



**VIKRAM DEB AUTONOMOUS COLLEGE  
JEYPORE, KORAPUT, ODISHA**



COURSE OF STUDIES  
OF  
**BACHELOR DEGREE SCIENCE  
UNDER CBCS**

Subject: **ZOOLOGY**

**WITH AFFECT FROM 21-22 ADMISSION BATCH**

Published by

**VIKRAM DEB AUTONOMOUS COLLEGE  
JEYPORE, KORAPUT, ODISHA**

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## **COURSE STRUCTURE**

### **First Semester**

<b><u>Course Opted</u></b>	<b><u>Course Name</u></b>	<b><u>Credits</u></b>	<b><u>Marks</u></b>
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)		4	75
GE I (Practical)		2	25

**Total Credit- 22**

**Total Marks- 400**

### **Second Semester**

<b><u>Course Opted</u></b>	<b><u>Course Name</u></b>	<b><u>Credits</u></b>	<b><u>Marks</u></b>
AECC II	AECC II	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)		4	75
GE II (Practical)		2	25

**Total Credit- 22**

**Total Marks- 400**

### **Third Semester**

<b><u>Course Opted</u></b>	<b><u>Course Name</u></b>	<b><u>Credits</u></b>	<b><u>Marks</u></b>
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 and microbiology	4	75
Core VII (Practical)	Fundamentals of Biochemistry and microbiology	2	25
SEC 1	SEC 1	4	100
GE I (Theory)		4	75
GE I (Practical)		2	25

**Total Credit- 28**

**Total Marks- 500**

**Fourth Semester**

<b><u>Course Opted</u></b>	<b><u>Course Name</u></b>	<b><u>Credits</u></b>	<b><u>Marks</u></b>
Core VIII (Theory)	Comparative anatomy of Vertebrates	4	75
Core VIII (Practical)	Comparative anatomy of Vertebrates	2	25
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 II (Theory)		4	75
GE II (Practical)		2	25

**Total Credit- 28****Total Marks- 500****Fourth Semester**

<b><u>Course Opted</u></b>	<b><u>Course Name</u></b>	<b><u>Credits</u></b>	<b><u>Marks</u></b>
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
Discipline Specific Elective -1	DSE-1	6	100
Discipline Specific Elective -2	DSE-2	6	100

**Total Credit- 24****Total Marks- 400****Sixth Semester**

<b><u>Course Opted</u></b>	<b><u>Course Name</u></b>	<b><u>Credits</u></b>	<b><u>Marks</u></b>
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
Discipline Specific Elective -3	DSE-3	6	100
Discipline Specific Elective-4	DSE-4	6	100

**Total Credit- 24****Total Marks- 400****Semester – 1<sup>st</sup> to 6<sup>th</sup> Semester****Total Credit- 148****Total Marks- 2600**

## **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)

### **(A) Programme Outcome**

1. After completing B.Ed. students can get job as a TGT in various school and junior colleges.
2. Job Opportunities by OPSC and UPSC exams, Railway Recruitments and Technical persons in Government Research labs, etc.
3. B.Sc Zoology students can do their Master's degree in Zoology, Environmental Science, Biotechnology and other related fields.
4. After completing GATE they can join IIT colleges for M.Sc + Ph.D. integrated programs.
5. They can also opt for Professional courses like M.B.A, M.C.A., M. Tech.
6. They can do LLB to pursue Law as profession.
7. They can clear IIT JAM to study MSc programs in various NITs and IITs.
8. They can do research oriented MSc programs in IISER, NISER.

### **(B) Program Specific Outcomes:**

#### **Students can**

1. Gain knowledge of Agro based Small Scale industries like sericulture, fish farming, butterfly farming and vermicompost preparation.
2. May get recruited in various jobs in sericulture, poultry, apiculture, animal husbandry, dairy, and fisheries departments.
3. They can do better entrepreneurship in vermicomposting, sericulture, apiculture...etc.
4. Understand the nature and basic concepts of Cell Biology, Genetics, Taxonomy, Physiology, Ecology and Applied Zoology
5. Analyse the relationships among animals, plants and microbes

6. Perform procedures as per laboratory standards in the areas of Taxonomy, Physiology, Ecology, Cell biology, Genetics, Applied Zoology, Clinical science, Tools and Techniques of Zoology, Toxicology, Entomology, Nematology Sericulture, Biochemistry, Fish Biology, Immunology.
  7. Understand the applications of biological sciences in Apiculture, Aquaculture, Agriculture and Medicine
  8. Gains knowledge about biostatistics, effective communication and skills of problem solving methods
  9. Gain knowledge and skill in the fundamentals of animal sciences, understands the complex interactions among various living organisms
  10. Analyse complex interactions among the various animals of different phyla, their distribution and their relationship with the environment
  11. Understand the complex evolutionary processes and behaviour of animals
  12. Correlate the physiological processes of animals and relationship of organ systems
  13. Understand the environmental conservation processes and its importance, pollution control and biodiversity and protection of endangered species
  14. Understands about various concepts of genetics and its importance in human health
  15. Apply ethical principles and commit to professional ethics and responsibilities in delivering his duties.
  16. Apply the knowledge and understanding of Zoology to one's own life and work
- Develops empathy and love towards the animals.

## Core Paper I

### Non-Chordates I: Protista to Pseudocoelomates

#### Course Outcome

1. Describe general taxonomic rules on animal classification
2. Classify Protista up to phylum using examples from parasitic adaptation
3. Classify Phylum Porifera to Echinodermata with taxonomic keys
4. Describe Phylum Nematoda and give examples of pathogenic Nematodes

#### **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 *Taenia solium*.

#### **Unit 4: Nemathelminthes**

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*,
5. *Metridium*, *Pennatulula*, *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/microphotographs).
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; 3rd 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 2003
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**

#### **Course Outcome**

1. Distribution of fauna in different realms interaction
2. Ecological factors
3. Biogeochemical cycles
4. Wild life conservation and management
5. Structure and function of ecosystem
6. Community characteristics
7. Attributes of population
8. Biostatistical methods

#### **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, 5th 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, 4th edition, 2012

## **Suggested Readings**

1. Kormondy, (2017). Concepts of Ecology, Updated 4/e, Pearson
2. Colinviaux, 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. 5th 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, 14th Edition. Cengage Publication, New Delhi.
7. Baneerjee Pranab Kumar, Introduction to biostatistics, S Chand & Company; 3rd Rev. Edn. 2006 edition
8. Chainy GBN, Mishra G, Mohanty PK, 2016, Basic Biostatistics, Kalyani Publisher 3rd edition

## **Core Paper III**

### **Non- Chordates II: Coelomates**

#### **Course Outcome**

### **Non- Chordates II: Coelomates**

1. Students will get to know about coelomates and Annelids
2. It will deal with evolution of coelom and metamerism and Excretion in Annelida.
3. Student will learn about classification Arthropoda and Onychophora General characteristics and Classification up to classes
4. Describe Vision and Respiration in Arthropoda and. Metamorphosis in Insects., Social life in bees and termites.
5. It will give illustrations on Mollusca Torsion and detorsion in Gastropoda, Evolutionary significance of trochophore larva.
6. It will discuss Echinodermata, Water-vascular system in Asteroidea, Larval forms in Echinodermata, and Affinities with Chordates.

#### **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*, *Carcinoscorpius*, *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**

#### **Course Outcome**

1. The learner will understand the importance of cell as a structural and functional unit of life.
2. The learner understands and compares between the prokaryotic and eukaryotic system and extrapolates the life to the aspect of development.
3. The dynamism of bio membranes indicates the dynamism of life. Its working mechanism and precision are responsible for our performance in life.

The cellular mechanisms and its functioning depends on endomembranes and structures. They are best studied with microscopy.

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

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions, Various models of plasma membrane structure. 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). MolecularBiology 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

#### Course Outcome

### Diversity and distribution of Chordates

1. Imparts conceptual knowledge of vertebrates, their adaptations and associations in relation to their environment
2. Classify phylum protochordates to mammalia
3. Complex vertebrate interactions

#### 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, l'AnsonH, 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**

#### **Course Outcome**

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

1. Students will learn about : tissues & tissue system
2. It will deal with histology of different types of muscle, propagation of action potential across nerve fibers, Physiology of hearing and vision.
3. Illuminate on reproductive system physiology, methods of contraception in male and female

It will impart knowledge on Endocrine System, Histology of endocrine glands, Classification of hormones and mechanism of hormone action.

#### **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, 12th 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 and microbiology**  
**Course Outcome**

1. Gain knowledge of basic terms in biochemistry.
2. Explain the structure, functions and reactions of the various biomolecules.
3. Correlate the changes in the levels of these biomolecules with the diseases in human
4. Attained the knowledge of macromolecule such as carbohydrates, protein and fat, their types and significance.
5. Described the enzymes, mechanism of enzyme action and factors affecting the enzyme activity
6. Understand the types and importance of vitamins.
7. Learn fundamentals of microbiology

**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: 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.

**Unit 4: Microbiology**

Bacteria: Classification, structure and reproduction Virus: classification, structure and reproduction, bacteriophages, viroids, prions, microbes of food, agriculture and industry Bacterial (typhoid, cholera and tuberculosis) and viral (swine flu, zika fever and AIDS) diseases of human

**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.
6. Identification of different bacteria and viruses through slide/photographs

**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, 8th edition, 2015. 4. Victor W., Rodwell, David A., Bender, Kathleen M., Botham, Peter J., Kennelly, P. Anthony, Harper's Illustrated Biochemistry, 31st edition. 5. Tortora GJ, Funke BR and Case CL (2016) Microbiology: An introduction, Pearson India Education Services Pvt.Ltd.11th 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.
6. Peleazar Jr.MJ, Chan E.C.S. and Krieg NR (2001) Microbiology, Mc-Graw Hill Education

## **Core Paper VIII**

### **Comparative Anatomy of Vertebrates**

#### **Course Outcome**

1. Student will learn about integumentary & skeletal system structure, functions and derivatives of integument
2. It will impart knowledge on anatomy of digestive & respiratory system
3. It will describe comparative anatomy of circulatory and urogenital system succession of kidney, types of mammalian uteri.
4. Students will learn nervous system & sense organs, comparative account of brain and receptors.

#### **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 Urogenital system**

General plan of circulation, evolution of heart and aortic arches; Succession of kidney, Evolution of urogenital 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**

#### **Course Outcome**

1. Students are taught the detailed concepts of digestion respiration excretion the functioning of nerves and muscles
2. Seeks to understand the mechanisms that work to keep the human body alive and functioning
3. Physiological and biochemical understanding through scientific enquiry into the nature of mechanical, physical, and biochemical functions of humans, their organs, and the cells of which they are composed
4. Interactions and interdependence of physiological and biochemical processes
5. Students gain fundamental knowledge of animal physiology
6. Describe the anatomy of different physiological systems at the tissue and cellular levels.
7. Evaluate the physiological functioning of different organs.
8. Analyze the physiological changes in relation to environmental conditions.
9. Identify different tissues related to anatomy and physiology from an evidence-based perspective.
10. Carry out physiological studies in the laboratory, Interpret data and graphs and write a report.
11. Correlate the organisms Internal and external environments with homeostasis and biological clocks.
12. Justify energy utilization in physiological and metabolic activities.
13. Students will gain skill to execute the roles of a biology teacher or medical lab technicians with training as they have basic fundamentals

#### **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 , 9th 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, 12th 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. Hercourt Asia PTE Ltd. W.B. Saunders Company.

## **Core Paper X**

### **Biochemistry of Metabolic Processes**

#### **Course Outcome**

1. It will deal with discuss Overview of and compartmentalization of metabolic pathways.
2. It will describe Shuttle systems and membrane transporters; ATP as "energy currency of cell"; coupled reactions
3. Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms.
4. Illuminate on carbohydrate metabolism pathways
5. It will enlighten on lipid and protein metabolism and fate of C-skeleton of glucogenic and ketogenic amino acids.
6. It will discuss regarding the details of oxidative phosphorylation and inhibitors and un-couplers of electron transport system

#### **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**

#### **Course Outcome**

1. DNA of structure
2. Central dogma of molecular biology
3. Genetic code
4. Molecular structure of genetic materials and understood the mechanism of gene expression and regulation character formation
5. Illustrate the mechanism of replication, transcription and translation
6. Justify the post transcriptional gene silencing
7. RNA interference

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

Salient features of DNA and RNA, Watson and Crick model of DNA., Nucleic acids cot curves, denaturation and renaturation 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 (A260nm 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. 8th 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**

#### **Course Outcome**

1. Structural and functional aspects of inheritance
2. Mendelian and non-Mendelian inheritance
3. Epistatic mechanism
4. Describe the genetic variation through linkage and crossing over, gene frequency, chromosomal aberrations and sex determination.
5. Understand the theories of classical genetics and blood group inheritance in man
6. Explain the concept of mutation.

#### **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**

#### **Course Outcome**

#### **Developmental Biology**

1. Explain the principles and process of fertilization and cleavage.
2. Prepare the flow chart of gametogenesis process.
3. Identify the developmental stages
4. Understood the process of development of animals.
5. Describe the process of gametogenesis.
6. Understood the process of organogenesis of selected organs, development of extra embryonic membrane and the nature and physiology of placenta.
7. Explain the theories of preformation, and concepts like growth, differentiation and reproduction.

#### **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**

#### **Course Outcome**

1. Understood the theories of evolution and highlighted the role of evidences in support of evolution
2. Explain the theories of organic evolution.
3. Describe the concept of origin of life and theories of origin of life.
4. Describe evolution of man.
5. Illustrate the presence of organisms at various geological time scale
6. Apply the knowledge in relevant experimentations.
7. Categorize different zoogeographical realms.
8. Compare animal distribution in different zoogeographical realms. Described the evolutionary knowledge through the concepts of coloration and mimicry.

#### **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, Background 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; 3rd 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**

### **DES-I ENDOCRINOLOGY**

#### **Course Outcome**

#### **Students will get to know about**

1. Basic details of endocrinology
2. Biological clock and their importance
3. Details of various endocrine glands pertaining to their structure and function

Mechanism and regulation of hormone action

#### **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-hypophyseal 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, Hypothalamohypophyseal 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

## **DES-II-Immunology**

### **Course Outcome**

**This course will give knowledge on**

1. Innate and adaptive immunity
2. The structure and importance of antigen and immunoglobulins
3. Major histocompatibility complex
4. Cytokines properties and function
5. Complement activation in disease regulation
6. Elaborate on *hypersensitivity* reactions and vaccine

### **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 Kuby, 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

## **DES-III Wildlife Conservation And Management**

### **Course Outcome**

This course will impart knowledge on

1. Values of wildlife,
2. Various kinds of conservation strategies
3. Wildlife protection act
4. Wildlife Population estimation
5. Management strategies of protected areas of India

### **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, Natality, 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. Gopal Rajesh (2011) Fundamentals of Wildlife Management, Natraj Publishers.

2. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.

29

### **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**

### **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**

#### **Course Outcome**

1. This course will focus on various aspects of Protista, Porifera, Radiata, Aceolomates and Pseudocoelomateslike Life cycle of *Plasmodium*, General characters, Life cycle of *Taeniasolium*, and Parasitic adaptations
2. It will focus on Coelomate, Protostomes, Arthropoda, Mollusca and Coelomate Deuterostomesin concepts like metamerism, Social life in insects, Torsion in gastropod, pearl formation, larval form in Echinodermata.
3. Reveal the process of Osmoregulation, Migration of Fishes, and Parental care in Amphibia.
4. Unravel the certain aspects of Reptiles, Aves and Mammals Amniotes like origin of reptiles and birds, terrestrial and flight adaptations, early evolution of mammals and dentition

#### **Unit 1: Protista, Porifera, Radiata, Aceolomates 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 *Taenia solium*, 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.

## **Generic Elective Paper II**

### **Course Outcome**

This course will enhance knowledge on

1. Aquatic Biomes Freshwater ecosystem
2. Lake as an Ecosystem, Nutrient Cycles in Lakes
3. Adaptation of hill-stream fishes.
4. Adaptations of deep sea organisms, Coral reefs, Sea weeds.
5. Management of Aquatic Resources , Sewage treatment Water quality assessment

### **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.

015

### **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; 3rd 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, 1st Edition
4. Trivedi and Goyal : Chemical and biological methods for water pollution studies
5. Welch : Limnology Vols. I-II