Health**

Infertility in male and female: causes, diagnosis and management; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning.

### **PRACTICAL**

Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.

1. Examination of vaginal smear rats from live animals.
2. Surgical techniques: principles of surgery in endocrinology. Ovariectomy, hysterectomy, castration and vasectomy in rats.
3. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
4. Human vaginal exfoliate cytology.
5. Sperm count and sperm motility in rat
6. Study of modern contraceptive devices.

### **TEXT BOOKS**

1. Austin, C.R. and Short, R.V. (1982) Reproduction in Mammals. Cambridge University Press.
2. C. Donnell Turner (2012) General Endocrinology Pub- Affiliated East-West press Pvt. Ltd.-New Delhi; 6th Edition
3. Tandulwadkar Sunita R (2015) The Art & Science Of Assisted Reproductive Technology, Jaypee Brothers Medical Publishers

### **SUGGESTED READINGS**

1. Tony M. Plant and Anthony J. Zeleznik (2015) Knobil and Neill's Physiology of Reproduction, Academic Press

**OR**

## **Immunology**

### **Unit 1: Innate and Adaptive Immunity**

Historical perspective of Immunology, Early theories of Immunology, Cells and organs of the Immune system. Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).

### **Unit 2: Antigens and Immunoglobulins**

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes, Immunoglobulins: Structure and functions of different classes of immunoglobulins, Antigen antibody interactions, Immunoassays (ELISA-Direct, Indirect, Competitive, Sandwich and RIA)

### **Unit 3: Major Histocompatibility Complex, Cytokines and Complement system**

Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation; Cytokines -Properties and functions of cytokines, Therapeutics Cytokines Complement System -Components and pathways of complement activation.

### **Unit 4: Hypersensitivity and Vaccines**

Gell and Coombs' classification and brief description of various types of hypersensitivities Vaccines -various types of vaccines, Advances in vaccine production.

### **PRACTICAL**

1. Study 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 White blood cells.
4. ABO blood group determination.
5. Total WBC counting.
6. Demonstration of ELISA.
7. Demonstration of Bone marrow smears to study Immune cells.

### **TEXT BOOKS**

2. Abbas K. Abul and Lechtman H. Andrew (2017) Cellular and Molecular Immunology. V Edition. Saunders Publication.
3. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kubly, J (2017). Immunology, VI Edition. W.H. Freeman and Company.

### **SUGGESTED READINGS**

1. Peter J. Delves and Seamus J. Martin (2017) Roitt's Essential Immunology, Wiley-Blackwell; 13th edition

## **Discipline Specific Elective Paper-III**

### **Fish and Fisheries**

#### **Unit 1: Systematics, Morphology and Physiology**

Systematic classification of native/exotic fishes (upto classes), Types of fins and their modification; Locomotion in fishes; Hydrodynamics; Types of scales, Use of scales in classification and determination of age of fish; Gills and gas exchange; Swim bladder; Reproductive strategies (Special reference to Indian fishes); Electric organs; Bioluminescence; Mechanoreceptors; Schooling; Migration

#### **Unit 2: Fisheries**

Inland fisheries; Marine fisheries; Environmental factors influencing the seasonal variation in fish; Fishing crafts and Gears; Depletion of Fisheries resources; Fisheries laws and regulations.

#### **Unit 3: Aquaculture**

Sustainable aquaculture; Extensive, semi-intensive and intensive culture of fish; Polyculture; Composite fish culture; brood stock management; Induced breeding of fish; Management of fin fish hatcheries; Preparation and maintenance of fish aquarium. Factors affecting aquaculture.

#### **Unit 4: Fish Pathology and Transgenesis**

Fish diseases: bacterial, viral and parasites; Preservation, diagnosis and treatment, Processing of harvested fish, Fishery byproducts; Transgenic fish, zebrafish as a model organism in research.

#### **PRACTICAL**

1. Study of Petromyzon, Myxine, Pristis, Chimaera, Exocoetus, Hippocampus, Gambusia, Labeo, Heteropneustes, Anabas
2. Study of different types of scales (Through permanent slides and photographs)
3. Study of crafts and gears used in fisheries.
4. Water quality criteria for aquaculture: assessment of pH, conductivity, total solids and total dissolved solids.
5. Study of air breathing organs in Channa, Heteropneustes, Anabas and Clarias.
6. Demonstration of induced breeding in fishes (Virtual).
7. Demonstration of parental care in fishes (Virtual).
8. Project report on a visit to any fish farm/ pisciculture unit/ zebrafish rearing lab

#### **TEXT BOOKS**

1. Q Bone and R Moore (2008), Biology of fishes, Taylor and Francis group, CRC Press, UK
2. S.S. Khanna and H.R. Singh (2014) A textbook of fish biology and fisheries, Narendra Publishing House, 3<sup>rd</sup> edition.

#### **SUGGESTED READINGS**

1. D H Evans and J D Claiborne, The Physiology of fishes, Taylor and Francis group, CRC, UK
2. R J Mogdans and B G Kapoor, The senses of fish: Adaptations for the reception of natural stimuli, Springer, Netherland

3. C B L Srivastava, Fish biology, Narendra Publishing House
4. J R Norman, A History of fishes, Hill and Wang Publishers.

**OR**

### **Wildlife Conservation And Management**

#### **Unit 1: Wildlife**

Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies, Conservation and protection Laws, wild animal of India and Odisha.

Habitat analysis, Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.

#### **Unit 2: Management of habitats**

Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats, In situ and Ex situ conservation, Wild life Protection act, wildlife trade and related laws.

#### **Unit 3: Population estimation**

Population density, Nataly, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Census methods; Bio- telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animals.

#### **Unit 4: Management planning of wildlife in protected areas**

Estimation of carrying capacity; Eco tourism / wild life tourism in forests; Concept of climax persistence; Ecology of perturbation, National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve.

#### **PRACTICAL**

1. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna India and Odisha.
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).
3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers, animal sounds.
4. Demonstration of different field techniques for flora and fauna.
5. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences)
6. Submission of field study report (national park/ reserve forest/ sanctuary)

#### **TEXT BOOKS**

1. GopalRajesh (2011) Fundamentals of Wildlife Management, Natraj Publishers.
2. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.

## **SUGGESTED READINGS**

1. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? 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.

## **Discipline Specific Elective Paper-IV**

### **Economic Zoology**

#### **Unit 1: Bee-keeping and Bee Economy (Apiculture)**

Varieties of honey bees and Bee pasturage; Setting up an apiary: Langstroth's/Newton's hive, bee veil, brood and storage chambers, iron frames and comb sheets, drone excluder, rearing equipments, handling of bees, artificial diet; Honey extraction techniques; Physico-chemical analysis of honey; Other beneficial products from bee.

#### **Unit 2: Silk and Silk Production (Sericulture)**

Different types of silk and silkworms in India; Rearing of Bombyxmori, Rearing racks and trays, disinfectants, rearing appliances, black boxing, Chawki rearing, bed cleaning, mountages, harvesting of cocoons; Silkworm diseases: Pebrine, Flacherie, Grasserie, Muscardine and Aspergillosis, and their management; Silkworm pests and parasites: Uzi fly, Dermestid beetles and their management; Silk reeling techniques and Quality assessment of silk fibre.

#### **Unit 3: Aquaculture**

Induced breeding of fish; Management of hatchery of fish; Management of nursery, rearing and stocking ponds; 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. Prawn farming; Culture of crab; Pearl culture.

#### **Unit 4: Dairy and Poultry Farming**

Introduction; Indigenous and exotic breeds; Rearing, housing, feed and rationing; Commercial importance of dairy and poultry farming; Varietal improvement techniques; Diseases and their management; Dairy or poultry farm management and business plan; Visit to any dairy farm or Poultry farm.

## **PRACTICAL**

1. Submission of report on anyone field visits related to Aquaculture/Apiculture/Sericulture/Poultry/ Dairy farm.
2. Study of different types of bees (Queens, Drones and Worker bees).
3. Study of different types of silk moths.
4. Study of different types of pearls.
5. Study of different types of fish diseases.
6. Identification of different types of scales in fishes.
7. Study of different types of fins.

8. Study of different modified structures of fishes (Saw of sawfish, Hammer of hammer head fish, tail of sharks etc.)
9. Identification of various types of natural silks.

#### **TEXT BOOKS**

1. Sarkar, Kundu and Chaki. (2014) Introduction to Economic Zoology. NCBA Publisher.
2. T.V.R. Pillay (Author), M.N. Kutty (2011) Aquaculture: Principles and Practices, Wiley India Pvt Ltd; Second edition

#### **SUGGESTED READINGS**

1. Dhyan Singh Bisht, Apiculture, ICAR Publication.
2. Dunham RA (2004) Aquaculture and Fisheries Biotechnology – Genetic Approaches. CABI publications, U.K.
3. Hafez ESE (1962) Reproduction in Farm Animals. Lea and Fabiger Publishers.
4. Knobil E and Neill JD (2006) The Physiology of Reproduction. Vol.2. Elsevier Publishers, USA.
5. Prost PJ (1962) Apiculture. Oxford and IBH, New Delhi.
6. Singh S. Beekeeping in India, Indian council of Agricultural Research, New Delhi.
7. Srivastava CBL (1999) Fishery Science and Indian Fisheries. Kitab Mahal publications, India.

**OR**

#### **Project Work**

Each student has to undertake a project work under the guidance of a teacher and submit the project report in the form of a thesis. There will be a presentation of the project work before an external examiner.

### **Generic Elective Paper I**

#### **Animal Diversity**

##### **Unit 1: Protista, Porifera, Radiata, Acelomates and Pseudocoelomates**

General characters of Protozoa; Life cycle of Plasmodium, General characters and canal system in Porifera, General characters of Cnidarians and polymorphism, General characters of Helminthes; Life cycle of Taeniasolium, General characters of Nemethehelminthes; Parasitic adaptations

##### **Unit 2: Coelomate Protostomes, Arthropoda, Mollusca and Coelomate Deuterostomes**

General characters of Annelida, Metamerism, General characters, Social life in insects, General characters of mollusca, torsion in gastropod, pearl formation, General characters of Echinodermata, larval form in Echinodermata.

##### **Unit 3: Protochordata , Pisces, Amphibia**

Salient features, Osmoregulation, Migration of Fishes, General characters, Adaptations for terrestrial life, Parental care in Amphibia.

#### **Unit 4: Reptiles, Aves and Mammals**

Amniotes, Origin of reptiles, Terrestrial adaptations in reptiles, Origin of birds; Flight adaptations, early evolution of mammals; Primates; Dentition in mammals.

#### **PRACTICAL**

1. Study of following specimens:

**Non Chordates:** Euglena, Noctiluca, Paramecium, Sycon, Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, T. gigas, Limulus, Hermitcrab, Daphnia, Millipede, Centipede, Beetle, Chiton, Dentalium, Octopus, Asterias and Antedon.

**Chordates:** Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Ichthyophis/Uraeotyphlus, Salamander, Rhacophorus Draco, Uromastix, Naja, Viper, model of Archaeopteryx, any three common birds-(Crow, duck, Owl), Squirrel and Bat.

2. Study of following Permanent Slides:

Cross section of Sycon, Sea anemone and Ascaris(male and female). T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine. Bipinnaria and Pluteus larva

3. Temporary mounts of Septal & pharyngeal nephridia of earthworm.

Unstained mounts of Placoid, cycloid and ctenoid scales.

#### **TEXT BOOKS**

1. Kotpal RL. (2016) Modern Textbook of Zoology –Vertebrates; Rastogi Publications – Meerut.
2. Kotpal RL.(2016) Modern Textbook of Zoology –Invertebrates; Rastogi Publications – Meerut.

#### **SUGGESTED READINGS**

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
3. Raven, P.H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications, New Delhi.
4. Kardong, K.V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.

**OR**

#### **Insect Vectors and Diseases**

##### **Unit 1: Insects, Concept of Vectors, Insects as Vectors**

General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts with reference to. feeding habits, Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity, Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

## **Unit 2: Dipteran as Disease Vectors**

Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly, Study of house fly as important mechanical vector, Myiasis, Control of house fly

## **Unit 3: Siphonaptera and Siphunculata as Disease Vectors**

Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas, Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever, Vagabond's disease, Phthiriasis; Control of human louse

## **Unit 4: Hemiptera as Disease Vectors**

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

## **PRACTICAL**

1. Study of different kinds of mouth parts of insects
2. Study of following insect vectors through permanent slides/ photographs: Aedes, Culex, Anopheles, Pediculushumanuscorporeus, Phthirus pubis, Xenopsylla cheopis, Cimexlectularius, Phlebotomus argentipes, Musca domestica through permanent slides/ photographs
3. Study of different diseases transmitted by above insect vectors.
4. Submission of a project report on any one of the insect vectors and disease transmitted.

## **TEXT BOOKS**

1. Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell
2. Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK

## **SUGGESTED READINGS**

1. Mike Service (2012) Medical Entomology for Students Cambridge University Press; 5th edition.
2. Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication

## **Generic Elective Paper II**

### **Aquatic Biology**

#### **UNIT 1: Aquatic Biomes**

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, Streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs

#### **UNIT 2: Freshwater Biology**

**Lakes:** 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



**Streams:** Different stages of stream development, Physico-chemical, environment, Adaptation of hill-stream fishes.

### **UNIT 3: Marine Biology**

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

### **UNIT 4: Management of Aquatic Resources**

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.

### **PRACTICAL**

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free, Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from nearby lake/ water body.
4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
5. A Project Report on a visit to a Sewage treatment plant/Marine bioreserve/ Fisheries Institutes.

### **TEXT BOOKS**

1. Wetzel RG (2001) Limnology: Lake and River Ecosystems, Academic Press; 3 edition

### **SUGGESTED READINGS**

1. Anathakrishnan : Bioresources Ecology 3rd Edition
2. Odum and Barrett : Fundamentals of Ecology, 5th Edition
3. Pawlowski: Physicochemical Methods for Water and Wastewater Treatment, 1<sup>st</sup> Edition
4. Trivedi and Goyal : Chemical and biological methods for water pollution studies
5. Welch : Limnology Vols. I-II

**OR**

## **Food, Nutrition And Health**

### **Unit 1: Basic concept of food and nutrition**

Food Components and food-nutrients, Concept of a balanced diet, nutrient needs and dietary pattern for various groups, adults, pregnant and nursing mothers, infants, school children, adolescents and elderly

### **Unit 2: Nutritional Biochemistry:**

Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role  
Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance  
Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions

### **Unit 3: Health**

Introduction to health- Definition and concept of health, Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any. Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications, Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention, Common ailments- cold, cough, and fevers, their causes and treatment

### **Unit 4: Food hygiene:**

Potable water- sources and methods of purification at domestic level Food and Water borne infections: **Bacterial infection:** Cholera, typhoid fever, dysentery; **Viral infection:** Hepatitis, Poliomyelitis, **Protozoan infection:** amoebiasis, giardiasis; **Parasitic infection:** taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention Brief account of food spoilage: Causes of food spoilage and their preventive measures

### **PRACTICAL**

1. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric
3. Estimation of Lactose in milk
4. Ascorbic acid estimation in food by titrimetry
5. Estimation of Calcium in foods by titrimetry
6. Study of the stored grain pests from slides/ photograph (*Sitophilus oryzae*, *Trogoderma granarium*, *Callosobruchus chinensis* and *Tribolium castaneum*): their identification, habitat and food sources, damage caused and control. Preparation of temporary mounts of the above stored grain pests.
7. Project- Undertake computer aided diet analysis and nutrition counseling for different age groups. OR Identify nutrient rich sources of foods (**fruits and vegetables**), their seasonal availability and price OR Study of nutrition labeling on selected foods

### **TEXT BOOKS**

1. Mudambi, SR and Rajagopal, MV (2018). Fundamentals of Foods, Nutrition and Diet Therapy; Sixth Ed; New Age International Publishers.
2. Bamji MS, Rao NP, and Reddy V.(2017) Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd., 4<sup>th</sup> edition

### **SUGGESTED READINGS**

1. Srilakshmi B. Nutrition Science; 2002; New Age International (P) Ltd.
2. Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd.
3. Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO

## Generic Elective Paper III

### Human Physiology

#### Unit 1: Digestion and Respiratory Physiology

Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins; Nervous and hormonal control of digestion (in brief), Ventilation, External and internal Respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases.

#### Unit 2: Functioning of Excitable Tissue (Nerve and Muscle)

Structure of neuron, Propagation of nerve impulse (myelinated and non-myelinated nerve fiber); Structure of skeletal muscle, Mechanism of muscle contraction (Sliding filament theory), Neuromuscular junction

#### Unit 3: Renal Physiology and Cardiovascular Physiology

Functional anatomy of kidney, Mechanism and regulation of urine formation, Structure of heart, Coordination of heartbeat, Cardiac cycle, ECG

#### Unit 4: Endocrine and Reproductive Physiology

Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Brief account of spermatogenesis and oogenesis, Menstrual cycle.

#### PRACTICAL

1. Preparation of temporary mounts: Neurons and Blood film.
2. Preparation of haemin and haemochromogen crystals.
3. Estimation of haemoglobin using Sahli's haemoglobinometer.
4. Examination of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, kidney, thyroid, pancreas, adrenal, testis, ovary.

#### TEXT BOOKS

1. Marieb EN and Hoehn K, (2015) Human Physiology, 10th global edition, Pearson Education, USA.
2. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.

#### SUGGESTED READINGS

1. Widmaier, E.P., Raff, H. and Strang, K.T. (2008). Vander's Human Physiology, XI Edition, McGraw Hill.
2. Kesar, S. and Vashisht, N. (2007). Experimental Physiology, Heritage Publishers.
3. Prakash, G. (2012). Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Company Ltd.
4. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley and Sons, Inc.

**OR**

**Environment And Public Health**

**UNIT 1: Environmental hazards**

Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure Assessment.

**UNIT 2: Pollution**

Air, water, noise pollution sources and effects, Pollution control; Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health

**Unit 3: Waste Management Technologies**

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, Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath

**Unit 4 Diseases**

Causes, symptoms and control of: Tuberculosis, Asthma, Cholera, Typhoid, Malaria and AIDS

**PRACTICAL (Credits 2)**

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

**TEXT BOOKS**

1. Cutter, S.L. (1999) Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Park K (2017) Parks Text Book Of Preventive & Social Medicine, Banarsidas Bhanot Publishers

**SUGGESTED BOOKS**

1. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff 1996. "Risk Assessment and Management Handbook", McGraw Hill Inc., New York.
2. Kofi Asante Duah 1998 "Risk Assessment in Environmental management", John Wiley and sons, Singapore.
3. Kasperson, J.X. and Kasperson, R.E. and Kasperson,R.E., 2003. Global Environmental Risks, V.N.University Press, New York,
4. Joseph F Louvar and B Diane Louver 1997 Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey.
5. Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.
6. Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.
7. Manay MS, Shadaksharaswamy. Food-Facts and Principles; 1998; New Age International (P) Ltd.

## Generic Elective Paper IV

### Animal Biotechnology

#### UNIT 1: Introduction and Techniques in Gene manipulation

Concept and Scope of Biotechnology, Outline process of genetic engineering and recombinant DNA technology, Isolation of genes, Concept of restriction and modification: Restriction endonucleases, DNA modifying enzymes, Cloning Vectors: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, HAC. Shuttle and Expression Vectors, Construction of Genomic libraries and cDNA libraries, Transformation techniques: microbial, plants and animals: Cloning in mammalian cells, Integration of DNA into mammalian genome- Electroporation and Calcium, Phosphate Precipitation method.

#### UNIT2: Animal cell Culture

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, DNA sequencing: Sanger method, Polymerase chain reaction, DNA Fingerprinting and DNA microarrays

#### UNIT 3: Fermentation

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

#### UNIT 4: Transgenic Animal Technology and Application in Health

Production of transgenic animals: nuclear transplantation, retroviral method, DNA microinjection method, Dolly and Polly, Development of recombinant Vaccines, Hybridoma technology, Gene Therapy, Production of recombinant Proteins: Insulin and growth hormones.

#### PRACTICAL

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of culture media.
3. Preparation of genomic DNA from E. coli/animals/ human.
4. Plasmid DNA isolation (pUC 18/19) and DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard).
5. Restriction digestion of lambda ( $\lambda$ ) DNA using EcoR1 and Hind III.
6. Preparation of competent cells and Transformation of E. coli with plasmid DNA using CaCl<sub>2</sub>, Selection of transformants on X-gal and IPTG (Optional).
7. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting, PCR, DNA Microarrays.

#### TEXTBOOKS

1. BD Singh, (2014) Biotechnology: Expanding Horizons, Kalyani Publishers
2. U.Satyanarayan and U Chakrapani, (2014) Biotechnology, Books & Allied Ltd

#### SUGGESTED READINGS

1. T.A. Brown (2008): Gene cloning and DNA analysis: An Introduction, Blackwell Science.
2. Animal Cell Culture Methods Academic Press
3. P.K. Gupta: Biotechnology and Genomics, Rastogi publishers (2017).

4. B.D. Singh: Biotechnology, Kalyani publishers, 1998 (Reprint 2001).
5. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis, IX Edition, Freeman & Co., N.Y., USA
6. Verma S A, Das S and Singh (2014) A. Laboratory Manual for Biotechnology. S Chand Publication.

**OR**

### **Cell and Molecular Biology**

#### **Unit 1: Cells and Plasma Membrane**

Prokaryotic and Eukaryotic cells, Various models of plasma membrane; Transport across membranes, The Endoplasmic Reticulum; Golgi apparatus; Lysosomes; Structure and function of mitochondria

#### **Unit 2: Nucleus, cell division**

Ultra structure of nucleus; Mitosis, Meiosis, Cell cycle and its regulation

#### **Unit 3: Nucleic Acids and DNA Replication**

Salient features of DNA double helix; Watson and Crick model of DNA, Structure of RNA, tRNA, DNA Replication in prokaryotes and eukaryotes; Mechanism of DNA replication

#### **Unit 4: Transcription and Translation**

Mechanism of transcription in prokaryotes and Eukaryotes, Process of protein synthesis in prokaryotes and translation

#### **PRACTICAL**

1. Study of prokaryotic and eukaryotic cell types through permanent slides.
2. Study of mitosis and meiosis through squashing in Grasshopper.
3. Demonstration of transport through cell membrane.
4. Preparation of DNA and RNA models.
5. Demonstration of protein synthesis through models.

#### **TEXT BOOKS**

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

#### **SUGGESTED READINGS**

1. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008) Molecular Biology of the Cell. 5<sup>th</sup> Edition. Garland publishing Inc., New York.
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni G P (2009) The World of the Cell. 7<sup>th</sup> Edition. Pearson Benjamin Cummings Publishing, San Francisco.
3. Cooper GM and Hausman RE (2009) The Cell: A Molecular Approach. 5<sup>th</sup> Edition. ASM Press, Washington D.C.
4. S Harisha (2007) Biotechnology procedures and experiments handbook., Infinity Science Press, Hingham