

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

Submitted
to

Utkal University
Bhubaneswar

Under

Choice Based Credit System
June 2015

SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B.Sc. ZOOLOGY PASS

SEMESTER	CORE COURSE(14)	ABILITY ENHANCEMENT COMPULSORY COURSE (2)	SKILL ENHANCEMENT COURSE (SEC) (2)	DISCIPLINE SPECIFIC ELECTIVE DCE (4)
I	DIVERSITY AND EVOLUTION OF NON-CHORDATA (PROTISTA TO PSEUDOCOELOMATES) (6 Credits, 100 Marks)	ENVIRONMENTAL SCIENCE (2 credits, 50 Marks)		
	PERSPECTIVES IN ECOLOGY (6 Credits, 100 Marks)			
	DIVERSITY AND EVOLUTION OF NON-CHORDATA (COELOMATE NONCHORDATES) (6 Credits, 100 Marks)			
II	PHYSIOLOGY: LIFE SUSTAINING SYSTEMS (6 Credits, 100 Marks)	ENGLISH/M.I.L./ COMMUNICATION (2 credits, 50 Marks)		
	DIVERSITY AND DISTRIBUTION OF CHORDATA (6 Credits, 100 Marks)			
	PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEM (6 Credits, 100 Marks)			
III	EVOLUTIONARY BIOLOGY (6 Credits, 100 Marks)		SEC -1 PUBLIC HEALTH AND HYGIENE (2 Credits, 50 Marks)	
	COMPARATIVE ANATOMY OF VERTEBRATES (6 Credits, 100 Marks)			
	BIOCHEMISTRY OF METABOLIC PROCESSES (6 Credits, 100 Marks)			

IV	CELL BIOLOGY AND GENETICS (6 Credits, 100 Marks)		SEC-2 Aquarium Fish Keeping (2 Credits, 50 Marks)	
	DEVELOPMENTAL BIOLOGY AND IMMUNOLOGY (6 Credits, 100 Marks)			
	MOLECULAR BIOLOGY (6 Credits, 100 Marks)			
V			SEC- 3 Poultry Farming (2 Credits, 50 Marks)	DSE 1 A Animal behavior (6 Credits, 100 Marks)
				DSE-2 A Economic Zoology (6 Credits, 100 Marks)
				DSE-3 A Wildlife Conservation (6 Credits, 100 Marks)
VI			SEC-4 Apiculture (2 credits, 50 Marks)	DSE -1 B MICROBIOLOGY (6 Credits, 100 Marks)
				DSE- 2 B Agrochemicals and Pest management (6 Credits, 100 Marks)
				Project (6 Credits, 100 Marks)

SEMESTER	COURSE OPTED	COURSE NAME	Credit	Marks
I	Ability Enhancement Compulsory Course-I	Environmental Science	2	50
	Core course-I	Diversity and evolution of non-chordata (protista to pseudocoelomates)	4	75
	Core Course-I Practical		2	25
	Core course-II	Perspectives in ecology	4	75
	Core Course-II Practical		2	25
	Core course-III	Diversity and evolution of nonchordata (coelomate nonchordates)	4	75
	Core course-III Practical		2	25
II	Ability Enhancement Compulsory Course-II	English/ M.I.L. Communications	2	50
	Core course-IV	Physiology: life sustaining systems	4	75
	Core Course-IV Practical		2	25
	Core course-V	Diversity and distribution of chordates	4	75
	Core Course-V Practical		2	25
	Core Course- VI	Physiology controlling and coordinating system	4	75
	Core Course- VI Practical		2	25
III	Core course-VII	Cell biology and Genetics	4	75
	Core Course-VII Practical		2	25
	Core course-VIII	Comparative anatomy of vertebrates	4	75
	Core Course-VIII Practical		2	25
	Core course-IX	Biochemistry of metabolic processes	4	75
	Core Course-IX Practical		2	25
	Skill Enhancement Course-1	Public Health and hygiene	2	50

IV	Core course-X	Evolutionary biology	4	75
	Course-X Practical		2	25
	Core course-XI	Developmental Biology and Immunology	4	75
	Course-XI Practical		2	25
	Core course-XII	Molecular Biology	4	75
	Core Course- XII Practical		2	25
	Skill Enhancement Course-2	Aquarium Fish Keeping	2	50
	Discipline Specific Elective -1 A	Animal Behaviour	4	75
V	Discipline Specific Elective -1 A Practical		2	25
	Discipline Specific Elective -2 A	Economic Zoology	4	75
	Discipline Specific Elective -2 A Practical		2	25
	Discipline Specific Elective -3 A	Wildlife Conservation	4	75
	Discipline Specific Elective -3 A Practical		2	25
	Skill Enhancement Course -2	Poultry Farming	2	50
VI	Discipline Specific Elective -1 B	Microbiology	4	75
	Discipline Specific Elective -1 B Practical		2	25
	Discipline Specific Elective – 2 B	Agrochemicals and Pest Management	4	75
	Discipline Specific Elective -2 B Practical		2	25
	Discipline Specific Elective -3 B	Project	6	100
	Skill Enhancement Course	Apiculture	2	50
Total			120	2100

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

(CREDITS: THEORY-4, PRACTICALS-2)

THEORY
LECTURES: 60

Marks 75

Unit 1: Phylum Protozoa

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

Unit 2: Phylum Porifera

General characteristics and classification up to classes; Canal system in sponges.

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 Nemathelminthes

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. 5th Edition.”

PRACTICALS

Marks 25

Phylum Protozoa

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 spongin 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. 5th Edition.”

SUGGESTED READINGS

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

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

THEORY
LECTURES: 60

Marks 75

Unit 1: Introduction to Ecology

History of ecology; Autecology and synecology; Levels of organization; Laws of limiting factors; Detailed study of temperature and light as physical factors.

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.

Unit 3: Community

Community characteristics: dominance, diversity, species richness, abundance, stratification; Ecotone and edge effect; Ecosystem development (succession) with example.

Unit 4: Ecosystem

Types of ecosystem; Food chain, Detritus and grazing food chains, Linear and Y-shaped food chains; Food web; Energy flow through the ecosystem; Ecological pyramids and Ecological efficiencies; Nutrient and biogeochemical cycle, Nitrogen cycle.

Unit 5: Conservation of Biodiversity

Types of biodiversity, its significance, loss of biodiversity; Conservation strategies (in situ and ex situ); Wildlife (Protection) Act, 1972.

PRACTICALS

Marks 25

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: fauna and flora Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO₂.
4. Report on a visit to National Park/Biodiversity Park/Wildlife sanctuary.

SUGGESTED READINGS

1. Colinvaux PA (1993) Ecology. II Edition. John Wiley and Sons, Inc., USA.
2. Dash MC (1993) Fundamentals of Ecology. McGraw Hill Book Company, New Delhi.
3. Joshi N and Joshi PC (2012) Ecology and Environment. 1st Edition. Himalaya Publishing House, New Delhi.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Odum EP (2008) Fundamentals of Ecology. Indian Edition. Brooks/Cole.
6. 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
NONCHORDATES)
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY
LECTURES: 60

Marks 75

Unit 1: Phylum Annelida

General characteristics and classification up to classes; 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 in insects (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.

Unit 5: Phylum Echinodermata

General characteristics and classification up to classes; Water-vascular system in Asterozoa; Larval forms in Echinodermata.

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

PRACTICAL

Marks 25

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 *Cyprea* (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*, 5th Edition, Holt Saunders International Edition”.

SUGGESTED READINGS

1. Arora MP (2006) Non-Chordata-I. 1st edition. Himalaya Publishing House, New Delhi.
2. Arora MP (2008) Non-Chordata-II. 1st edition. Himalaya Publishing House, New Delhi.
3. Barnes RD (1982) *Invertebrate Zoology*. 6th Edition. Holt Saunders International Edition.
4. Barnes RSK, Calow P, Olive PJW, Golding DW & Spicer JI (2002) *The Invertebrates: A New Synthesis*. 3rd Edition. Blackwell Science, USA.
5. Barrington EJW (1979) *Invertebrate Structure and Functions*. 2nd 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 75

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 dioxide transport in the blood 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 and Coagulation 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.

PRACTICAL

Marks 25

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. 4th 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. 9th Edition. W.B. Saunders Company, Philadelphia.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Tortora GJ and Derrickson B (2012) Principles of Anatomy & Physiology. 13th Edition John Wiley and sons, USA.
6. Victor PE (2008) diFiore's Atlas of Histology with Functional Correlations. 12th Edition. Lippincott W. & Wilkins, USA.

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

THEORY
LECTURES: 60

Marks 75

Unit 1: Protochordata and Origin of Chordates

General characters of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata.

Unit 2: Introduction to Vertebrata and Agnatha

Advanced features of vertebrates over Protochordata; General characters and classification of cyclostomes up to class. Structure 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; General characters and classification up to order and Parental care in Amphibia.

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; 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; Zoogeographical realms and Distribution of vertebrates in different realms.

PRACTICAL

Marks 25

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, Tetradon, 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. 1st Edition. Himalaya Publishing House, New Delhi.
3. Hall BK and Hallgrimsson B (2008) *Strickberger's Evolution*. 4th Edition. Jones and Bartlett Publishers Inc., USA.
4. Jordan EL and Verma PS (1963) Chordate Zoology. Revised Edition. S. Chand, New Delhi.
5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
6. Young JZ (2004) *The Life of Vertebrates*. 3rd Edition. Oxford University Press, New York.

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

THEORY
LECTURES: 60

Marks 75

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.

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 and Reflex arc.

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.

Unit 5: Endocrine System

Functional Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, thymus, pancreas, adrenals; 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.

PRACTICALS

Marks 25

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. 4th 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. 9th Edition. W.B. Saunders Company, Philadelphia.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Tortora GJ and Derrickson B (2012) Principles of Anatomy & Physiology. 13th Edition John Wiley and sons, USA.
6. Victor PE (2008) diFiore's Atlas of Histology with Functional Correlations. 12th Edition. Lippincott W. and Wilkins, USA.

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

THEORY
LECTURES: 60

Marks 75

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 and Evolution of urinogenital ducts.

Unit 5: Nervous System and Sense Organs

Comparative account of brain; Autonomic nervous system; Spinal Nerves; Spinal cord; Cranial nerves in Mammals.

PRACTICAL

Marks 25

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs.
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. 4th Edition. McGraw-Hill Higher Education, New York.
3. Kent GC and Carr RK (2000) Comparative Anatomy of the Vertebrates. 9th Edition. The McGraw-Hill Companies, New York.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Weichert CK and William Presch (1970) Elements of Chordate Anatomy. Tata McGraw Hill, New York.
- 6.

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

THEORY
LECTURES: 60

Marks 75

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; Glycogenesis.

Unit 3: Lipid Metabolism

β -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

Kinetics and Mechanism of action of enzymes; Inhibition of enzyme action.

PRACTICALS

Marks 25

1. Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, 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. 6th Edition, W.H. Freeman and Co., New York.
2. Cox MM and Nelson DL (2008) Lehninger Principles of Biochemistry. 5th Edition. W.H. Freeman and Co., New York.
3. Devesena T (2014) Enzymology. 2nd Edition. Oxford University Press, New York.

4. Hames BD and Hooper NM (2000) Instant Notes in Biochemistry. 2nd Edition. BIOS Scientific Publishers Ltd., U.K.
5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
6. Murray RK, Bender DA, Botham KM, Kennelly PJ, Rodwell VW and Well PA (2009) Harper's Illustrated Biochemistry. 28th Edition. International Edition. The McGraw-Hill Companies Inc., New York.

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

THEORY
LECTURES: 60

Marks 75

Unit 1: Cell and Plasma Membrane

Prokaryotic and Eukaryotic cells; Various models of plasma membrane; Transport across membranes (Diffusion, Active transport, Passive transport, Uniport, Symport and Antiport); Cell junctions.

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; Semiautonomous nature of mitochondria; Endosymbiotic hypothesis; Peroxisomes.

Unit 3: Cytoskeleton, Nucleus and Cell Cycle

Microtubules, microfilaments and their functional dynamics; Ultra structure of nucleus; Nuclear Envelope-Structure of nuclear pore complex; Chromosomal DNA and its packaging; Structure and function of Nucleolus; Cell cycle.

Unit 4: Mendelian Genetics, Linkage, Crossing Over and Chromosomal Mapping

Principles of inheritance; Incomplete dominance and co-dominance; Multiple alleles, Lethal alleles; Epistasis; Pleiotropy; Sex-linked inheritance; 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; Somatic cell hybridization.

Unit 3: Determination of Sex and Mutations

Chromosomal mechanisms of sex determination; Sex-linked, sex-influenced and sex limited characters; 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; DNA repair mechanisms.

PRACTICAL

Marks 25

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/cheek cells. (Preparation of permanent slides).

5. To study the Mendelian laws and gene interactions and their verification by Chisquare analyses using seeds/beads/*Drosophila*.
6. Identification of various mutants of *Drosophila*.

(In practical examination, 05 marks should be of permanent slide submission; one markeach 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. 7th 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, V Edition, Garland publishing Inc., New York and London.
3. Cooper GM and Hausman RE (2009) The Cell: A Molecular Approach. 5th Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Gardner EJ, Simmons MJ, Snustad DP (2008) Principles of Genetics. 8th Edition. Wiley India.
6. Griffiths AJF, Wessler SR, Lewontin RC and Carroll SB. Introduction to Genetic Analysis. 9th Edition. W. H. Freeman and Co., New York.
7. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley and Sons. Inc., USA.
8. Klug WS, Cummings MR, Spencer CA (2012) Concepts of Genetics. 10th Edition. Benjamin Cummings, USA.
9. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
10. Russell, P. J. (2009). Genetics- A Molecular Approach. 3rd Edition. Benjamin Cummings.
11. Snustad DP, Simmons MJ (2009) Principles of Genetics. 5th Edition. John Wiley and Sons Inc., USA.
12. Verma, P.S. and Agarwal, V.K. (2010) Genetics, 9th Edition, S. Chand, New Delhi.

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

**THEORY
LECTURES: 60**

Marks 75

Unit 1: History of Life, theories of Evolution and Extinction

Chemogeny, Biogeny, RNA World; Lamarckism; Darwinism; Neo-Darwinism; Mass extinction (Causes, Names of five major extinctions, 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.

Unit 3: Processes of Evolutionary Change

Organic variations; Isolating mechanisms; Natural selection (Industrial melanism, Pesticide/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.

Unit 5: Species Concept and Evolution above species level

Biological concept of species; Sibling species, Polymorphic species, Polytypic species, Ring species; Modes of speciation (Allopatric, Sympatric); Convergence, Divergence and Parallelism.

PRACTICAL

Marks 25

1. Study of fossil evidences from plaster cast models and pictures.
2. Study of homology and analogy from suitable specimens/ 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*. 9th Edition. Pearson Education Inc., New York.
3. Douglas JF (1997) *Evolutionary Biology*. Sinauer Associates, USA.
4. Hall BK and Hallgrimsson B (2008) *Evolution*. 4th Edition. Jones and Bartlett Publishers.
5. Mohanty PK (2000) *Illustrated Dictionary of Biology*. Kalyani Publishers, Ludhiana.
6. Pevsner J (2009) *Bioinformatics and Functional Genomics*. 2nd Edition. Wiley-Blackwell, USA.
7. Ridley M (2004) *Evolution*. 3rd Edition. Blackwell Publishing, USA.

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

THEORY
LECTURES: 60

Marks 75

Unit 1: Introduction

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: Embryonic Development

Fate of germ layers; Extra-embryonic membranes in birds; Implantation of embryo in humans; Placenta (Structure, types and functions of placenta); Metamorphosis: Changes, hormonal regulations in amphibians; Regeneration: Modes of regeneration (epimorphosis, morphallaxis and compensatory regeneration); Ageing: Concepts and models.

Unit 4: Immune System and Immunity

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 5: Antigens, Antibodies and Vaccines.

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes; Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays, Polyclonal sera, Monoclonal antibodies, Hybridoma technology and Vaccine.

PRACTICAL

Marks 25

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 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. Demonstration of lymphoid organs.
6. ABO blood group determination.

SUGGESTED READINGS

1. Abbas KA and Lichtman HA (2003) Cellular and Molecular Immunology. 5th Edition. Saunders Publication, Philadelphia.
2. Balinsky BI and Fabian BC (1981) An Introduction to Embryology. 5th Edition. International Thompson Computer Press.
3. David M, Jonathan B, David RB and Ivan R (2006) Immunology. 7th Edition. Elsevier Publication, USA .
4. Gilbert SF (2010) Developmental Biology. 9th Edition. Sinauer Associates, Inc., USA.
5. Kalthoff (2008) Analysis of Biological Development. 2nd Edition. McGraw-Hill, New York.
6. Kindt TJ, Goldsby RA, Osborne BA and Kuby J (2006) Immunology. 6th Edition. W.H. Freeman and Company, New York.
7. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
8. Wolpert L, Beddington R, Jessell T, Lawrence P, Meyerowitz E and Smith J (2002) Principles of Development. 1st Edition, Oxford University Press, New York.

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

THEORY
LECTURES: 60

Marks 75

Unit 1: Nucleic Acids and DNA Replication

Salient features of DNA double helix; DNA denaturation and renaturation; DNA topology - linking number and DNA topo-isomerases; Structure of RNA, tRNA and DNA and RNA associated proteins; DNA Replication in prokaryotes and eukaryotes; 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.

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; 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

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 25

1. Study of DNA replication using Photographs or slides and special cases, e.g., Polyteny using 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*. 7th 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*, 4th Edition. Garland publishing Inc., New York
3. Cooper GM and Hausman RE (2007) *The Cell: A Molecular Approach*. 4th Edition, ASM Press, USA.
4. De Robertis EDP and De Robertis EMF (2006) *Cell and Molecular Biology*. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp G (2010) *Cell and Molecular Biology: Concepts and Experiments*. 6th Edition. John Wiley and Sons. Inc., USA.
6. Mohanty PK (2000) *Illustrated Dictionary of Biology*. Kalyani Publishers, Ludhiana.

DISCIPLINE SPECIFIC ELECTIVE – 1 A
ANIMAL BEHAVIOUR
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY
LECTURES: 60

Marks 75

Unit 1: Introduction and Mechanisms of Behaviour

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

Unit 2: Patterns of Behaviour

Reflexes: Types of reflexes, reflex path, characteristics of reflexes (latency, after discharge, summation, fatigue, inhibition) and its comparison with complex behavior.

Orientation: Primary and secondary orientation; kinesis-orthokinesis, klinokinesis; taxistropotaxis and klinotaxis and menotaxis (light compass orientation) and mnemotaxis.

Learning: Associative learning, classical and operant conditioning, Habituation and Imprinting.

Unit 3: Social Behaviour

Insects' society; Honey bee: Society organization, polyethism, foraging, round dance, waggle dance, Experiments to prove distance and direction component of dance, learning ability in honey bee, formation of new hive/queen; Reciprocal altruism, Hamilton's rule and inclusive fitness with suitable examples.

Unit 4: Sexual Behaviour

Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Infanticide, Consequences of mate choice for female fitness, Sexual conflict for male versus female parental care and Courtship behaviour in three spine stickleback.

Unit 5: Biological Clocks

Circadian rhythm, Tidal rhythm, Lunar rhythm, Advantages of biological clocks, Jet lag and Entrainment.

PRACTICAL

Marks 25

1. To study different types of animal behaviour such as habituation, social life, courtship behaviour in insects, and parental care from short videos/movies and prepare a short report.
2. To study nests and nesting habits of the birds and social insects.

3. To study the behavioural responses of wood lice to dry condition.
4. To study behavioural responses of wood lice in response to humid condition.
5. To study geotaxis behaviour in earthworm.
6. To study the phototaxis behaviour in insect larvae.
7. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.

SUGGESTED READINGS

1. David McF. Animal Behaviour. Pitman Publishing Limited, London, UK.
2. John A (2001) Animal Behaviour. 7th Edition. Sinauer Associate Inc., USA.
3. Manning A and Dawkins MS. An Introduction to Animal Behaviour. Cambridge University Press, UK.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Paul WS and John A. Exploring Animal Behaviour. Sinauer Associate Inc., Massachusetts, USA.

DISCIPLINE SPECIFIC ELECTIVE – 2 A
ECONOMIC ZOOLOGY
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY
LECTURES: 60

Marks 75

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

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

Unit 2: Silk and Silk Production (Sericulture)

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

Unit 3: Aquaculture I

Brood stock management; Induced breeding of fish; Management of hatchery of fish; Management of nursery, rearing and stocking ponds; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish; Fishery by-products.

Unit 4: Aquaculture II

Prawn farming; Culture of crab; Pearl culture and Culture of air breathing fishes.

Unit 5: Dairy and Poultry Farming

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

* Submission of report on anyone field visits mentioned above.

PRACTICAL

Marks 25

1. Study of different types of bees (Queens, Drones and Worker bees).
2. Study of different types of silk moths.
3. Study of different types of pearls.
4. Study of different types of fish diseases.
5. Identification of different types of scales in fishes.
6. Study of different types of fins.
7. Study of different modified structures of fishes (Saw of sawfish, Hammer of hammer head fish, tail of sharks etc.)
8. Identification of various types of natural silks.

SUGGESTED READINGS

1. Dhyan Singh Bisht, Apiculture, ICAR Publication.
2. Dunham RA (2004) Aquaculture and Fisheries Biotechnology – Genetic Approaches. CABI publications, U.K.
3. Hafez ESE (1962) Reproduction in Farm Animals. Lea and Fabiger Publishers, .
4. Knobil E and Neill JD (2006) The Physiology of Reproduction. Vol. 2. Elsevier Publishers, USA.
5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
6. Prost PJ (1962) Apiculture. Oxford and IBH, New Delhi.
7. Singh S. Beekeeping in India, Indian council of Agricultural Research, New Delhi.
8. Srivastava CBL (1999) Fishery Science and Indian Fisheries. Kitab Mahal publications, India.

DISCIPLINE SPECIFIC ELECTIVE - 3 A
WILDLIFE CONSERVATION AND MANAGEMENT
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

LECTURES: 60

Marks 75

- Unit 1:** Wildlife: Values of wildlife, positive and negative; Our conservation ethics; Importance of conservation; Causes of depletion and World conservation strategies.
- Unit 2:** Habitat analysis; Evaluation and management of wildlife; Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS; Management of habitats; Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction and Preservation of general genetic diversity.
- 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; Pug marks and census method
- Unit 4:** National Organizations involved in wildlife conservation; Wild life Legislation: Wildlife Protection Act, 1972, its amendments and implementation; Management planning of wildlife in protected areas; Estimation of carrying capacity; Eco tourism / wildlife tourism in forests; Concept of climax persistence; Ecology of perturbation.
- Unit 5:** Management of excess population & translocation; Bio- telemetry; Care of injured and diseased animal; Quarantine and Common diseases of wild animal; Protected areas National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation: Tiger reserves in India and Management challenges in Tiger reserve.

PRACTICALS

Marks 25

1. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna.
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 etc.
4. Demonstration of different field techniques for flora and fauna.
5. PCQ, Ten tree method, Circular, Square & rectangular plots, Parker's 2 Step and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment.
6. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences).

SUGGESTED READINGS

1. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
2. Singh JS, Gupta SR and Singh SP (2014) Ecology, Environmental Science and Conservation. S. Chand, New Delhi.

DISCIPLINE SPECIFIC ELECTIVE – 1 B
MICROBIOLOGY
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY
LECTURES: 60

Marks 75

- Unit 1:** History of Microbiology; Microbial World: Characterization, Classification and identification of microbes.
- Unit 2:** Prokaryotes: General morphology and classification of bacteria, their characters and economic importance; Gram-positive and Gram-negative bacteria.
- Unit 3:** Eukaryotes: General morphology of Protista and Fungi; classification and economic importance.
- Unit 4:** Viruses: structure, genome, replication cycle; Epidemiology of infectious diseases with reference of Human Hosts: Bacterial (Tuberculosis), Viral (Hepatitis), Protozoan (Amoebiasis) and Fungal (any one) disease.
- Unit 5:** Microbe interactions; Immune Responses; Antibiotics and other chemotherapeutic agents; Applied microbiology in the fields of food, agriculture, industry and environment.

PRACTICAL

Marks 25

1. Cleaning of glasswares, sterilisation principle and methods - moist heat - dry heat and filtration methods.
2. Media preparation: Liquid media, Solid media, Agar slants, Agar plates. Basal, enriched, selective media preparation - quality control of media, growth supporting properties, sterility check of media.
3. Pure culture techniques: Streak plate, pour plate and decimal dilution.
4. Cultural characteristics of microorganisms: Growth on different media, growth characteristics and description and demonstration of pigment production.
5. Staining techniques: Smear preparation, simple staining, Gram's staining, Acid fast staining and staining for metachromatic granules.
6. Morphology of microorganisms.
7. Antibiotic sensitivity testing: Disc diffusion test - Quality control with standard strains
8. Physiology characteristics: IMViC test, H₂S, Oxidase, catalase, urease test, Carbohydrate fermentation, Maintenance of pure culture, Paraffin method, Stab culture and maintenance of mold culture.

SUGGESTED READINGS

1. Arora DR and Arora B (2001) Medical Parasitology. 2nd Edition. CBS Publications and Distributers.
2. Dubey RC and Maheshwari DK (2013) A text book of Microbiology, S. Chand Publishing, New Delhi.
3. Pelczar MJ, Chan ECS and Krieg NR (1993) Microbiology. 5th Edition, Tata McGraw Hill Publishing Co.Ltd., New York.

**DISCIPLINE SPECIFIC ELECTIVE
AGRO-CHEMICALS AND PEST MANAGEMENT
(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY
LECTURES: 60**

Marks 75

Unit 1: Fundamentals of Pest Management

Pest: Definition, pest resurgence, secondary pest outbreak, Economic injury level, Economic threshold; Types of pests according to damage (sub economic, occasional, perennial).

Unit 2: Insects of Importance

General morphological features of different groups of insects; Study of biting and chewing, and piercing and sucking type of mouth parts.

Unit 3: Pest Management

Integrated Pest Management: Cultural, biological, chemical, genetic control; Agrochemicals: Pesticides, brief history, nomenclature, mode of action of insecticides, tools and techniques for pesticide application, environmental issues; Measurement of insecticide toxicity by estimation of LD₅₀ value of any one insect pest.

Unit 4: Study of Pest in Laboratory and Field

Visit to agricultural field to study biology, damage and management practices of pests of agricultural crops (*Papilio demoleus*, *Helicoverpa armigera*, *Leptocorisa acuta*, *Leucinodes orbonalis*, *Epilachna vigintioctopunctata*).

Unit 5: Rearing of Pests

Rearing of any two important pests; one each from stored grain and agricultural crop in the laboratory and study their different stages.

PRACTICALS

Marks 25

1. Trips – IARI fields, CWC, FCI, Stored grain institutes (any two).
2. Biological Agents; (Pathogens – NPV); Parasites (*Trichogramma* etc); Predators (Gambusia fish, lady bird beetle etc.) [Collection, preservations & Slide preparation].
3. Field Specimen – Infested plant/plant parts.
4. Determination of LD₅₀ or LC₅₀ of insecticides based on the data provided.
5. Instruments used in IPM.
6. Bioefficacy of EPN.
7. Dry Lab exercise for SIT efficacy.

SUGGESTED READINGS

1. Atwal, A.S. (1993) Agricultural pest of India and South East Asia. Kalyani Pub., New Delhi.
2. Dennis, S. Hill. (2005) Agricultural Insect pests of the tropics and their management, Cambridge University press, UK.
3. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
4. Pedigo L. P. (2002). *Entomology and Pest Management*, Prentice Hall Publication.

5. Pradhan, S. (1969). *Insect Pests of Crops*. National Book Trust, India Book House.
6. Robert F. Norris, Edward P. Caswell-Chen and Marcos Kogan, *Concepts of Integrated Pest Management*, Prentice Hall of India.

SKILL ENHANCEMENT COURSES - 1
PUBLIC HEALTH AND HYGIENE
(Credits 2)

Lectures: 30

Marks 50

Unit 1: Scope of Public health and Hygiene; nutrition and health; classification of foods; Nutritional deficiencies; Vitamin deficiencies.

Unit 2: Pollution: water pollution, air pollution, soil pollution, noise pollution, thermal pollution and radioactive pollution.

Unit 3: Environment and Health hazards; Environmental degradation; health hazards due to pollutants.

Unit 4: Communicable diseases and their control measures such as Measles, Polio, Chikungunya, Rabies, Plague, Leprosy and AIDS.

Unit 5: Non-Communicable diseases and their preventive measures such as Hypertension, Coronary Heart diseases, Stroke, Diabetes, Obesity and Mental ill-health.

SUGGESTED READINGS

1. Arora DR and Arora B (2001) Medical Parasitology. 2nd Edition. CBS Publications and Distributers.
2. Dubey RC and Maheshwari DK (2013) A text book of Microbiology. S. Chand, New Delhi.
3. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
4. Pelczar MJ, Chan ECS and Krieg NR (1993) Microbiology. 5th Edition. Tata McGraw Hill Publishing Co. Ltd., New York.

SKILL ENHANCEMENT COURSES – 2
AQUARIUM FISH KEEPING
(CREDITS 2)

LECTURES: 30

Marks 50

- Unit 1:** The potential scope of Aquarium Fish Industry as a Cottage Industry; Exotic and Endemic species of Aquarium Fishes.
- Unit 2:** Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish.
- Unit 3:** Food and feeding of Aquarium fishes; Use of live fish feed organisms; Preparation and composition of formulated fish feeds.
- Unit 4:** Live fish transport; Fish handling, packing and forwarding techniques; General Aquarium maintenance; budget for setting up an Aquarium Fish Farm as a Cottage Industry.
- Unit 5:** Health Education in India; WHO Programmes; Government and Voluntary Organizations and their health services; Precautions, First Aid and awareness on Sporadic diseases.

SUGGESTED READING

1. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

SKILL ENHANCEMENT COURSES - 3
POULTRY FARMING
(CREDITS 2)

LECTURES: 30

Marks 50

- Unit 1:** External morphology of variety of Fowls such as Plymouth Rock, Light Sussex, Minorca, Rhode Island, Red and White Leghorn.
- Unit 2:** Classification of Fowls based on their use : Meat type such as Broilers, Egg type such as White Leghorn and Commercial layers, Dual purpose varieties, Game and Ornamental purpose varieties.
- Unit 3:** Feeding Poultry – Management of Egg Layers – Management of Broilers in large scale farms.
- Unit 4:** Poultry diseases Viral, Bacterial, Fungal, Protozoan and Parasitic Lice etc., Prevention and precautions during vaccination.
- Unit 5:** Management of a modern Poultry Farms – Progressive plans to promote Poultry as a Self-Employment venture.

SUGGESTED READING

1. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

SKILL ENHANCEMENT COURSES - 4
APICULTURE
(CREDITS 2)

LECTURES: 30

Marks 50

Unit 1:History – Biology and classification of honey bee species of honey bees Social organization of honey bee colony.

Unit 2: Bee hive; Flora for apiculture; Selection of bees for apiculture, Method of bee Keeping and Indigenous method of Extraction of honey.

Unit 3: Modern method of apiculture; Appliances for modern method; Diseases of Honey bee and control measures.

Unit 4: Products of bee keeping : Honey, Bee wax and Bee Yeman; Honey : Production, Chemical composition and Economic importance of Honey bee wax.

Unit 5: Bee enemies; Bee keeping industry; Recent efforts; Modern method in employing honey bees for cross pollination in horticultural gardens.

SUGGESTED READING

2. Dhyan Singh Bisht, Apiculture, ICAR Publication.
3. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
4. Prost PJ (1962) Apiculture. Oxford and IBH, New Delhi.
5. Singh S. Beekeeping in India, Indian council of Agricultural Research, New Delhi.