Revised
SYLLABUS FOR
Bachelor of Science (Honours)

ZOOLOGY

THREE YEAR DEGREE COURSE
SEMESTER SYSTEM

(Under New UGC CBCS Guidelines)

COURSE STRUCTURE

SEMESTER	COURSE	COURSE NAME	COURSE CODE	CREDIT
I	Core 1	Non-chordates I: Protista to Pseudocoelomates (Theory)	ZOC 1.11	4
		Non-chordates I: Protista to Pseudocoelomates (Practical)	ZOC 1.12	2
	Core 2	Principles of Ecology (Theory)	ZOC 1.21	4
		Principles of Ecology (Practical)	ZOC 1.22	2
II	Core 3	Non-chordates II: Coelomates (Theory)	ZOC 2.11	4
		Non-chordates II: Coelomates (Practical)	ZOC 2.12	2
	Core 4	Cell Biology (Theory)	ZOC 2.21	4
		Cell Biology (Practical)	ZOC 2.22	2
III	Core 5	Diversity of Chordates (Theory)	ZOC 3.11	4
		Diversity of Chordates (Practical)	ZOC 3.12	2
	Core 6	Physiology: Controlling and Coordinating Systems (Theory)	ZOC 3.21	4
		Physiology: Controlling and Coordinating Systems (Practical)	ZOC 3.22	2
	Core 7	Fundamentals of Biochemistry (Theory)	ZOC 3.31	4
		Fundamentals of Biochemistry (Practical)	ZOC 3.32	2
	Skill Enhancement Course 1	Apiculture OR Sericulture	ZOS 3.11(a) ZOS 3.11(b)	2
IV	Core 8	Comparative Anatomy of Vertebrates (Theory)	ZOC 4.11	4
		Comparative Anatomy of Vertebrates (Practical)	ZOC 4.12	2
	Core 9	Physiology: Life Sustaining Systems (Theory)	ZOC 4.21	4
		Physiology: Life Sustaining Systems (Practical)	ZOC 4.22	2
	Core 10	Biochemistry of Metabolic Processes (Theory)	ZOC 4.31	4
		Biochemistry of Metabolic Processes (Practical)	ZOC 4.32	2
	Skill Enhancement Course 2	Medical Diagnostics OR Aquarium Fish Keeping	ZOS 4.11(a) ZOS 4.11(b)	2
V	Core 11	Molecular Biology (Theory)	ZOC 5.11	4
		Molecular Biology (Practical)	ZOC 5.12	2
	Core 12	Principles of Genetics (Theory)	ZOC 5.21	4
		Principles of Genetics (Practical)	ZOC 5.22	2
	Discipline Specific Elective 1	Biology of Insects (Theory) OR Animal Behaviour and Chronobiology (Theory)	ZOD 5.11(a) ZOD 5.11(b)	4

		Biology of Insects (Practical) OR Animal Behaviour and Chronobiology (Practical)	ZOD 5.12(a) ZOD 5.12(b)	2
	Discipline Specific Elective 2	Parasitology (Theory) OR Reproductive Biology (Theory)	ZOD 5.21(a) ZOD 5.21(b)	4
		Parasitology (Practical) OR Reproductive Biology (Practical)	ZOD 5.22(a) ZOD 5.22(b)	2
VI	Core 13	Developmental Biology (Theory)	ZOC 6.11	4
		Developmental Biology (Practical)	ZOC 6.12	2
	Core 14	Evolutionary Biology (Theory)	ZOC 6.21	4
		Evolutionary Biology (Practical)	ZOC 6.22	2
	Discipline Specific Elective 3	Fish and Fisheries (Theory) OR Wildlife Conservation and Management (Theory)	ZOD 6.11(a) ZOD 6.11(b)	4
		Fish and Fisheries (Practical) OR Wildlife Conservation and Management (Practical)	ZOD 6.12(a) ZOD 6.12(b)	2
	Discipline Specific Elective 4	Immunology (Theory) OR Endocrinology (Theory)	ZOD 6.21(a) ZOD 6.21(b)	4
		Immunology (Practical) OR Endocrinology (Practical)	ZOD 6.22(a) ZOD 6.22(b)	2

SEMESTER - I

CORE 1 (ZOC 1.11)
NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES

Theory Credit: 4

UNIT I **Protista, Parazoa and Metazoa**
General characteristics and Classification up to classes
Morphological study of *Euglena*, *Amoeba* and *Paramecium*
Life cycle and pathogenicity of *Plasmodium vivax*
Mode of locomotion and Reproduction in Protista

UNIT II **Porifera**
General characteristics and Classification up to classes
Reproduction and development in sponges: sycon, leucosolenia.
Structural organization of sycon.
Canal system and spicules in sponges

UNIT III **Cnidaria**
General characteristics and Classification up to classes
Metagenesis in *Obelia*
Reproduction in Aurelia
Polymorphism in Cnidaria
Corals and coral reefs

UNIT IV **Ctenophora and Platyhelminthes**
General characteristics and Evolutionary significance of Ctenophora
General characteristics and Classification up to classes of Platyhelminthes
Life cycle and pathogenicity of *Fasciola hepatica*

UNIT V **Nemathelminthes**
General characteristics and Classification up to classes
Life cycle, and pathogenicity of *Ascaris lumbricoides* and *Ancylostomaduodenali*
Parasitic adaptations in helminthes

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

CORE 1 (ZOC 1.12)
NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES

Practical Credit: 2

1. Study of whole mount of *Amoeba, Monocystic and Trypanosoma.*
2. Binary fission and Conjugation in *Paramecium*
3. Culture of *Paramecium* and *Euglena.*
4. Study of *Sycon* (T.S. and L.S.), *Hyalonema, Spongilla, Obelia, Physalia, Gorgonia*
5. One specimen/slide of any ctenophore
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/microphotographs)

7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs).
8. Temporary mounting of Spicules and Gemmules.

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

Recommended Books and References:

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

CORE 2 (ZOC 1.21)
PRINCIPLES OF ECOLOGY

Theory Credit: 4

UNIT I **Introduction to Ecology**

Concept of Species; sympatric and Allopatric
Law of limiting factors: Liebig's law of minimum and Shelford's law of Tolerence.
History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors

UNIT II **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 III **Community**

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological –Aquatic and terrestrial.
Theories pertaining to climax community

UNIT IV **Ecosystem**

Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies Biogeochemical cycle of Nitrogen and Carbon.

UNIT V **Applied Ecology**

Wildlife Conservation and Management: Strategies, Threats, Acts, Methods.
Human modified ecosystem

CORE 2 (ZOC 1.22)
PRINCIPLES OF ECOLOGY

Practical Credit: 2

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 quadrate method and calculation of Shannon-Weiner diversity index for the same community
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO_2
4. Field Study

Recommended Books and References:

1. Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
3. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Robert Leo Smith Ecology and field biology Harper and Row publisher
5. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Pres

SEMESTER - II

CORE 3 (ZOC 2.11)
NON-CHORDATES II: COELOMATES

Theory Credit: 4

UNIT I **Introduction to Coelomates**
Evolution and types of coelom and metamerism,
Significance of Coelom and Metamerism,
Level of organization.

UNIT II **Annelida and Onychophora**
General characteristics and Classification of Annelida up to classes
Excretion in Annelida. Locomotion in Annelida, Economic importance of Annelida
General characteristics and Evolutionary significance of Onychophora

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

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

UNIT V **Echinodermata**
General characteristics and Classification up to classes
Water-vascular system in Asteroidea
Larval forms in Echinodermata
Affinities with Chordates

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

CORE 3 (ZOC 2.12)
NON-CHORDATES II: COELOMATES

Practical Credit: 2

1. Study of following specimens:
   Annelids - *Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria*
   Arthropods - *Limulus*, *Palamnaeus, Palaemon, Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, *Bombyx*, *Periplaneta,* termites and honey bees
   Onychophora - *Peripatus*

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

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

2. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm
3. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm
4. Mount of mouth parts and dissection of digestive system and nervous system of*Periplaneta**
5. To submit a Project Report on life cycle of Anopheles/Culex/Housefly

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

Recommended Books and References:

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition
2. Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis,* III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

CORE 4 (ZOC 2.21)
CELL BIOLOGY

Theory Credit: 4

UNIT I **Overview of Cells and Plasma Membrane**

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

UNIT II **Endomembrane System**

Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes
Protein sorting and Transport system(ER, Golgi Apparatus, Lysosome)

UNIT III **Mitochondria, Peroxisomes and Cytoskeleton**

Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis
Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis; Peroxisomes;
Cytoskeleton: Structure and Functions: Microtubules, Microfilaments and Intermediate filaments

UNIT IV **Nucleus**

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

UNIT V **Cell Division and Cell Signaling**

Mitosis, Meiosisand their significance, Cell cycle and its regulation and check points, GPCR and Role of second messenger (cAMP)

CORE 4 (ZOC 2.22)
CELL BIOLOGY

Practical Credit: 2

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

Recommended Books and References:

1. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition.ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. 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.

SEMESTER – III

CORE 5 (ZOC 3.11)
DIVERSITY OF CHORDATA

Theory Credit: 4

UNIT I **Introduction to Chordates and Protochordata**

General characteristics and outline classification of chordate. General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata.

UNIT II **Origin of Chordata and Agnatha**

Echinoderm theory of origin of chordates. Theories of Chordate Ancestry
External morphology, habit and habitat of petromyzon. Advanced features of vertebrates over Protochordata. General characteristics and classification of cyclostomes up to class.

UNIT III **Pisces and Amphibia**

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

UNIT IV **Reptilia and Aves**

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

UNIT V **Mammals and Zoogeography**

General characters and classification of mammals up to order; Affinities of ototheria; Adaptive radiation with reference to locomotory appendage. Distribution of vertebrates in different Zoogeographical realms

CORE 5 (ZOC 3.12)
DIVERSITY OF CHORDATA

Practical Credit: 2

1. **Protochordata**
   Balanoglossus, Herdmania, Branchiostoma, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions.

2. **Agnatha**
   Petromyzon, Myxine

3. Fishes

Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas, Flat fish

4. Amphibia

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

5. Reptilia

Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus

Key for Identification of poisonous and non-poisonous snakes

6. Aves

Study of six common birds from different orders. Types of beaks and claws

7. Mammalia

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

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

Classification from Young, J. Z. (2004) to be followed

Recommended Books and References:

1. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
2. Pough H. *Vertebrate life,* VIII Edition, Pearson International.
3. Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub Co.
4. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

CORE 6 (ZOC 3.21)
ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS

Theory Credit: 4

UNIT I **Tissues Bone and Cartilage**

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

UNIT II **Nervous System**

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

UNIT III **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 IV **Reproductive System**

Histology of testis and ovary; Physiology of male and female reproduction; Puberty, Methods of contraception in male and female

UNIT V **Endocrine System**

Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; Hypothalamus (neuroendocrine gland) - neuroendocrine control of anterior pituitary and endocrine system.

CORE 6 (ZOC 3.22)
ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS

Practical Credit: 2

* 1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such asknee jerk reflex)
3. Preparation of temporary mounts: Squamous epithelium and Striated muscle fibres
4. Study of permanent slides of Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
5. Microtomy: Preparation of permanent slide of any five mammalian (Goat/whiterat) tissues
6. Dissection of Endocrine Glands in albino mice.
7. Dissection of reproduction system in albino mice

*(*Subject to UGC guidelines)*

Recommended Books and References:

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

CORE 7 (ZOC 3.31)
FUNDAMENTALS OF BIOCHEMISTRY

Theory Credit: 4

UNIT I **Carbohydrates**

Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates

UNIT II **Lipids**

Structure, properties and functional significance of saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids,
Steroids

UNIT III **Proteins**

Amino acids: Structure, Classification and General properties of α-amino acids; Physiological importance of essential and non-essential α-amino acids

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

UNIT IV **Nucleic Acids**

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

UNIT V **Enzymes**

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affect ingrate of enzyme-catalyzed reactions; Multi-substrate reactions; Enzyme inhibition; Regulation of enzyme action

CORE 7 (ZOC 3.32)
FUNDAMENTALS OF BIOCHEMISTRY

Practical Credit: 2

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

Recommended Books and References:

1. Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
5. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

SEMESTER – IV

CORE 8 (ZOC 4.11)
COMPARATIVE ANATOMY OF VERTEBRATES

Theory Credit: 4

UNIT I **Integumentary System and Skeletal System**
Structure, functions and derivatives of integument
Overview of axial and appendicular skeleton

UNIT II **Digestive System and Respiratory System**
Alimentary canal and associated glands, dentition
Skin, gills, lungs and air sacs; Accessory respiratory organs

UNIT III **Circulatory System and Urinogenital System**
General plan of circulation, evolution of heart and aortic arches
Succession of kidney, Evolution of urinogenital ducts

UNIT IV **Nervous System**
Comparative account of brain
Autonomic nervous system, Spinal cord, Cranial nerves in mammals

UNIT V **Sense Organs**
Classification of receptors
Brief account of visual and auditory receptors in man

CORE 8 (ZOC 4.12)
COMPARATIVE ANATOMY OFVERTEBRATES

Practical Credit: 2

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, *Varanus,* Fowl, Rabbit
3. Mammalian skulls: One herbivorous and one carnivorous animal
4. Dissection of mice to study arterial and urinogenital system (subject to permission)
5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)
6. Project on skeletal modifications in vertebrates (may be included if dissection not permitted)

Recommended Books and References:

1. Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education
2. Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies
3. Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons
4. Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House

CORE 9 (ZOC 4.21)
ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS

Theory Credit: 4

UNIT I **Physiology of Digestion**

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

UNIT II **Physiology of Respiration**

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

UNIT III **Renal Physiology**

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance

UNIT IV **Blood**

Components of blood and their functions; Structure and functions of haemoglobin
Haemostasis: Blood clotting system, Kallikrein-Kinninogen system, Complement system& Fibrinolytic system, Haemopoiesis
Blood groups: Rh factor, ABO and MN

UNIT V **Physiology of Heart**

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

CORE 9 (ZOC 4.22)
ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS

Practical Credit: 2

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

Recommended Books and References:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company.

2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills

CORE 10 (ZOC 4.31)
BIOCHEMISTRY OF METABOLIC PROCESSES

Theory Credit: 4

UNIT I **Overview of Metabolism**
Catabolism *vs* Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms

UNIT II **Carbohydrate Metabolism**
Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis

UNIT III **Lipid Metabolism**
β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis

UNIT IV **Protein Metabolism**
Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

UNIT V **Oxidative Phosphorylation**
Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System

CORE 10 (ZOC 4.32)
BIOCHEMISTRY OF METABOLIC PROCESS

Practical Credit: 2

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
3. To study the enzymatic activity.
4. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.
5. Calorimetric estimation of Protein.

Recommended Books and References:

1. Cox, M.M and Nelson, D.L. (2008). *Lehninger Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.

2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bende*r, D.A.,* Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.

SEMESTER - V

CORE 11 (ZOC 5.11)
MOLECULAR BIOLOGY

Theory Credit: 4

UNIT I **Nucleic Acids and DNA Replication**
Watson and Crick model of DNA; DNA as a genetic material. DNA Replication in prokaryotes and eukaryotes, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, replication of telomeres

UNIT II **Transcription**
RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors

UNIT III **Translation**
Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

UNIT IV **Post Transcriptional Modifications and Processing of Eukaryotic RNA**
Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA

UNIT V **Gene Regulation and DNA Repair Mechanisms**
Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp* operon; Transcription regulation in eukaryotes; Pyrimidine dimerization and mismatch repair

CORE 11 (ZOC 5.12)
MOLECULAR BIOLOGY

Practical Credit: 2

1. Study of Polytene chromosomes from Chironomous / Drosophila larvae
2. Preparation of liquid culture medium (LB) and raise culture of *E. coli*
3. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking
4. Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results
5. Quantitative estimation of DNA and RNA.
6. Study and interpretation of electron micrographs/ photograph showing
   (a) DNA replication
   (b) Transcription
   (c) Split genes

Recommended Books and References:

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, San
2. Francisco.

3. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
4. Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach***,** V Edition, ASM Press and Sinauer Associates.
5. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
6. Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
7. Lewin B. (2008). *Gene XI*, Jones and Bartlett
8. McLennan A., Bates A., Turner, P. and White M. (2015). *Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.

CORE 12 (ZOC 5.21)
PRINCIPLES OF GENETICS

Theory Credit: 4

UNIT I **Mendelian Genetics and its Extension**

Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex-influenced and sex-limited characters inheritance.

UNIT II **Linkage, Crossing Over and Chromosomal Mapping**

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

UNIT III **Mutations**

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

UNIT IV **Sex Determination and Extra-chromosomal Inheritance**

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

UNIT V **Polygenic Inheritance, Recombination in Bacteria and Viruses and Transposable Genetic Elements**

Polygenic inheritance with suitable examples; Conjugation, Transformation and Transduction in Bacteriophage Transposons in bacteria, Transposons in humans

CORE 12 (ZOC 5.22)
PRINCIPLES OF GENETICS

Practical Credit: 2

1. To study the Mendelian laws and gene interactions.
2. Chi-square analyses using seeds/beads/*Drosophila*.
3. Linkage maps based on data from *Drosophila* crosses.
4. Study of human karyotype (normal and abnormal).
5. Pedigree analysis of some human inherited traits.

Recommended Books and References:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
2. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
4. Russell, P. J. (2009). *Genetics- A Molecular Approach.* III Edition. Benjamin Cummings
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co
6. Fletcher H. and Hickey I. (2015). *Genetics.* IV Edition. GS, Taylor and Francis Group, New York and London.

SEMESTER - VI

CORE 13 (ZOC 6.11)
DEVELOPMENTAL BIOLOGY

Theory Credit: 4

UNIT I **Introduction**
Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division

UNIT II **Early Embryonic Development**
Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick upto gastrulation; Embryonic induction and organizers

UNIT III **Late Embryonic Development**
Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)

UNIT IV **Post Embryonic Development**
Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories

UNIT V **Implications of Developmental Biology**
Teratogenesis: Teratogenic agents and their effects on embryonic development; *In vitro* fertilization, Stem cell (ESC), Amniocentesis

CORE 13 (ZOC 6.12)
DEVELOPMENTAL BIOLOGY

Practical Credit: 2

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 96hours of incubation (Hamilton and Hamburger stages)
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture
4. Study of different sections of placenta (photomicropgraph/slides)
5. Project report on *Drosophila* culture/chick embryo development

Recommended Books and References:

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA

2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
3. Carlson, R. F. Patten's Foundations of Embryology
4. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

CORE 14 (ZOC 6.21)
EVOLUTIONARY BIOLOGY

Theory Credit: 4

UNIT I Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism Evidences of Evolution, geological time scale, evolution of horse, Sources of variations: Heritable variations and their role in evolution

UNIT II Population genetics: Hardy-Weinberg Law, Factor influencing H-W equilibrium; Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, Genetic Drift, Role of Migration and Mutation in changing allele frequencies

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

UNIT IV Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*, molecular analysis of human origin

UNIT V Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees

CORE 14 (ZOC 6.22)
EVOLUTIONARY BIOLOGY

Practical Credit: 2

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

Recommended Books and References:

1. Ridley, M (2004) Evolution III Edition Blackwell publishing
2. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
3. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
4. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
5. Snustad. S Principles of Genetics.
6. Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell

DISCIPLINE CENTRIC ELECTIVE COURSES

DISCIPLINE SPECIFIC ELECTIVE 1 (ZOD 5.11(a))
BIOLOGY OF INSECTA

Theory Credit: 4

UNIT I **Introduction and Insect Taxonomy**
General Features of Insects
Distribution and Success of Insects on the Earth
Basis of insect classification; Classification of insects up to orders

UNIT II **General Morphology of Insects**
External Features; Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits
Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat
Abdominal appendages and genitalia

UNIT III **Physiology of Insects**
Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system
Sensory receptors
Growth and metamorphosis

UNIT IV **Insect Society**
Group of social insects and their social life
Social organization and social behaviour (w.r.t. any one example)

UNIT V **Insect Plant Interaction and Vectors**
Host-plant selection by phytophagous insects, Insects as plant pests
Insects as mechanical and Biological vectors, Brief discussion on houseflies and mosquitoes as important insect vectors

DISCIPLINE SPECIFIC ELECTIVE 1 (ZOD 5.12(a))
BIOLOGY OF INSECTA

Practical Credit: 2

1. Study of one specimen from each insect order
2. Study of different kinds of antennae, legs and mouth parts of insects
3. Study of head and sclerites of any one insect
4. Study of insect wings and their venation.
5. Study of insect spiracles
6. Methodology of collection, preservation and identification of insects.
7. Morphological studies of various castes of *Apis*
8. Study of any three insect pests and their damages
9. Study of any three beneficial insects and their products
10. Field study of insects and submission of a project report on the insect diversity

Recommended Books and References:

1. A general text book of entomology, Imms, A. D., Chapman & Hall, UK
2. The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK
3. Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA
4. Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication, USA
5. The Insect Societies, Wilson, E. O., Harward Univ. Press, UK
6. Host Selection by Phytophagous insects, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
7. Physiological system in Insects, Klowden, M. J., Academic Press, USA
8. The Insects, An outline of Entomology, Gullan, P. J., and Cranston, P. S., Wiley Blackwell, UK
9. Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA

DISCIPLINE SPECIFIC ELECTIVE 1 (ZOD 5.11(b))
ANIMAL BEHAVIOUR AND CHRONOBIOLOGY

Theory Credit: 4

UNIT I **Introduction to Animal Behaviour**

Origin and history of Ethology; Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behaviour, Methods and recording of a behaviour

UNIT II **Patterns of Behaviour**

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

UNIT III **Social and Sexual Behaviour**

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

UNIT IV **Introduction to Chronobiology**

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

UNIT V **Biological Rhythm and Clocks**

Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation seasonal reproduction of vertebrates; Role of melatonin. Relevance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy.

DISCIPLINE SPECIFIC ELECTIVE 1 (ZOD 5.12(b))
ANIMAL BEHAVIOUR AND CHRONOBIOLOGY

Practical Credit: 2

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

Recommended Books and References:

1. David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
2. Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.
3. John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
4. Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
5. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
6. Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.)R.D. Lewis. (3rdEd) 2002 Barens and Noble Inc. New York, USA
7. Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

DISCIPLINE SPECIFIC ELECTIVE 2 (ZOD 5.21(a))
PARASITOLOGY

Theory Credit: 4

UNIT I **Introduction to Parasitology**
Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship

UNIT II **Parasitic Protists**
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica, Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani, Plasmodium vivax*

UNIT III **Parasitic Platyhelminthes**
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciolopsis buski, Schistosoma haematobium, Taenia solium* and *Hymenolepis nana*

UNIT IV **Parasitic Nematodes**
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis.* Study of structure,

lifecycle and importance of *Meloidogyne* (root knot nematode), *Pratylencus* (*lesion nematode*)

UNIT V **Parasitic Arthropoda**

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

DISCIPLINE SPECIFIC ELECTIVE 2 (ZOD 5.22(a))
PARASITOLOGY

Practical Credit: 2

1. Study of life stages of Entamoeba histolytica, Giardia intestinalis, Trypanosomagambiense, Leishmania donovani and Plasmodium vivaxthrough permanent slides/micro photographs
2. Study of adult and life stages of Fasciolopsisbuski, Schistosomahaematobium, Taenia solium and Hymenolepis nana through permanentslides/micro photographs
3. Study of adult and life stages of Ascaris lumbricoides, Ancylostomaduodenale, Wuchereriabancrofti and Trichinella spiralis throughpermanent slides/micro photographs
4. Study of plant parasitic root knot nematode, Meloidogyne from the soil sample
5. Study of Pediculushumanus (Head louse and Body louse), Xenopsyllacheopis and Cimexlectularius through permanent slides/ photographs
6. Study of monogenea from the gills of fresh/marine fish [Gills can beprocured from fish market as by product of the industry]
7. Study of nematode/cestode parasites from the intestines of Poultry bird[Intestine can be procured from poultry/market as a byproduct]
8. Submission of a brief report on parasitic vertebrates vertebrates

Recommended Books and References:

1. Arora, D. R and Arora, B. (2001) *Medical Parasitology*. II Edition. CBS Publications and Distributors
2. E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea & Febiger
3. Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) *Biology of Disease.* Taylor and Francis Group
4. Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi
5. Rattan Lal Ichhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi
6. Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers
7. K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS *Publishers*& Distributors (P) Ltd.

DISCIPLINE SPECIFIC ELECTIVE 2 (ZOD 5.21(b))
REPRODUCTIVE BIOLOGY

Theory Credit: 4

UNIT I **Reproductive Endocrinology**

Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in male and female; Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation.

UNIT II **Functional anatomy of male reproduction**

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

UNIT III **Functional anatomy of female reproduction**

Outline and histological of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract;

UNIT IV **Fertilization**

Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation

UNIT V **Reproductive Health**

Infertility in male and female: causes, diagnosis and management; Assisted Reproductive

Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning

DISCIPLINE SPECIFIC ELECTIVE 2 (ZOD 5.22(b))
REPRODUCTIVE BIOLOGY

Practical Credit: 4

1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.
2. Examination of vaginal smear rats from live animals.
3. Surgical techniques: principles of surgery in endocrinology. Ovarectomy, hysterectorny, castration and vasectomy in rats.
4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
5. Human vaginal exfoliate cytology.

6. Sperm count and sperm motility in rat
7. Study of modern contraceptive devices

Recommended Books and References:

1. Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press.
2. Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company.
3. Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
4. Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

DISCIPLINE SPECIFIC ELECTIVE 3 (ZOD 6.11 (a))
FISH AND FISHERIES

Theory Credit: 4

UNIT I **Introduction and Classification:**
General description of fish; Account of systematic classification of fishes (upto classes); Classification based on feeding habit, habitat and manner of reproduction.

UNIT II **Morphology and Physiology:**
Types of fins and their modifications; Locomotion in fishes; Hydrodynamics;
Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Osmoregulation in Elasmobranchs; Reproductive strategies (special reference to Indian fishes); Electric organs; Bioluminiscience; Mechanoreceptors; Schooling; Parental care; Migration

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

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

UNIT V **Fish in research**
Transgenic fish, Zebrafish as a model organism in research

DISCIPLINE SPECIFIC ELECTIVE 3 (ZOD 6.12 (a))
FISH AND FISHERIES

Practical Credit: 2

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

Recommended Books and References:

1. Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
2. D. H. Evans and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK von der Emde, R.J. Mogdans and B.G. Kapoor. The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands
3. C.B.L. Srivastava, Fish Biology, Narendra Publishing House
4. J.R. Norman, A history of Fishes, Hill and Wang Publishers
5. S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House

DISCIPLINE SPECIFIC ELECTIVE 3 (ZOD 6.11(b))
WILD LIFE CONSERVATION AND MANAGEMENT

Theory Credit: 4

UNIT I **Introduction to Wild Life**
Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.

UNIT II **Evaluation and management of wild life**
Habitat analysis, Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.

UNIT III **Management of habitats**
Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats

UNIT IV **Population estimation and management**
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. Bio- telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animal

UNIT V **Protected areas**

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

DISCIPLINE SPECIFIC ELECTIVE 3 (ZOD 6.12(b))
WILD LIFE CONSERVATION AND MANAGEMENT

Practical Credit: 2

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)

Recommended Books and References:

1. Caughley, G., and Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science.
2. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). *People and Wildlife, Conflict or Co-existence*? Cambridge University.
3. Bookhout, T.A. (1996). *Research and Management Techniques for Wildlife and Habitats,* 5 th edition. The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000). *The Conservation Handbook: Research, Management and Policy*. Blackwell Sciences
5. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). *Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing.

DISCIPLINE SPECIFIC ELECTIVE 4 (ZOC 6.21(a))
IMMUNOLOGY

Theory Credit: 4

UNIT I **Overview of Immune System and Antigens**

Historical perspective of Immunology, Early theories of Immunology,
Cells and organs of the Immune system

Important features of Immunogens, Adjuvants, haptens and epitopes;
Factors influencing immunogenicity

UNIT II **Innate and Adaptive Immunity**

Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions (brief account of autoimmunity with reference to AIDS).

UNIT III **Immunoglobulins**

Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (Principles of ELISA and RIA), Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis

UNIT IV **Major Histocompatibility Complex and Cytokines**

Structure and functions of MHC molecules; Endogenous and exogenous pathways of antigen processing and presentation;
Properties and functions of cytokines, Therapeutics Cytokines

UNIT V **Complement System, Hypersensitivity and Vaccines**

Components and pathways of complement activation.
Gell and Coombs' classification and brief description of various types of Hypersensitivities; Various types of vaccines (in use and in development).

DISCIPLINE SPECIFIC ELECTIVE 4 (ZOC 6.22(a))
IMMUNOLOGY

Practical Credit: 2

1*. Demonstration of lymphoid organs.
2. Histological study of spleen, thymus and lymph nodes through slides/photographs
3. Preparation of stained blood film to study various types of blood cells.
4. Enumeration of total count of WBC.
5. Demonstration of:
   a. ELISA
   b. Immuno electrophoresis

** The experiments can be performed depending upon usage of animals in UG courses.*

Recommended Books and References:

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company.
2. David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology,* VII Edition, Mosby, Elsevier Publication.
3. Abbas, K. Abul and Lechtman H. Andrew (2003.) *Cellular and Molecular Immunology.* V Edition. Saunders Publication.

DISCIPLINE SPECIFIC ELECTIVE 4 (ZOD 5.21(b))
ENDOCRINOLOGY

Theory Credit: 4

UNIT I Introduction to Endocrinology

Classification, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones, Regulation of neuroendocrine glands.

UNIT II Epiphysis and Hypothalamus

Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction.

Structure of hypothalamus, Hypothalamic nuclei and their functions, Feedback mechanisms.

UNIT III Pituitary glands

Structure of pituitary gland, Hormones and their functions, Hypothalamohypophysial portal system, Disorders of pituitary gland.

UNIT IV Peripheral Endocrine Glands

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

UNIT V Regulation of Hormone Action

Hormone action at Cellular level: Hormone receptors, transduction and regulation

Hormone action at Molecular level: Molecular mediators, Genetic control of hormone action.

DISCIPLINE SPECIFIC ELECTIVE 4 (ZOD 6.22(b))
ENDOCRINOLOGY

Practical Credit: 2

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

Recommended Books and References:

1. General Endocrinology C. Donnell Turner Pub- Saunders Toppan
2. Endocrinology: An Integrated Approach; Stephen Nussey and Saffron Whitehead.
3. Oxford: BIOS Scientific Publishers; 2001.
4. Hadley, M.E. and Levine J.E. 2007. Endocrinology, 6th Edition. Pearson Prentice-Hall, Pearson Education Inc., New Jersey.
5. Vertebrate Endocrinology by David O. Norris,

SKILL ENHANCEMENT COURSES

SKILL ENHANCEMENT COURSE 1 (ZOS 3.11(a))
APICULTURE

Theory Credit: 2

UNIT I **Biology of Bees**
History, Classification and Biology of Honey Bees
Social Organization of Bee Colony

UNIT II **Rearing of Bees**
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth
Bee Pasturage
Selection of Bee Species for Apiculture
Bee Keeping Equipment
Methods of Extraction of Honey (Indigenous and Modern)

UNIT III **Diseases and Enemies**
Bee Diseases and Enemies
Control and Preventive measures

UNIT IV **Bee Economy**
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc

UNIT V **Entrepreneurship in Apiculture**
Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

Recommended Books and References:

1. Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
2. Bisht D.S., *Apiculture*, ICAR Publication.
3. Singh S., *Beekeeping in India*, Indian council of Agricultural Research, New Delhi.

SKILL ENHANCEMENT COURSE 1 (ZOS 3.11(b))
SERICULTURE

Theory Credit: 2

UNIT I **Introduction**
Sericulture: Definition, history and present status; Silk route
Types of silkworms, Distribution and Races
Exotic and indigenous races
Mulberry and non-mulberry Sericulture

UNIT II **Biology of Silkworm**
Life cycle of *Bombyx mori*
Structure of silk gland and secretion of silk

UNIT III **Rearing of Silkworms**

Selection of mulberry variety and establishment of mulberry garden
Rearing house and rearing appliances
Disinfectants: Formalin, bleaching powder, RKO
Silkworm rearing technology: Early age and Late age rearing
Types of mountages
Spinning, harvesting and storage of cocoons

UNIT IV **Pests and Diseases**

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates
Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial
Control and prevention of pests and diseases

UNIT V **Entrepreneurship in Sericulture**

Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.

Recommended Books and References:

1. Manual on Sericulture; Food and Agriculture Organisation, Rome 1976
2. Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
3. Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn.& Pub. Govt. Press, Bangalore
4. Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
5. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan1972.
6. Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
7. Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
8. A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
9. Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986.

SKILL ENHANCEMENT COURSE 2 (ZOC 4.11(a))
MEDICAL DIAGNOSTICS

Theory Credit: 2

UNIT I **Diagnostics Methods Used for Analysis of Blood**

Introduction to Medical Diagnostics and its Importance, Blood composition, Preparation of blood smear and Differential Leucocyte Count(D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)

UNIT II **Diagnostic Methods Used for Urine Analysis**

Urine Analysis: Physical characteristics; Abnormal constituents

UNIT III **Non-infectious Diseases**

Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type Iand Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit

UNIT IV **Infectious Diseases**

Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis

UNIT V **Tumours**

Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).

Recommended Books and References:

1. Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers
2. Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani Publishing House
3. Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
4. Guyton A.C. and Hall J.E. T*extbook of Medical Physiology*, Saunders
5. Robbins and Cortan, *Pathologic Basis of Disease*, VIII Edition, Saunders
6. Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd.

SKILL ENHANCEMENT COURSE 2 (ZOS 4.11(b))
AQUARIUM FISH KEEPING

Theory Credit: 2

UNIT I **Introduction to Aquarium Fish Keeping**

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

UNIT II **Biology of Aquarium Fishes**

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 III **Food and feeding of Aquarium fishes**

Use of live fish feed organisms. Preparation and composition of formulated fish feeds

UNIT IV **Fish Transportation**

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

UNIT V **Maintenance of Aquarium**

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