

**Syllabus and Scheme of Examination  
for  
B.Sc. Honours Zoology**

Submitted  
to

**Utkal University**  
Bhubaneswar

Under

**Choice Based Credit System**  
June 2016

## SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B.Sc. ZOOLOGY HONOURS

SEMESTER	CORE COURSE(14)	ABILITY ENHANCEMENT COMPULSORY COURSE (2)	SKILL ENHANCEMENT COURSE (SEC) (2)	DISCIPLINE SPECIFIC ELECTIVE DCE (4)	GENERIC ELECTIVE: (GE) (4)
I	DIVERSITY AND EVOLUTION OF NON-CHORDATA (PROTISTA TO PSEUDOCOELOMATES) (6 Credits, 100 Marks)	ENVIRONMENTAL STUDIES (4Credits, 100 Marks)			GE-1 Animal Diversity (Non-Chordates), Physiology and Endocrinology
	PERSPECTIVES IN ECOLOGY AND BIOSTATISTICS (6 Credits, 100 Marks)				
II	DIVERSITY AND EVOLUTION OF NON-CHORDATA (COELOMATE NONCHORDATES) (6 Credits, 100 Marks)	ENGLISH COMMUNICATION (4Credits, 100 Marks)			GE-2 Animal Diversity (Protochordata and Chordata), Developmental Biology and Immunology
	PHYSIOLOGY: LIFE SUSTAINING SYSTEMS (6 Credits, 100 Marks)				
III	DIVERSITY AND DISTRIBUTION OF CHORDATA (6 Credits, 100 Marks)		SEC -1 COMMUNICATING ENGLISH/ ENGLISH WRITING (4Credits, 100 Marks)		GE-3 Food, Nutrition and Health (6 Credits, 100 Marks)
	PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEM (6 Credits, 100 Marks)				
	COMPARATIVE ANATOMY OF VERTEBRATES (6 Credits, 100 Marks)				
IV	BIOCHEMISTRY OF METABOLIC PROCESSES (6 Credits, 100 Marks)		SEC -2 PUBLIC HEALTH AND HYGIENE (4Credits, 100 Marks)		GE-4 Biotechnology (Microbes to animals) (6 Credits, 100 Marks)
	CELL BIOLOGY (6 Credits, 100 Marks)				
	PRINCIPLES OF GENETICS (6 Credits, 100 Marks)				
V	DEVELOPMENTAL BIOLOGY (6 Credits, 100 Marks)			DSE-1 Animal Behaviour (6 Credits, 100 Marks)	
	MOLECULAR BIOLOGY (6 Credits, 100 Marks)			DSE-2 Economic Zoology (6 Credits, 100 Marks)	
VI	IMMUNOLOGY (6 Credits, 100 Marks)			DSE -3 Microbiology (6 Credits, 100 Marks)	
	EVOLUTIONARY BIOLOGY (6 Credits, 100 Marks)			DSE -4 Project (6 Credits, 100 Marks)	

<b>SEME STER</b>	<b>COURSE OPTED</b>	<b>COURSE NAME</b>	<b>Credit</b>	<b>Marks</b>
<b>I</b>	<b>Ability Enhancement Compulsory Course-I</b>	<b>Environmental Studies</b>	<b>4</b>	<b>100</b>
	<b>Core course-I</b>	<b>Diversity and evolution of non- chordata (protista topseudocoelomates)</b>	<b>4</b>	<b>70</b>
	<b>Core Course-I Practical</b>		<b>2</b>	<b>30</b>
	<b>Core course-II</b>	<b>Perspectives in Ecology and Biostatistics</b>	<b>4</b>	<b>70</b>
	<b>Core Course-II Practical</b>		<b>2</b>	<b>30</b>
	<b>Generic Elective -1</b>	<b>Animal Diversity (Non- Chordates), Physiology and Endocrinology</b>	<b>4</b>	<b>70</b>
	<b>Generic Elective -1 Practical/Tutorial</b>		<b>2</b>	<b>30</b>
<b>II</b>	<b>Ability Enhancement Compulsory Course-II</b>	<b>English communications</b>	<b>4</b>	<b>100</b>
	<b>Core course-III</b>	<b>Diversity and evolution of nonchordata (coelomate nonchordates)</b>	<b>4</b>	<b>70</b>
	<b>Core Course-III Practical</b>		<b>2</b>	<b>30</b>
	<b>Core course-IV</b>	<b>Physiology: Life sustaining systems</b>	<b>4</b>	<b>70</b>
	<b>Core Course-IV Practical</b>		<b>2</b>	<b>30</b>
	<b>Generic Elective -2</b>	<b>Animal Diversity (Protochordata and Chordata), Developmental Biology and Immunology</b>	<b>4</b>	<b>70</b>
	<b>Generic Elective - 2Practical</b>		<b>2</b>	<b>30</b>
<b>III</b>	<b>Core course-V</b>	<b>Diversity and distribution of chordates</b>	<b>4</b>	<b>70</b>
	<b>Core Course-V Practical</b>		<b>2</b>	<b>30</b>

	<b>Core course-VI</b>	<b>Physiology: Controlling and coordinating system</b>	<b>4</b>	<b>70</b>
	<b>Core Course-VI Practical</b>		<b>2</b>	<b>30</b>
	<b>Core course-VII</b>	<b>Comparative anatomy of vertebrates</b>	<b>4</b>	<b>70</b>
	<b>Core Course-VII Practical</b>		<b>2</b>	<b>30</b>
	<b>Skill Enhancement Course-1</b>	<b>Communicative English/ English Writing</b>	<b>4</b>	<b>100</b>
	<b>Generic Elective -3</b>	<b>Food, Nutrition and Health</b>	<b>4</b>	<b>70</b>
	<b>Generic Elective -3 Practical</b>		<b>2</b>	<b>30</b>
<b>IV</b>	<b>Core course-VIII</b>	<b>Biochemistry of metabolic processes</b>	<b>4</b>	<b>70</b>
	<b>Course-VIII Practical</b>		<b>2</b>	<b>30</b>
	<b>Core course-IX</b>	<b>Cell Biology</b>	<b>4</b>	<b>70</b>
	<b>Course-IX Practical</b>		<b>2</b>	<b>30</b>
	<b>Core course-X</b>	<b>Principles of Genetics</b>	<b>4</b>	<b>70</b>
	<b>Core Course- X Practical</b>		<b>2</b>	<b>30</b>
	<b>Skill Enhancement Course-2</b>	<b>Public health and hygiene</b>	<b>4</b>	<b>100</b>
	<b>Generic Elective -4</b>	<b>Biotechnology (Microbes to animals)</b>	<b>4</b>	<b>70</b>
	<b>Generic Elective -4 Practical</b>		<b>2</b>	<b>30</b>
<b>V</b>	<b>Core course-XI</b>	<b>Developmental Biology</b>	<b>4</b>	<b>70</b>
	<b>Core Course-XI Practical</b>		<b>2</b>	<b>30</b>
	<b>Core course-XII</b>	<b>Molecular Biology</b>	<b>4</b>	<b>70</b>
	<b>Core Course-</b>		<b>2</b>	<b>30</b>

	<b>XII Practical</b>			
	<b>Discipline Specific Elective -1</b>	<b>Animal Behaviour</b>	<b>4</b>	<b>70</b>
	<b>Discipline Specific Elective -1 Practical</b>		<b>2</b>	<b>30</b>
	<b>Discipline Specific Elective -2</b>	<b>Economic Zoology</b>	<b>4</b>	<b>70</b>
	<b>Discipline Specific Elective-2 Practical/Tutorial</b>		<b>2</b>	<b>30</b>
<b>VI</b>	<b>Core course-XIII</b>	<b>Immunology</b>	<b>4</b>	<b>70</b>
	<b>Core Course-XIII Practical/Tutorial</b>		<b>2</b>	<b>30</b>
	<b>Core course-XIV</b>	<b>Evolutionary Biology</b>	<b>4</b>	<b>70</b>
	<b>Core Course-XIV Practical/Tutorial</b>		<b>2</b>	<b>30</b>
	<b>Discipline Specific Elective -3</b>	<b>Microbiology</b>	<b>4</b>	<b>70</b>
	<b>Discipline Specific Elective -3 Practical/Tutorial</b>		<b>2</b>	<b>30</b>
	<b>Discipline Specific Elective-4</b>	<b>Project Report</b>	<b>6</b>	<b>100</b>
<b>Total</b>			<b>148</b>	<b>2600</b>

**CORE COURSE: ZOOLOGY**  
**Paper I**  
**DIVERSITY AND EVOLUTION OF NON-CHORDATA**  
**(PROTISTA TO PSEUDOCOELOMATES)**

**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**  
**LECTURES: 60**

**Marks 70**

**Unit 1: Kingdom Protista**

General characteristics and classification up to classes: Life cycle, pathogenicity and prophylaxis of *Plasmodium vivax*, *Trypanosoma gambiense* and *Entamoeba histolytica*; Locomotion and reproduction in Protista.

**Unit 2: Phylum Porifera and Ctenophora**

General characteristics and classification up to classes; Canal system in sponges: General characteristics and evolutionary significance; Evolution of Parazoa and Metazoa.

**Unit 3: Phylum Cnidaria**

General characteristics and classification up to classes; Metagenesis in *Obelia*; Polymorphism in Cnidaria; Corals and coral reefs.

**Unit 4: Phylum Platyhelminthes**

General characteristics and classification up to classes: Life cycle, pathogenicity and prophylaxis of *Fasciola hepatica* and *Taenia solium*; Parasitic adaptations.

**Unit 5: Phylum Nematelminthes**

General characteristics and classification up to classes: Life cycle, pathogenicity and prophylaxis of *Ascaris lumbricoides* and *Wuchereria bancrofti*; Parasitic adaptations.

**Note:** Classification to be followed from “Barnes RD (1982) Invertebrate Zoology. 5<sup>th</sup> Edition”.

**PRACTICALS**

**Marks 30**

**Kingdom Protista**

1. Morphology of *Paramecium*, Binary fission and Conjugation in *Paramecium*.
2. Life stages of *Plasmodium vivax*, *Trypanosma gambiense* and *Entamoeba histolytica* (Slides/Micro-photographs).
3. Examination of pond water for protists.

**Phylum Porifera**

4. Study of *Sycon* (including T.S. and L.S.), *Hyalonema*, and *Euplectella*.
5. Temporary mounts of spicules, gemmules and sponging fibres.

**Phylum Cnidaria**

6. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, Ephyra larva, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia* and *Metridium* (including T.S. and L.S.).

**Phylum Ctenophora**

7. Any one specimen/slide.

**Phylum Platyhelminthes**

8. Study of adult *Fasciola hepatica*, *Taenia solium* and their life stages (Slides/microphotographs).

**Phylum Nemathelminthes**

9. Study of adult *Ascaris lumbricoides*, *Wuchereria bancrofti* and their life stages (Slides/microphotographs).

**Note:** Classification to be followed from “Barnes RD (1982) Invertebrate Zoology. 5<sup>th</sup> Edition.”

**SUGGESTED READINGS**

1. Arora MP (2006) Non-Chordata-I. 1<sup>st</sup> edition. Himalaya Publishing House, New Delhi.
2. Arora MP (2008) Non-Chordata-II. 1<sup>st</sup> edition. Himalaya Publishing House, New Delhi.
3. Barnes RD (1982) Invertebrate Zoology. 6<sup>th</sup> Edition. Holt Saunders International Edition.
4. Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JI (2002) The Invertebrates: A New Synthesis. 3<sup>rd</sup> Edition. Blackwell Science, USA.
5. Barrington EJW (1979) Invertebrate Structure and Functions. 2<sup>nd</sup> Edition. ELBS and Nelson.
6. Boradale LA and Potts EA (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
7. Jordan EL and Verma PS (1963) Invertebrate Zoology. Revised Edition. S. Chand, New Delhi.
8. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

**CORE COURSE: ZOOLOGY**  
**PAPER II**  
**PERSPECTIVES IN ECOLOGY AND BIostatISTICS**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**  
**LECTURES: 60**

**Marks 70**

**Unit 1: Introduction to Ecology and Ecosystem**

Relevance of studying ecology; History of ecology; Laws of limiting factors; Detailed study of temperature and light as physical factors; Types of ecosystem; Food chain, Detritus and grazing food chains; Food web; Energy flow through the ecosystem; Ecological pyramids.

**Unit 2: Population**

Unitary and modular populations; Unique and group 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; Lotka-Volterra equation for competition and Predation, functional and numerical responses.

**Unit 3: Community**

Community characteristics: dominance, diversity, species richness, abundance, stratification; Ecotone and edge effect; Ecosystem development (succession) with example, Theories pertaining to climax community; Nutrient and biogeochemical cycles, Nitrogen cycle and Sulphur cycle.

**Unit 4: Conservation of Biodiversity**

Types of biodiversity, its significance, loss of biodiversity; Conservation strategies (in situ and ex situ); Endangered species concept; Role of ZSI, WWF, IUCN; Wildlife (Protection) Act, 1972.

**Unit 5: Biostatistics**

Concept, definition and scope of biostatistics, biological data, sampling techniques, measures of central tendency (mean, median and mode), measures of dispersion, hypothesis and testing of hypothesis (chi square test, t test and Z test), correlation and regression analysis; Data analysis using EXCEL programme.



## PRACTICALS

Marks 30

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical or real data provided.
2. Determination of population density in a natural or hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: fauna and flora, Measurement of area, temperature, turbidity or penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO<sub>2</sub>.
4. Report on a visit to National Park or Biodiversity Park or Wildlife sanctuary.
5. Determination of mean, median, mode and standard deviation of biological data.

## SUGGESTED READINGS

1. Chainy, GBN, Mishra G and Mohanty PK. Basic Biostatistics, Kalyani Publishers, Ludhiana.
2. Colinvax PA (1993) *Ecology*. II Edition. John Wiley and Sons, Inc., USA.
3. Dash MC (1993) *Fundamentals of Ecology*. McGraw Hill Book Company, New Delhi.
4. Joshi N and Joshi PC (2012) *Ecology and Environment*. 1<sup>st</sup> Edition. Himalaya Publishing House, New Delhi.
5. Mohanty PK (2000) *Illustrated Dictionary of Biology*. Kalyani Publishers, Ludhiana.
6. Odum EP (2008) *Fundamentals of Ecology*. Indian Edition. Brooks/Cole.
7. Ricklefs, R.E., (2000). *Ecology*. 5<sup>th</sup> Edition. Chiron Press.
8. Robert Leo Smith *Ecology and field biology* Harper and Row.
9. Singh JS, Gupta SR and Singh SP (2014) *Ecology, Environmental Science and Conservation*. S. Chand, New Delhi.

**CORE COURSE: ZOOLOGY**  
**PAPER III**  
**DIVERSITY AND EVOLUTION OF NON-CHORDATA**  
**(COELOMATE NON-CHORDATES)**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**  
**LECTURES: 60**

**Marks 70**

**Unit 1: Phylum Annelida**

General characteristics and classification up to classes; Evolution of coelom; Metamerism and Excretion in Annelida.

**Unit 2: Phylum Arthropoda**

General characteristics and classification up to classes; Vision in Arthropoda; Respiration in Arthropoda; Moulting in insects, Metamorphosis in insects; Social life of bees and termites and Larval forms in Crustacea.

**Unit 3: Phylum Onychophora**

General characteristics, evolutionary significance and affinities of *Peripatus*.

**Unit 4: Phylum Mollusca**

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

**Unit 5: Phylum Echinodermata**

General characteristics and classification up to classes; Water-vascular system in Asterozoa; Larval forms in Echinodermata and Evolutionary significance (Affinities with Chordates).

**Note:** Classification to be followed from “Barnes, R.D. (1982). *Invertebrate Zoology*, 5<sup>th</sup> Edition, Holt Saunders International Edition.”

**PRACTICAL**

**Marks 30**

**Phylum Annelida**

1. Study of *Aphrodite*, *Nereis*, *Sabella*, *Terebella*, *Serpula*, *Chaetopterus*, *Pheretima* and *Hirudinaria*.
2. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
3. T.S. through crop of leech.

### **Phylum Arthropoda**

4. Study of *Limulus*, *Palamnaeus*, *Palaemon*, *Daphnia*, *Balanus*, *Sacculina*, Cancer, *Eupagurus*, *Scolopendra*, *Julus*, termite, louse, honeybee, silk moth, wasp and dragon fly.

### **Phylum Onychophora**

5. Any one specimen/slide.

### **Phylum Mollusca**

6. Study of *Chiton*, *Dentalium*, *Pila*, *Doris*, *Helix*, *Unio*, *Ostrea*, *Mytilus*, *Loligo*, *Sepia*, *Octopus* and *Nautilus* and *Cypraea* (cowrie).

### **Phylum Echinodermata**

7. Study of echinoderm larvae.
8. Study of *Pentaceros*, *Asterias*, *Ophiura*, *Clypeaster*, *Echinus*, *Echinocardium*, *Cucumaria* and *Antedon*.

**Note:** Classification to be followed from “Barnes, R.D. (1982). *Invertebrate Zoology*, 5<sup>th</sup> Edition, Holt Saunders International Edition”.

## **SUGGESTED READINGS**

1. Arora MP (2006) Non-Chordata-I. 1<sup>st</sup> edition. Himalaya Publishing House, New Delhi.
2. Arora MP (2008) Non-Chordata-II. 1<sup>st</sup> edition. Himalaya Publishing House, New Delhi.
3. Barnes RD (1982) *Invertebrate Zoology*. 6<sup>th</sup> Edition. Holt Saunders International Edition.
4. Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JI (2002) *The Invertebrates: A New Synthesis*. 3<sup>rd</sup> Edition. Blackwell Science, USA.
5. Barrington EJW (1979) *Invertebrate Structure and Functions*. 2<sup>nd</sup> Edition. ELBS and Nelson.
6. Boradale LA and Potts EA (1961) *Invertebrates: A Manual for the use of Students*. Asia Publishing Home.
7. Jordan EL and Verma PS (1963) *Invertebrate Zoology*. Revised Edition. S. Chand, New Delhi.
8. Mohanty PK (2000) *Illustrated Dictionary of Biology*. Kalyani Publishers, Ludhiana.

**CORE COURSE: ZOOLOGY**  
**PAPER IV**  
**PHYSIOLOGY: LIFE SUSTAINING SYSTEMS**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**  
**LECTURES: 60**

**Marks 70**

**Unit 1: Digestive System**

Structural organization, histology and functions of gastrointestinal tract and its associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Role of gastrointestinal hormones on the secretion and control of enzymes of gastrointestinal tract.

**Unit 2: Respiratory System**

Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volume and capacity; Transport of oxygen in the blood; Oxygen- hemoglobin and myoglobin, dissociation curve and the factors influencing it; Carbon monoxide poisoning; Carbon dioxide transport in the blood; buffering action of blood and haemoglobin and Control of respiration.

**Unit 3: Excretory System**

Structure of kidney and its histological details; Renal blood supply; Mechanism of urine formation and its regulation and Regulation of acid-base balance.

**Unit 4: Blood**

Components of blood and their functions; Structure and functions of haemoglobin; Haemopoiesis; Haemostasis, Coagulation of blood and Disorders of blood.

**Unit 5: Heart**

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

**PRACTICAL**

**Marks 30**

1. Enumeration of red blood cells using haemocytometer.
2. Estimation of haemoglobin using Sahli's haemoglobinometer.
3. Preparation of haemin and haemochromogen crystals.
4. Recording of blood pressure using a Sphygmomanometer.
5. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung and kidney.

**SUGGESTED READINGS**

1. Arey LB (1974) Human Histology. 4<sup>th</sup> Edition. W.B. Saunders, USA.
2. Chatterjee CC (2008) Human Physiology. Vol. I and II. Medical Allied Agency, Kolkata.
3. Guyton AC and Hall JE (2006) Textbook of Medical Physiology. 9<sup>th</sup> Edition. W.B. Saunders Company, Philadelphia.
4. Tortora GJ and Derrickson B (2012) Principles of Anatomy and Physiology. 13<sup>th</sup> Edition John Wiley and Sons, USA.
5. Victor PE (2008) diFiore's Atlas of Histology with Functional Correlations. 12<sup>th</sup> Edition. Lippincott W. & Wilkins, USA

**CORE COURSE: ZOOLOGY**  
**PAPER V**  
**DIVERSITY AND DISTRIBUTION OF CHORDATA**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**  
**LECTURES: 60**

**Marks 70**

**Unit 1: Protochordata and Origin of Chordates**

General characters of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata; Dipleurula concept and the Echinoderm theory of origin of chordates.

**Unit 2: Introduction to Vertebrata and Agnatha**

Advanced features of vertebrates over Protochordata; General characters and classification of cyclostomes up to class; Structural peculiarities and affinities of *Petromyzon* and *Myxine*.

**Unit 3: Pisces and Amphibia**

General characters of Chondrichthyes and Osteichthyes and classification up to order; Migration; Osmoregulation and Parental care in fishes; Scales in fishes; Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characters and classification up to order and Parental care in Amphibians.

**Unit 4: Reptilia and Aves**

General characters and classification up to order; Skull in Reptilia; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes; General characters and classification up to order; Principles and aerodynamics of flight, Flight adaptations; *Archaeopteryx*- a connecting link and Migration in birds.

**Unit 5: Mammals and Zoogeography**

General characters and classification up to order; Affinities of Prototheria and Metatheria; Dentition in mammals; Adaptive radiation with reference to locomotory appendages; Zoogeographical realms; Theories pertaining to distribution of animals and Distribution of vertebrates in different realms.

**PRACTICAL**

**Marks 30**

**1. Protochordata**

1. *Balanoglossus*, *Herdmania*, *Branchiostoma* and Colonial Urochordata.
2. Sections of *Balanoglossus* through proboscis and branchiogenital regions.
3. Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions.
4. Permanent slide of spicules of *Herdmania*.

## **2. Agnatha**

5. *Petromyzon* and *Myxine*.

## **3. Fishes**

6. *Sphyrna*, *Pristis*, *Trygon*, *Torpedo*, *Chimaera*, *Notopterus*, *Mystus*, *Heteropneustes*, *Hippocampus*, *Exocoetus*, *Echeneis*, *Anguilla*, *Tetrodon*, *Diodon*, *Anabas* and Flat fish.

## **4. Amphibia**

7. *Ichthyophis/Ureotyphlus*, *Necturus*, *Duttaphrynus*, *Polypedates*, *Hyla*, *Alytes* and *Salamandra*.

## **5. Reptiles**

8. *Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Draco*, *Ophiosaurus*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*, *Zamenis* and *Crocodylus*.

9. Key for Identification of poisonous and non-poisonous snakes.

## **6. Aves**

10. Study of six common birds from different orders.

11. Types of beaks and claws.

12. Types of feathers.

## **7. Mammalia**

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

### **SUGGESTED READINGS**

1. Agarwal VK (2011) Zoology for degree students. S. Chand, New Delhi.
2. Arora MP (2006) Chordata-1. 1<sup>st</sup> Edition. Himalaya Publishing House, New Delhi.
3. Hall BK and Hallgrimsson B (2008) *Strickberger's Evolution*. 4<sup>th</sup> Edition. Jones and Bartlett Publishers Inc., USA.
4. Jordan EL and Verma PS (1963) Chordate Zoology. Revised Edition. S. Chand, New Delhi.
5. Young JZ (2004) *The Life of Vertebrates*. 3<sup>rd</sup> Edition. Oxford University Press, USA.

**CORE COURSE: ZOOLOGY**  
**PAPER VI**  
**PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEM**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**

**LECTURES: 60**

**Marks 70**

**Unit 1: Tissues and Glands, Bone and cartilage**

Structure, location, function and classification of Epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue; Types of glands and their functions; Structure and types of bones and cartilages; Ossification, bone growth and resorption.

**Unit 2: Nervous System**

Structure of neuron, resting membrane potential; Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapsis, Synaptic transmission; Neuromuscular junction; Reflex action and its types, Reflex arc and Physiology of hearing and vision.

**Unit 3: Muscle**

Histology of different types of muscle; Ultra-structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor Unit, summation and tetanus.

**Unit 4: Reproductive System**

Histology of male and female reproductive systems; Puberty; Physiology of reproduction of male and female; Methods of contraception (depicted through chart).

**Unit 5: Endocrine System**

Functional histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, thymus, pancreas, adrenal; Hormones secreted by them and their mechanism of action; Gonadal hormones; Classification of hormones; Regulation of their secretion; Mode of hormone action; Signal transduction pathways utilized by steroidal and non-steroidal hormones; Hypothalamus (neuroendocrine gland), Principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system and Placental hormones.

**PRACTICALS**

**Marks 30**

1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells.
3. Examination of sections of mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid.

**SUGGESTED BOOKS**

1. Arey LB (1974) Human Histology. 4<sup>th</sup> Edition. W.B. Saunders, USA.
2. Chatterjee CC (2008) Human Physiology. Vol. I and II. Medical Allied Agency, Kolkata.
3. Guyton AC and Hall JE (2006) Textbook of Medical Physiology. 9<sup>th</sup> Edition. W.B. Saunders Company, Philadelphia.
4. Tortora GJ and Derrickson B (2012) Principles of Anatomy and Physiology. 13<sup>th</sup> Edition John Wiley and sons, USA.
5. Victor PE (2008) diFiore's Atlas of Histology with Functional Correlations. 12<sup>th</sup> Edition. Lippincott Williams and Wilkins, USA.

**CORE COURSE: ZOOLOGY**  
**PAPER VII**  
**COMPARATIVE ANATOMY OF VERTEBRATES**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**

**LECTURES: 60**

**Marks 70**

**Unit 1: Integumentary System and Skeletal System**

Structure, functions and derivatives of integument; Axial and appendicular skeletons; Jaw suspensorium in vertebrates.

**Unit 2: Digestive and Respiratory System**

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

**Unit 3: Circulatory System**

General plan of circulation; Evolution of heart and aortic arches.

**Unit 4: Urinogenital System**

Succession of kidney; Evolution of urinogenital ducts and Types of mammalian uteri.

**Unit 5: Nervous System and Sense Organs**

Comparative account of brain; Autonomic nervous system; Spinal Nerves; Spinal cord; Cranial nerves in Mammals; Classification of receptors: visual receptors, chemoreceptors and mechanoreceptors.

**PRACTICAL**

**Marks 30**

1. Study of placoid, cycloid and ctenoid scales through permanent slides
2. Disarticulated skeleton of Frog, *Varanus*, Fowl and Rabbit.
3. Carapace and plastron of turtle or tortoise.
4. Mammalian skulls (One herbivorous and one carnivorous animal).

**SUGGESTED READINGS**

1. Hilderbrand M and Gaslow GE. Analysis of Vertebrate Structure. John Wiley and Sons., USA.
2. Kardong KV (2005) Vertebrates' Comparative Anatomy, Function and Evolution. 4<sup>th</sup> Edition. McGraw-Hill Higher Education, New York.
3. Kent GC and Carr RK (2000) Comparative Anatomy of the Vertebrates. 9<sup>th</sup> Edition. The McGraw-Hill Companies, New York.
4. Weichert CK and William Presch (1970) Elements of Chordate Anatomy. Tata McGraw Hill, New York.



**CORE COURSE: ZOOLOGY**  
**PAPER VIII**  
**BIOCHEMISTRY OF METABOLIC PROCESSES**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**  
**LECTURES: 60**

**Marks 70**

**Unit 1: Biomolecules**

Structures and properties of important mono-, di- and polysaccharides; Fatty acids, triglycerides and steroids; and Amino acids and proteins.

**Unit 2: Carbohydrate Metabolism**

Glycolysis; Citric acid cycle; Pentose phosphate pathway; Gluconeogenesis; Shuttle systems (Malate-aspartate shuttle, Glycerol 3-phosphate shuttle); Glycogenolysis and Glycogenesis.

**Unit 3: Lipid Metabolism**

Beta-oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid and Ketogenesis and its regulation.

**Unit 4: Protein Metabolism**

Catabolism of amino acids: Transamination, Deamination; Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids.

**Unit 5: Enzymes and Oxidative Phosphorylation**

Kinetics and Mechanism of action of enzymes; Inhibition of enzyme action; Allosteric enzymes; Oxidative phosphorylation in mitochondria; Respiratory chain, ATP synthase, Inhibitors and Uncouplers.

**PRACTICALS**

**Marks 30**

1. Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose and Fructose).
2. Colour tests of functional groups in protein solutions.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH on the action of salivary amylase.
5. Effect of temperature on the action of salivary amylase.
6. Estimation of total protein in given solutions by Lowry's method.

**SUGGESTED READINGS**

1. Berg JM, Tymoczko JL and Stryer L (2007) Biochemistry. 6<sup>th</sup> Edition, W.H. Freeman and Co., New York.
2. Cox MM and Nelson DL (2008) Lehninger Principles of Biochemistry. 5<sup>th</sup> Edition. W.H. Freeman and Co., New York.
3. Devesena T (2014) Enzymology. 2<sup>nd</sup> Edition. Oxford University Press, UK.
4. Hames BD and Hooper NM (2000) Instant Notes in Biochemistry. 2<sup>nd</sup> Edition. BIOS Scientific Publishers Ltd., U.K.
5. Murray RK, Bender DA, Botham KM, Kennelly PJ, Rodwell VW and Well PA (2009) Harper's Illustrated Biochemistry. 28<sup>th</sup> Edition. International Edition. The McGraw-Hill Companies Inc., New York.

**CORE COURSE: ZOOLOGY**  
**PAPER IX**  
**CELL BIOLOGY**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**  
**LECTURES: 60**

**Marks 70**

**Unit 1: Cells and Plasma Membrane**

Prokaryotic and Eukaryotic cells; Mycoplasma; Virus, Viroids, Virions and Prions; Various models of plasma membrane; Transport across membranes; Cell junctions: Occluding junctions (Tight junctions), Anchoring junctions (desmosomes), Communicating junctions (gap junctions) and Plasmodesmata.

**Unit 2: Endomembrane System, Mitochondria and Peroxisomes**

The Endoplasmic Reticulum; Golgi apparatus; Mechanism of vesicular transport; Lysosomes; Structure and function of mitochondria: Chemi-osmotic hypothesis; Semi-autonomous nature of mitochondria; Endosymbiotic hypothesis and Peroxisomes.

**Unit 3: Cytoskeleton and Nucleus**

Structure and functions of intermediate filament, microtubules and microfilaments; Ultra-structure of nucleus; Nuclear envelope: Structure of nuclear pore complex; Chromosomal DNA and its packaging; Structure and function of nucleolus.

**Unit 4: Cell Cycle and Cell Signaling**

Cell cycle, Regulation of cell cycle; Signaling molecules and their receptors.

**Unit 5: Apoptosis and Cancer**

Extrinsic (Death Receptor) Pathway and Intrinsic (Mitochondrial) Pathway; Growth and development of tumors and Metastasis.

**PRACTICAL**

**Marks 30**

1. Gram's staining technique for visualization of prokaryotic cells.
2. Study various stages of mitosis from permanent slides.
3. Study various stages of meiosis from permanent slides.
4. Study the presence of Barr body in human female blood cells or cheek cells. (Preparation of permanent slides).
5. Cytochemical demonstration (Preparation of permanent slides).
  - i. DNA by Feulgen reaction.
  - ii. Mucopolysaccharides by PAS reaction.
  - iii. Proteins by Mercurbromophenol blue.
  - iv. DNA and RNA by Methyl Green Pyronin.

**(In practical examination, 05 marks should be of permanent slide submission; one mark each for DNA, PAS, Proteins, MGP and Barr body slide.)**

## SUGGESTED READINGS

1. 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.
2. 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.
3. Cooper GM and Hausman RE (2009) *The Cell: A Molecular Approach*. 5<sup>th</sup> Edition. ASM Press, Washington D.C.
4. De Robertis EDP and De Robertis EMF (2006) *Cell and Molecular Biology*. 8<sup>th</sup> Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp G (2010) *Cell and Molecular Biology: Concepts and Experiments*. 6<sup>th</sup> Edition. John Wiley and Sons. Inc., USA.

**CORE COURSE: ZOOLOGY**  
**PAPER X**  
**PRINCIPLES OF GENETICS**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**  
**LECTURES: 60**

**Marks 70**

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

Principles of inheritance; Incomplete dominance and Co-dominance; Multiple alleles, Lethal alleles; Epistasis; Pleiotropy; Sex-linked inheritance.

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

Linkage and crossing over; Cytological basis of crossing over; Molecular mechanisms of crossing over; Recombination frequency as a measure of linkage intensity; Two factor and three factor crosses; Interference and coincidence and Somatic cell hybridization.

**Unit 3: Mutations**

Gene mutations; Chromosomal mutations: Deletion, duplication, inversion, translocation; Aneuploidy and polyploidy; Induced versus spontaneous mutations; Backward and forward mutations; Suppressor mutations; Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method and DNA repair mechanisms.

**Unit 4: Sex Determination and Quantitative Genetics**

Chromosomal mechanisms of sex determination; Sex-linked, sex-influenced and sex limited characters; Polygenic inheritance and Transgressive variation.

**Unit 5: Extra-chromosomal Inheritance**

Criteria for extra-chromosomal inheritance; Antibiotic resistance in *Chlamydomonas*; Mitochondrial mutations and Maternal effects.

**PRACTICAL**

**Marks 30**

1. To study the Mendelian laws and gene interactions and their verification by Chi square analyses using seeds or beads or *Drosophila*.
2. Identification of various mutants of *Drosophila*.
3. To calculate allelic frequencies by Hardy-Weinberg Law.
4. Linkage maps based on data from crosses of *Drosophila*.
5. Study of human karyotype (normal and abnormal).
6. Pedigree analysis of some human inherited traits.
7. Preparation of polytene chromosomes from larva of *Chironomous/Drosophila*.
8. To study mutagenicity in *Salmonella/E. coli* by Ames test.

### **SUGGESTED READINGS**

1. Gardner EJ, Simmons MJ and Snustad DP (2008) Principles of Genetics. 8<sup>th</sup> Edition. Wiley India.
2. Griffiths AJF, Wessler SR, Lewontin RC and Carroll SB (2014) Introduction to Genetic Analysis. 9<sup>th</sup> Edition. W. H. Freeman and Co., New York.
3. Klug WS, Cummings MR, Spencer CA and Palladino MA (2012) Concepts of Genetics. 10<sup>th</sup> Edition. Pearson Education, Inc., USA.
4. Russell PJ (2009) Genetics- A Molecular Approach. 3<sup>rd</sup> Edition. Benjamin Cummings, USA.
5. Snustad DP and Simmons MJ (2012) Principles of Genetics. 6<sup>th</sup> Edition. John Wiley and Sons Inc., USA.
6. Verma PS and AgarwalVK (2010) Genetics. 9<sup>th</sup> Edition. S. Chand, New Delhi.

**CORE COURSE: ZOOLOGY**  
**PAPER XI**  
**DEVELOPMENTAL BIOLOGY**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**  
**LECTURES: 60**

**Marks 70**

**Unit 1: Introduction**

History and basic concepts: Epigenesis, preformation, Mosaic and regulative development; Discovery of induction; Cell-Cell interaction; Pattern formation; Differentiation and growth; Differential gene expression; Cytoplasmic determinants and asymmetric cell division.

**Unit 2: Early Embryonic Development**

Gametogenesis (Spermatogenesis, Oogenesis); Types of eggs; Egg membranes; Fertilization: Changes in gametes, monospermy and polyspermy; Planes and patterns of cleavage; Early development of frog and chick up to gastrulation; Fate maps; Embryonic induction and Organizers.

**Unit 3: Late Embryonic Development**

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

**Unit 4: Post Embryonic Development**

Metamorphosis: Changes, hormonal regulations in amphibians; Regeneration: Modes of regeneration (epimorphosis, morphallaxis and compensatory regeneration); Ageing: Concepts and models.

**Unit 5: Implications of Developmental Biology**

Teratogenesis: Teratogenic agents and their effects on embryonic development; *in vitro* Fertilization (IVF); Stem cell culture and Amniocentesis.

**PRACTICAL**

**Marks 30**

1. Study of whole mount 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 mount 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 developmental stages (above mentioned) by raising chick embryo in the laboratory.
4. Study of the developmental stages and life cycle of *Drosophila* from stock culture.
5. Study of different types of placenta.
6. Project report on *Drosophila* culture or chick embryo development.

### **SUGGESTED READINGS**

1. Balinsky BI and Fabian BC (1981) *An Introduction to Embryology*. 5<sup>th</sup> Edition. International Thompson Computer Press.
2. Gilbert SF (2010) *Developmental Biology*. 9<sup>th</sup> Edition. Sinauer Associates, Inc., USA.
3. Kalthoff (2008) *Analysis of Biological Development*. 2<sup>nd</sup> Edition. McGraw-Hill, New York.
4. Wolpert L, Beddington R, Jessell T, Lawrence P, Meyerowitz E and Smith J (2002) *Principles of Development*. 1<sup>st</sup> Edition, Oxford University Press, New York.

**CORE COURSE: ZOOLOGY**  
**PAPER XII**  
**MOLECULAR BIOLOGY**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**  
**LECTURES: 60**

**Marks 70**

**Unit 1: Nucleic Acids and DNA Replication**

Salient features of DNA double helix; Watson and Crick model of DNA; DNA denaturation and renaturation; DNA topology - linking number and DNA topoisomerases; Cot curves; Structure of RNA, tRNA and DNA and RNA associated proteins; DNA Replication in prokaryotes and eukaryotes; Mechanism of DNA replication; Role of proteins and enzymes in replication; Licensing factors; Semi-conservative, bidirectional and semi-discontinuous replication; RNA priming; Replication of circular and linear *ds*-DNA and replication of telomeres.

**Unit 2: Transcription**

RNA polymerase and transcription Unit; Mechanism of transcription in prokaryotes and eukaryotes; Synthesis of rRNA and mRNA; Transcription factors and regulation of transcription.

**Unit 3: Translation**

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 4: 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.

**Unit 5: Gene Regulation and 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, silencers elements; Gene silencing, Genetic imprinting; Ribo-switches, RNA interference, miRNA and siRNA.

**PRACTICAL**

**Marks 30**

1. Study of DNA replication using Photographs or slides and special cases, e.g., Polytenyusing permanent slides of polytene chromosomes.
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. Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results.
6. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement).
7. Quantitative estimation of RNA using Orcinol reaction.

### **SUGGESTED READINGS**

1. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) *The World of the Cell*. 7<sup>th</sup> Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2008) *Molecular Biology of the Cell*, 4<sup>th</sup> Edition. Garland publishing Inc., New York.
3. Cooper GM and Hausman RE (2007) *The Cell: A Molecular Approach*. 4<sup>th</sup> Edition, ASM Press, USA.
4. De Robertis EDP and De Robertis EMF (2006) *Cell and Molecular Biology*. 8<sup>th</sup> Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp G (2010) *Cell and Molecular Biology: Concepts and Experiments*. 6<sup>th</sup> Edition. John Wiley and Sons. Inc., USA.

**CORE COURSE: ZOOLOGY**  
**PAPER XIII**  
**IMMUNOLOGY**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**  
**LECTURES: 60**

**Marks 70**

**Unit 1: Immune System and Immunity**

Historical perspective of Immunology, Early theories of immunology, Haematopoiesis, 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 and Immune dysfunctions.

**Unit 2: Antigens**

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T - Cell epitopes.

**Unit 3: Immunoglobulins**

Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays, Polyclonal sera, Monoclonal antibodies and Hybridoma technology.

**Unit 4: Major Histocompatibility Complex and Complement System**

Structure and functions of endogenous and exogenous pathway of antigen presentation; Components and pathways of complement activation.

**Unit 5: Cytokines, Hypersensitivity and Vaccines**

Properties and functions of cytokines; Cytokine-based therapies; Gell and Coombs' classification and Brief description of various types of hypersensitivities; Types of vaccines: Recombinant vaccines and DNA vaccines.

**PRACTICAL**

**Marks 30**

1. Demonstration of lymphoid organs.
2. Ouchterlony's double immuno-diffusion method.
3. Determination of ABO blood group.
4. Preparation of single cell suspension of splenocytes from chick spleen, cell counting and viability test.
5. ELISA or dot Elisa (using kit).
6. Principles, experimental set up and applications of immuno-electrophoresis, RIA, F.

**SUGGESTED READINGS**

1. Abbas KA and Lichtman HA (2003) Cellular and Molecular Immunology. 5<sup>th</sup> Edition. Saunders Publication, Philadelphia.
2. David M, Jonathan B, David RB and Ivan R (2006) Immunology. 7<sup>th</sup> Edition. Elsevier Publication, USA .
3. Kindt TJ, Goldsby RA, Osborne BA and Kuby J (2006) Immunology. 6<sup>th</sup> Edition. W.H. Freeman and Company, New York.

**CORE COURSE: ZOOLOGY**  
**PAPER XIV**  
**EVOLUTIONARY BIOLOGY**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY**

**LECTURES: 60**

**Marks 70**

**Unit 1: History of Life, Theories of Evolution and Extinction**

Chemogeny, Biogeny, RNA World, Major events in history of life; Lamarckism; Darwinism; Neo-Darwinism; Background of extinction, Mass extinction (Causes, Names of five major extinction, K-T extinction in detail) and Role of extinction in evolution.

**Unit 2: Evidences of Evolution**

Fossils and its types; Dating of fossils, Phylogeny of horse and human; Molecular evidences (Globin gene families as an example) and Molecular clock concept.

**Unit 3: Processes of Evolutionary Change**

Organic variations; Isolating mechanisms; Natural selection (Industrial melanism, Pesticide or Antibiotic resistance); Types of natural selection (Directional, Stabilizing, Disruptive), Sexual Selection and Artificial selection.

**Unit 4: Principles of population genetics**

Concept of gene pool, Gene frequencies – equilibrium frequency (Hardy-Weinberg equilibrium), Shift in gene frequency without selection – Genetic drift, Mutation pressure and Gene flow and Shifts in gene frequencies with selection.

**Unit 5: Species Concept and Evolution above species level**

Biological concept of species (Advantages and Limitations); Sibling species, Polymorphic species, Polytypic species, Ring species; Modes of speciation (Allopatric, Sympatric); Macro-evolutionary Principles (Darwin's Finches); Convergence, Divergence and Parallelism.

**PRACTICAL**

**Marks 30**

1. Study of fossil evidences from plaster cast models and pictures.
2. Study of homology and analogy from suitable specimens or pictures.
3. Demonstration of changing allele frequencies with and without selection.
4. Construction of cladogram based on morphological characteristics.
5. Construction of phylogenetic tree with bioinformatics tools (Clustal X and Phylip).
6. Interpretation of phylogenetic trees.

**SUGGESTED READINGS**

1. Barton NH, Briggs DEG, Eisen JA, Goldstein DB and Patel NH (2007) Evolution. Cold Spring Harbour Laboratory Press.
2. Campbell NA and Reece JB (2011) Biology. 9<sup>th</sup> Edition. Pearson Education Inc., New York.
3. Douglas JF (1997) Evolutionary Biology. Sinauer Associates, USA.
4. Hall BK and Hallgrimsson B (2008) Evolution. 4<sup>th</sup> Edition. Jones and Bartlett Publishers, USA.
5. Pevsner J (2009) Bioinformatics and Functional Genomics. 2<sup>nd</sup> Edition. Wiley-Blackwell, USA.
6. Ridley M (2004) Evolution. 3<sup>rd</sup> Edition. Blackwell Publishing, USA