VIDYASAGAR UNIVERSITY

Midnapore, West Bengal

PROPOSED CURRICULUM & SYLLABUS (DRAFT) OF

BACHELOR OF SCIENCE (HONOURS)

MAJOR IN ZOOLOGY

4-YEAR UNDERGRADUATE PROGRAMME

(w.e.f. Academic Year 2023-2024)

Based on

Curriculum & Credit Framework for Undergraduate Programmes

(CCFUP), 2023 & NEP, 2020

VIDYASAGAR UNIVERSITY
BACHELOR OF SCIENCE (HONOURS) MAJOR IN ZOOLOGY
(under CCFUP, 2023)

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
								CA	ESE	TOTAL
B.Sc. (Hons.)	3rd	V	SEMESTER-V							
			Major-8	ZOOHMJ08	T: Molecular Biology; P: Practical	4	3-0-1	15	60	75
			Major-9	ZOOHMJ09	T: Taxonomy, Adaptation, & Evolution; P: Practical	4	3-0-1	15	60	75
			Major-10	ZOOHMJ10	P: Histology & Endocrinology; P: Practical	4	3-1-0	15	60	75
			Major Elective-01	ZOOHDSE1	Fish & Fisheries OR Toxicology	4	3-1-0/ 3-0-1	15	60	75
			Minor-5 (Disc.-I)	ZOOMIN05	T: Animal Physiology & Biochemistry; P: Practical *(To be taken from other Discipline)*	4	3-0-1	15	60	75
					Semester-V Total	20				375
		VI	SEMESTER-VI							
			Major-11	ZOOHMJ11	T: Parasitology; P: Practical	4	3-0-1	15	60	75
			Major-12	ZOOHMJ12	T: Immunology; P: Practical	4	3-0-1	15	60	75
			Major-13	ZOOHMJ13	T: Developmental Biology; P: Practical	4	3-0-1	15	60	75
			Major Elective-02	ZOOHDSE2	Microbiology OR Animal Behavior & Chronobiology	4	3-1-0/ 3-0-1	15	60	75
			Minor-6 (Disc.-II)	ZOOMIN06	T: Ecology, Ethology & Wildlife Biology; P: Practical *(To be taken from other Discipline)*	4	3-0-1	15	60	75
					Semester-VI Total	20				375
					YEAR-3	40				750
			Eligible to be awarded Bachelor of Science in Zoology *on Exit*			126	Marks (Year: I+II+III)			2325

MJ = Major, MI = Minor Course, DSE = Discipline Specific Elective Course, CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical

SEMESTER-V

MAJOR (MJ)

MJ-8: Molecular Biology **Credits 04 (Full Marks: 75)**

About the Course

This course is designed to introduce the basic structure and functional role of nucleic acids. The students may get knowledge of the central dogma of molecular biology (replication, transcription, translation of nucleic acids) and gene regulation. The syllabus also describes the DNA lesions and their repair mechanism.

Course Outcomes

The student, after the course, will be able to:

1. Understand the structure and properties of DNA & RNA.
2. Learn how the DNA is packaged inside the chromosome.
3. Explain the underpinnings of the mechanism of DNA replication and DNA repair.
4. Demonstrate a profound understanding of the process of transcription and translation.
5. Demonstrate a deeper understanding of the mechanisms of post-transcriptional processing and the role of this process in the control of gene expression.

MJ-8T: Molecular Biology (Theory) **Credits 03**

Course Contents	Hours
Unit 1: Nucleic Acids Salient features of DNA and RNA; Chargaff's Rule; Hypo and Hyperchromic shift; RNA types & functions; Watson and Crick Model of DNA; DNA packaging inside the chromosome.	6 hrs
Unit 2: DNA Replication Mechanism of DNA Replication in Prokaryotes: Semi-conservative, bidirectional, and discontinuous Replication; RNA priming; Replication of circular and linear ds-DNA; Replication of telomeres.	8 hrs
Unit 3: Transcription Mechanism of Transcription in prokaryotes and eukaryotes; Transcription factors; Synthesis of rRNA; Difference between prokaryotic and eukaryotic transcription. **Unit 4: Post-Transcriptional Modifications and Processing of Eukaryotic RNA**	8 hrs

Capping and Poly A tail formation in mRNA; Split genes: concept of introns and exons; Splicing mechanism, alternative splicing, exon shuffling, and RNA editing.	8hrs
Unit 5: Translation Mechanism of protein synthesis in prokaryotes; Ribosome structure and assembly in prokaryotes; Fidelity of protein synthesis; Aminoacyl tRNA synthetases; Charging of tRNA; Proteins involved in initiation, elongation, and termination of polypeptide chain; Genetic code; Degeneracy of the genetic code and Wobble Hypothesis; Inhibitors of protein synthesis; Compare prokaryotic and eukaryotic translation.	
Unit 6: Gene Regulation Regulation of Transcription in Prokaryotes: lac operon and trp operon. Regulation of Transcription in Eukaryotes: Activators, enhancers, silencers, repressors, and genetic imprinting.	8 hrs
Unit 7: DNA Repair Mechanisms Types of DNA repair mechanisms: Pyrimidine dimerization and mismatch repair; RecBCD model in prokaryotes; Nucleotide and base excision repair; SOS repair; Repair defects and human disease.	7 hrs

MJ-8P: Molecular Biology (Practical) Credits 01

Course Outline:

1. Identification of giant chromosomes from photographs.
2. Isolation of genomic DNA from animal tissue.
3. Agarose gel electrophoresis for DNA (demonstration).
4. Demonstration of the isolation and quantification process of genomic DNA using a spectrophotometer (A260 measurement).
5. Study and interpretation of electron micrographs/ photographs showing a) DNA replication, b) Transcription, c) exons & introns.
6. Problems related to the mutations of the lac operon through the merozygotic condition.

Recommended Readings

1. Allison LA. 2007. Fundamental Molecular Biology. Blackwell Publishing. W.H. Freeman.
2. Bruce A, Dennis B, Julian L, Martin R, Keith R, James W. 2008.
3. Cooper GM, Hausman RE. 2009. The Cell: A Molecular Approach. ASM.
4. Harvey L. 2004. Molecular Cell Biology. W.H. Freeman.

5. Karp G. 2008. Cell and Molecular Biology: Concepts and Applications. John Wiley.
6. Lackie JM. 2013. Dictionary of Molecular Biology. Academic Press.
7. Lewin B. 2008. Gene IX. Joned and Barlett.
8. Lodish, B, Matsudaira, K.B., Plough, A, and Martin, 2016. Molecular Cell Biology. W.H. Freeman
9. Pal A. 2011. Textbook of Cell and Molecular Biology, Books and Allied Pub.
10. Russel PJ. 2010. iGenetics: A Molecular Approach, Pearson Benjamin.
11. Turner, McLennan, Bales & White; 2005. Instant Notes in Molecular Biology. Taylor Francis.
12. Twyman, Advanced Molecular Biology. Viva Publication.

MJ-9: Taxonomy, Adaptation and Evolution Credits 04 (Full Marks: 75)

About the Course

The course is designed to get familiar with the taxonomy and geological history of the origin of life on Earth. It deals with the theories of evolution, speciation, and extinction of species on Earth. It is also designed to know the basic modes of adaptation of species in different habitats on Earth.

Course Outcomes

The student at the completion of the course will be able to:

1. Understand the prebiotic environment and protobiogenesis.
2. Understand the evolutionary principles that can bring about evolution.
3. Know the biological properties of organisms based on adaptive behaviors and survival strategies.
4. Understand the basics of zoological studies on classification, systematics, and taxonomy.
5. Understand the rules of animal nomenclature and formation and extinction of species.
6. Use knowledge gained from the study of variations and genetic drift to ensure that conservation efforts for small threatened populations are focused in the right direction

MJ-9T: Taxonomy, Adaptation and Evolution (Theory) Credits 03

Course Contents	Hours
Unit 1: Life's Beginning Meaning of life; Conditions of primitive earth and its environment; Chemogeny; Biogeny; RNA World hypothesis; Evolution of eukaryotes.	5 hrs
Unit 2: Evolutionary concept Definition and kinds of evolution; Lamarckism; Darwinism and Neo Darwinism; Variations (types, sources and role in evolution).	5 hrs
Unit 3: Evidence of Evolution Geological time scale; Continental drift; Dispersal and Barrier for animal dispersal; Discontinuous distribution of animals; Fossils; Neutral theory of molecular evolution; Molecular clock.	5 hrs
Unit 4: Population genetics Hardy-Weinberg Law: Statement and derivation of the law and application of law to bi-allelic population; Evolutionary forces upsetting Hardy-Weinberg equilibrium: Mutation, migration, genetic drift & natural selection in changing allele frequencies; Types of selection, Selection	9 hrs

coefficient, Darwinian fitness; Effect of heterozygous advantage & nonrandom mating on HWE; Concept on industrial melanism; Founder's effect; Bottleneck phenomenon and Genetic load.	
Unit 5: Evolution of Human Evolution of humans; Unique Hominin characteristics contrasted with primate characteristics; Molecular analysis of human origin.	3 hrs
Unit 6: Adaptation Adaptation and its types; Adaptive radiations in reptiles and birds; Convergent and Divergent adaptation in mammals; Protective Adaptation, Concept of volant, arboreal, cursorial, fossorial, desert & aquatic adaptations.	7 hrs
Unit 7: Taxonomy, Speciation, and Extinction of Species Definition, relationship & utility of systematics, taxonomy, classification & Nomenclature; Stages of taxonomy; Cytotaxonomy; Kinds of classification; Linnaean hierarchy; Species concept and its limitations; Sibling Species (example, cause & importance); Rules of zoological nomenclature; Reproductive isolation; Speciation: Allopatric speciation, parapatric speciation, sympatric speciation and quantum speciation; Extinction of species.	8 hrs
Unit 8: Phylogeny Features, types, and examples of phylogenetic trees; Parsimony analysis.	3 hrs

MJ-9P: Taxonomy, Adaptation, and Evolution (Practical) **Credits 01**

1. Study of fossils from models/pictures.
2. Study of homology and analogy from suitable specimens.
3. Calculation of allele and genotype frequencies.
4. Study and verification of the Hardy-Weinberg Law by chi-square analysis.
5. Construction and Interpretation of phylogenetic tree from supplied data.
6. Study of adaptive features of some selected animals: *Exocoetus*, Sucker fish, Flat fish, *Rhachophorous*, *Phrynosoma*, *Draco*, *Columba*, *Pteropus*, *Funambulus* & Mole.

Suggested Reading:

1. Barton NH, Birggs DEG, Elsen JA, Goldstein DB, Patel NH. 2007. Evolution. CSHLPress.
2. Bergstorm CT, Dujatkin LA. 2012. Evolution. 1st Edn. W.W. Norton and Co.
3. Campbell NA, Reece JB. 2011. Biology. IX Edition. Pearson.
4. Chaki K C; Kundu G & Sarkar S. Introduction to General Zoology; Vol.1, NCBA,Kolkata.
5. Freeman S, Herron JC. 2016. Evolutionary Analysis. Pearson Education Limited, India.

6. Futuyma DJ. 1997. Evolutionary Biology. Sinauer Associates.
7. Gillespie JH. 1998. Population Genetics: A Concise Guide. John Hopkins Univ Press.
8. Hall BK, Hallgrimson B. 2008. Stirckberger's Evolution. 4th Edn. Jones and Barlett Pub.
9. Kardong K. 2004. An Introduction to Biological Evolution. McGraw Hill.
10. Rauchfuss H. 2010. Chemical Evolution and the Origin of Life. Springer.
11. Ridley M. 1996. Evolution. 2nd Edn. Blackwell Science.
12. Russell PJ. 2009. iGeneics: A Molecular Approach. 3rd edition. Pearson Education India.
13. Smith JM. 1998. Evolutionary Genetics. 2nd Edn. Oxford Univ Press.
14. Volpe EP, Rossenbaum PA. 1999. Evolution. McGraw Hill.
15. Mayr, E. (2020). Principles of Systematic Zoology. United book prints.

MJ-10: Histology & Endocrinology **Credits 04(Full Marks: 75)**

About the Course

The primary objective of this paper is to provide students with a fundamental understanding of the histological structure of human body tissues & endocrine glands, as well as their functions and signaling pathways.

Learning Outcomes

Upon successful completion of this course, the student should be able to

1. Understanding the processing and staining techniques to prepare a histological section from different body tissues.
2. Understand and describe the histological structure of the basic tissues of the human body.
3. Acquire knowledge of the endocrine system.
4. Understanding the molecular mechanism of hormone action and its regulation.
5. Learn different types of endocrine disorders.

MJ-10T: Histology & Endocrinology (Theory) **Credits 03**

Course Contents	**Hours**
Unit 1: Tissues, Bone, and Cartilage Structure, location, classification, and functions of epithelial tissue, connective tissue, muscular tissue, and nervous tissue; Chemical basis of fixation and staining of tissues; Structure and types of bones and cartilages; Ossification of bones.	9hrs
Unit 2: Histology of the Digestive System Histological structure and functions of different parts of the alimentary canal, including liver, gall bladder, and exocrine pancreas; Histological structure and functions of digestive glands (salivary glands, gastric glands & intestinal glands).	9hrs
Unit 3: Hormones & Their Regulation Definition, characteristics, and classification of hormones; Endocrine, paracrine, and autocrine modes of hormone delivery; Feedback mechanism; Hormone action at the cellular level; Hormone receptors; Regulation of Hormone action.	9hrs
Unit 4: Hypothalamo-Hypophysial Axis Structure of pineal gland, Secretion and their functions in biological rhythms and reproduction; Structure of hypothalamus, Hypothalamic nuclei and their functions; Regulation of neuroendocrine glands; Feedback mechanisms; Structure of pituitary	9hrs

gland, its hormones and their functions; Hypothalamo-hypophysial portal system.	
Unit 5: Peripheral Endocrine Glands Definition, characteristics, and classification of endocrine glands; Structure, Hormones, Functions, and Regulation of Thyroid gland, Parathyroid gland, Adrenal gland, Endocrine Pancreas, Ovary, and Testis; Disorders of endocrine glands.	9hrs

MJ-10T: Histology & Endocrinology (Practical) **Credits 01**

1. Identification of histological sections with reasons: liver, stomach, intestine, cartilage, bone, spinal cord, nerve cell, pituitary, pancreas, testis, ovary, adrenal, thyroid, and parathyroid.
2. Basic idea of fixatives, preservatives & stains with their preparation method for the study of museum specimens.
3. Tissue processing for microtomy and slide preparation of any mammalian endocrine glands.
4. Double staining of histological slides.
5. Dissection and demonstration of the endocrine glands of the rat.

Suggested readings:

1. Turner, C. D. (1971) General Endocrinology, Pub- Saunders Toppan.
2. Nussey, S.S. and Whitehead, S.A. (2001) Endocrinology: An Integrated Approach, Oxford: BIOS Scientific Publishers.
3. Hadley, M.E. and Levine J.E. (2007) Endocrinology (6th edition) Pearson Prentice-Hall, New Jersey.
4. Fox T, Brooks A, Baidya B. 2015. Endocrinology. JP Medical, London.
5. Neal JM. 2000. Basic Endocrinology- An Interactive Approach. Blackwell Science.
6. Norris DO. 2007. Vertebrate Endocrinology. 4th Edn. Elsevier Academic Press.

MAJOR ELECTIVE (DSE)

Major Elective -1: Fish and Fisheries **Credits 04(Full Marks: 75)**

About the Course

The program is designed to develop both practical and academic skills in fish biology, pond management, water and soil quality management, habitat conservation, and stock monitoring.

Learning Outcomes

Upon successful completion of this course, the student should be able to-

1. Acquire knowledge on the taxonomy and morphology of fish
2. Understanding of the scope and significance of aquaculture
3. Enrich knowledge on transgenic fish
4. Learn different types and practices of Aquaculture

MJ DSE-1T: Fish and Fisheries (Theory) **Credits 03**

Course contents	Hours
Unit 1: Introduction and Classification General description of fish; Feeding habit, habitat, and manner of reproduction; Classification of fish (up to Subclasses).	4hrs
Unit 2: Morphology and Physiology Types of fins and their modifications; Locomotion in fish; Hydrodynamics; Types of Scales, Use of scales in classification and determination of age of fish; Gills and gas exchange; Swim Bladder: types, role in respiration & buoyancy; Reproductive strategies (special reference to Indian fish); Electric organ; Bioluminescence.	12hrs
Unit 3: 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; Fisheries law and regulations.	12hrs
Unit 4: 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; Jeol fish culture, Aquaponics, Role of	12 hrs

water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products.	
Unit 5: Fish in Research Transgenic fish; Zebra fish as a model organism in research; Sex Reversal in Fish.	5hrs

MJ DSE-1P: Fish and Fisheries (Practical) **Credits 01**

1. Morphometric and meristic characters of fishes.
2. Identification of *Scoliodon. Tryonyx, Catla, Cirrhinus, Ctenopharyngodon, Chanda, Wallago, Ophieocephalus, Mystus, Clarias, Heteropneustes* & *Anabas*.
3. Study of different types of scales (through demonstration/permanent slides/ photographs).
4. Study of crafts and gears used in Fisheries.
5. Estimation of pH, salinity, and total dissolved solids in water.
6. Study of air-breathing organs in Ophiocephalus, Heteropneustes, Anabas, and *Clarias.*
7. Report on a visit to any Fish farm/ Pisciculture unit/Zebra fish rearing lab.

Suggested Readings:

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.
3. von der Emde, R.J. Mogdans and B.G. Kapoor.The Senses of Fish: Adaptations for the Reception of Natural Stimuli Springer, Netherlands
4. C.B.L. Srivastava, Fish Biology, Narendra Publishing House J.R. Norman, A history of Fishes, Hill and Wang Publishers
5. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House.
1. Note: Classification to be followed from: Romar A. S. (1959)

OR

Major Elective -1: Toxicology **Credits 04(Full Marks: 75)**

About the Course

The graduate-level course in Toxicology will provide an understanding of the effects of chemical substances on human health. It will be helpful in the monitoring of environmental pollution.

Learning Outcomes

Upon successful completion of this course, the student should be able to

1. Learning about different types of toxicants.
2. Understanding of xenobiotics and their effects.
3. Enrich knowledge about the effects of pesticides and heavy metals.
4. Learn how to analyze and interpret toxicological tests.

MJ DSE-1T: Toxicology (Theory) **Credits 03**

Couse Contents	Hours
Unit 1: Basic Concept of Toxicology Introduction of toxicology; Definition of toxicology & toxicity; Definition and classification of poison & toxicants; Mode of action of toxic agents.	10hrs
Unit 2: Xenobiotics Introduction to xenobiotics; Important xenobiotics concerned with Human health; Absorption, distribution, accumulation, biotransformation, and excretion of xenobiotics; Adverse effects of xenobiotics; Mechanism of xenobiotic translocation.	14hrs
Unit 3: Pesticides and Heavy Metal Toxicity Pesticides and their toxicological effects; Classification of pesticides; Mode of action of pesticides; Introduction, dispersion, and general principle of heavy metal toxicity; Sources & toxic effects of metals like arsenic, aluminum, cadmium, chromium, lead, mercury, manganese, zinc, and nickel.	14hrs
Unit 4: Evaluation of toxicity Acute, sub-Acute, and chronic assays; LD50 & LC50; Ecotoxicology, clinical toxicology, and occupational toxicology.	7 hrs

MJ DSE-1T: Toxicology (Practical) **Credits 01**

1. Study of sources, symptoms, and prevention of diseases due to the toxicity of arsenic, cadmium, mercury, chromium, lead, manganese, and zinc.
1. Determination of LD_{50} and LC_{50}.
2. Determination of COD and BOD of the given water sample.
3. Study on plant-based insecticides (Neem and citrus oil extract)
4. Field visit to nearby industry.

Suggested Readings:

1. Williams, P.L.; James, R. C. Roberts, S.M. (2003) Principles of Toxicology: Environmental and Industrial Applications, John Wiley & Sons, Inc.
2. Klaassen, C. (2007) Casarett and Doull's Toxicology The basic science of poisons – McGraw-Hill.
3. Duffs, J. and Worth, H. (2006) Fundamental Toxicology, RSC Publishing.
5. Pandey, Shukla and Trivedi (2013) Fundamental Toxicology, NCBA (P) Ltd.
6. Walker, C. H., S. P. Hopkin, R. M. Sibley & D. B. Peakall. Principles of Ecotoxicology; Taylor & Francis.

MINOR (MI)

Minor (MI)-5: Animal Physiology & Biochemistry **Credits 04(Full Marks: 75)**

About the Course

This course is designed at the graduation level to know the process of digestion, physiology of respiration and circulation, renal physiology, as well as basic principles of biochemistry and kinetics of enzyme-catalyzed reactions. The students will gain knowledge about the structure and function of carbohydrates, proteins, and lipids, as well as their respective metabolic processes. Students will also know the process of nerve impulse propagation along the nerve fibre and synaptic transmission.

Course Outcomes

The student, after the course, will be able to:

1. Learn the physiology of digestion, respiration, circulation, excretion, osmoregulation, and thermoregulation.
2. Understand the physiology of muscles and their contraction mechanism.
3. Understand the process of nerve impulse propagation and osmoregulation.
4. Interpret structure-functional relationships of carbohydrates, proteins, and lipids
5. Describe the mechanism of enzyme action, enzyme kinetics, and inhibition of enzymes.
6. Understand the metabolism of carbohydrates, proteins, and lipids through various anabolic and catabolic pathways and their regulation.

Minor (MI)-5T: Animal Physiology & Biochemistry **Credits 03**

Course Contents	Hours
Unit 1: Digestion Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids; Source and Functions of digestive hormones and digestive enzymes.	4hrs
Unit 2: Respiration Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood; Structure & function of haemoglobin.	4hrs
Unit 3: Circulation Composition of blood; Structure of Heart; Cardiac Cycle and cardiac output.	4hrs
Unit-4: Excretion & Osmoregulation Structure & function of the Kidney and nephron; Mechanism of urine formation; Osmoregulation in vertebrates.	4hrs
Unit 5: Nerve and Muscle Structure of a neuron; Origin and propagation of action potential across the myelinated and unmyelinated nerve fibres; Types of synapse; Synaptic transmission; Muscle contraction.	5hrs 5hrs
Unit 6: Reproduction and Endocrine Glands Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle; Structure and function of pituitary, thyroid, pancreas, and adrenal glands.	

Unit 7: Carbohydrate: Structure and Metabolism Types and structures of Carbohydrates; Isomerism and derivatives of monosaccharides; Carbohydrate metabolism: Glycolysis; Krebs cycle; Pentose phosphate pathway; Gluconeogenesis.	5hrs
Unit 8: Lipid: Structure and Metabolism Classification of Lipid: Structure and Significance: Saturated and unsaturated fatty acids, omega fatty acids, tri-acyl glycerol, phospholipids, glycolipids, pteroids, and wax; Lipid Metabolism: β-oxidation of fatty acids.	5hrs
Unit 9: Protein: Structure and metabolism Classification and physicochemical properties of amino acids and proteins; Structure of primary, secondary, tertiary, and quaternary structures of protein; Transamination, Deamination, and Urea Cycle.	5hrs
Unit 10: Enzymes Classification of Enzymes; Mechanism of action; Enzyme Kinetics; Enzyme Inhibition; Allosteric enzymes.	4hrs

Minor (MI)-5P: Animal Physiology & Biochemistry **Credits 01**

1. Preparation of temporary mounts: Squamous epithelium.
2. Preparation of stained blood film to study various types of blood cells. Calculation of total count and differential count from blood.
3. Preparation of haemin crystals.
4. Identification of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland, small intestine, liver, lung, and kidney.
5. Qualitative tests for functional groups in carbohydrates.
6. Qualitative tests for urea, uric acid, and ammonia.

Suggested Readings:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edn. W.H Freeman & Co.
2. Das, D. (2000). Biochemistry. Central Book Agency, Kolkata.
3. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
4. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.
5. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
6. Sathyanarayana U. and Chakrapani, (2002). Biochemistry –Books & Allied (P) Ltd, Kolkata.
7. Sembulingam and Sembulingam (2012) Essentials of Medical Physiology. 6th Edn. Jaypee Pub, New Delhi.
8. Sherwood, L. (2013). Human Physiology from cells to systems. 8th Edn., Brooks & Cole.
9. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc. 13. Widmaier, E.P., Raff, H.

SEMESTER-VI

MAJOR (MJ)

MJ-11: Parasitology **Credits 04 (Full Marks: 75)**

About the Course

This course aims to provide students with a basic understanding of Parasitology. It focuses on the host-parasite interaction and different types of association. Students will be able to understand the life history of some important parasites, their transmission pattern, pathogenicity, prevention, and control.

Course Outcomes

Upon completion of the course of parasitology, students will be able to-

1. Learn the various types of parasites and hosts.
2. Establish the relationship between a parasite and the host and their effects.
3. Learn the morphology and life cycle of medically essential parasites
4. Describe and explain the appropriate measures for the prevention and control of parasitic diseases.

MJ-11T: Parasitology (Theory) **Credits 03**

Course Contents	Hours
Unit 1: Introduction to Parasitology Definition and Classification of parasite and host; Parasitism: definition, features, and types.	4 hrs
Unit 2: Parasitic Protists Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis, and Treatment of Entamoeba histolytica, Plasmodium vivax, and *Trypanosoma gambiense*.	8 hrs
Unit 3: Parasitic Platyhelminthes Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis, and Treatment of *Fasciola hepatica* and *Taenia solium*.	6 hrs
Unit 4: Parasitic Nematodes Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis, and Treatment of Ascaris lumbricoides, Ancylostoma duodenale, and *Wuchereria bancrofti*.	8 hrs
Unit 5: Parasitic Arthropods Biology, importance, and control of Soft tick (Ornithodoros), Hard tick (Ixodes), Mite (Sarcoptes), Lice (Pediculus), Flea (Xenopsylla), and Bug (*Cimex*).	7 hrs
Unit 6: Parasitic Vertebrates Cookicutter Shark, Hood Mockingbird, Vampire bats, their parasitic Behavior and effect on the host.	6 hrs
Unit 7: Host-Parasite Relationship Origin and evolution of parasitism; Host-parasite interaction; Host immune response against parasite.	6 hrs

MJ-11P: Parasitology (Practical) **Credits 01**

Course Outline:

1. Identification of *Balantidium* sp., *Trypanosoma* sp, *Leishmania* sp, *Plasmodium* sp, *Fasciola* sp, *Taenia* sp, *Cimex* sp, *Pediculus sp.* (permanent slides/micro photographs)
2. Isolation and mounting of parasite(s) from the gills of fish.
3. Staining of any protozoan/helminth parasite from the gut of the cockroach.
4. Whole mount preparation of any arthropod parasite.

Suggested Readings

1. Arora D R, Arora B. 2001. Medical Parasitology. II Edition. CBS Publications and Distributors.
2. Bogitsch B J, Carter CE, Oeltmann TN. 2013. Human Parasitology. 4th Edn. Elsevier.
3. Bose M. 2017. Parasitoses and zoonoses. New Central Book Agency.
4. Chatterjee K D. 2009. Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers.
5. Dailey MD. 1996. Meyer, Olsen & Schmidt's Essentials of Parasitology. W.C. Brown Publishers.
6. Gunn A, Pitt SJ. 2012. Parasitology: An Integrated Approach. Wiley Blackwell.
7. John DT, Petri WA. 2006. Markell and Voge's Medical Parasitology. Elsevier.
8. Marr JJ, Nilsen TW, Komuniecki RW. 2003. Molecular Medical Parasiology. 2nd Edn. Academic Press.
9. Muller R, Wakelin D. 2002. Worms and Human Disease. CAB International Publication.
10. Noble ER, Noble GA. 1989. Parasitology: The biology of animal parasites. Lea & Febiger.
11. Smyth, J.D.2005. Animal Parasitology. Cambridge University Press.
12. Roberts, L. S., Janovy, J. and Nadler S. (2013) *Gerald D. Schmidt &Lary S. Roberts' Foundation of Parasitology*. 9th ed. McGraw-Hill International.
13. Hati, A. K. (2001). *Medical Parasitology*. Allied Book Agency, Kolkata.
14. Cox, F. E. G. (1993). *Modern Parasitology*. 2nd ed. Blackwell Scientific Publications. Lea and Febiger, Philadelphia.

MJ-12: Immunology Credits 04 (Full Marks: 75)

About the Course

This course is designed at the graduate level to provide an understanding of basic mechanisms and functional interplay of innate and adaptive immunity. The students will also observe the structure and function of the antigen and the antibody, as well as their interaction. It also includes the humoral and cellular processes to achieve immunity, as well as knowledge about the vaccination process.

Course Outcomes

The student after the course will be able to:

1. Develop knowledge about the structures and functions of immune cells, immunoglobulins, antigens, and their interactions with antibodies.
2. Describe the cellular/molecular pathways of humoral/cell-mediated adaptive responses, including the role of the Major Histocompatibility Complex.
3. know about cytokines, hypersensitivity reactions, and the cellular mode of immunity development.
4. Know the basic knowledge of immunology of diseases and vaccination.
5. Demonstrate the basic immune techniques RIA, Immunoelectrophoresis, ELISA, etc.

MJ-12T: Immunology (Theory) Credits 03

Course Contents:	Hours
Unit 1: Overview of the Immune System Historical perspective of Immunology: Cells and organs of the Immune system.	3 hrs
Unit 2: Innate and Adaptive Immunity Anatomical barriers, Inflammation, Cells and molecules involved in innate immunity; Adaptive immunity (Cell-mediated and humoral).	5 hrs
Unit 3: Antigens Antigenicity and immunogenicity; Immunogens; Adjuvants and happens; Factors influencing immunogenicity; B and T-Cell epitopes.	5 hrs
Unit 4: Immunoglobulins Structure and functions of different classes of immunoglobulins; Antigen- antibody interactions; Monoclonal antibody production through Hybridoma technology.	6 hrs
Unit 5: Major Histocompatibility Complex and Antigen Presentation Structure and functions of MHC molecules. Structure of T Cell Receptor and its signaling; T cell development & selection pathways of antigen processing and presentation.	6 hrs
Unit 6: Cytokines Types, properties, and functions of cytokines.	6 hrs

Unit 7: Complement System Components and pathways of complement activation.	4 hrs
Unit 8: Vaccines Various types of vaccines. Active & passive immunization (Artificial and natural).	5 hrs
Unit 9: Immunotechniques Immunoelectrophoresis, RIA, ELISA, and Immunofluorescence.	5 hrs

MJ-12P: Immunology (Practical) **Credits 01**

Course Outline:

1. Demonstration of lymphoid organs.
2. Histological study of spleen, thymus, lymph nodes, bursa of Fabricius, and bone marrow through slides/photographs.
3. Preparation of stained blood film to study various types of blood cells.
4. Determination of ABO blood group.

Suggested Reading:

1. Abbas K A, Lechtman H Andrew. 2003. Cellular and Molecular Immunology. Saunders Publication.
2. Abbas KA, Andrew, LH. 2011. Basic Immunology: Functions and Disorders of Immune System. Saunders Elsevier Publication.
3. Delves PJ, Martin SJ, Burton DR, Roitt I M. 2006. Roitt's Essential Immunology. Blackwell Pub.
4. Kindt TJ, Goldsby RA, Osborne BA, Kuby J 2006. Immunology, W.H. Freeman and Company.
5. Mohanty SK, Leela KS. 2014. Text book of Immunology. 2nd Edn. Jaypee Pub. N. Delhi
6. Playfair, JHL, Chain BM 2001. Immunology at a glance. 7 th Edn. Blackwell Pub.
7. Shetty N. 2005. Immunology: Introductory Textbook, New Age International Pub.
8. Virella G. 2007. Medical Immunology, Informa Healthcare.

MJ-13: Developmental Biology Credits 04 (Full Marks: 75)

About the Course

This course is designed at the graduation level to know basic developmental pathways. The students will also see the pattern of growth, differentiation, early embryonic development, and late embryonic development. It also includes the post-embryonic development, such as regeneration.

Course Outcomes

After the completion of the course, the students will be able to:

1. Understand the process of gametogenesis, fertilization, types of eggs, cleavage patterns, etc.
2. Obtain the knowledge on the process of morphogenesis, the organizer concept, and the mechanism of regeneration.
3. Understand the fate of germ cells, formation of the embryonic membrane in the chick, and the placenta in mammals.

MJ-13T: Developmental Biology (Theory) Credits 03

Course Contents	Hours
Unit 1: Introduction Basic Concepts Phases of Development; Cell-cell interaction; Differentiation and growth; Differential gene expression.	7 hrs
Unit 2: Early Embryonic Development a). Gametogenesis: Spermatogenesis process in mammals; Structure of sperm; Regulation of sperm motility; Oogenesis in mammals; Structure of ovum; Types of eggs; Egg membranes. b). Fertilization: Types of fertilization; Process of fertilization in mammals; Molecular strategy to avoid polyspermy in fertilization. c). Cleavage: Planes and patterns of cleavage; cleavage process in frog and chick. Types of blastula; Fate maps (including Techniques). d). Gastrulation: Definition & significance and process of gastrulation in frog and chick. e) Embryonic induction and organizers: Spemann & Mangold's experiment in Xenopus; Primary embryonic induction; Functions of the organizer.	26 hrs
Unit 3: Late Embryonic Development Fate of germ layers; Extra-embryonic membranes in Chick; Implantation of embryo in humans; Structure, types, and functions of placenta.	7 hrs
Unit 4: Post Embryonic Development Regeneration: Modes of regeneration; Limb regeneration in Salamander; Regeneration in Hydra.	5 hrs

MJ-13P: Developmental Biology (Practical) **Credits 01**

Course Outline:

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

Suggested Reading:

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.
6. Slack JMW, Essential Developmental Biology Inc.
7. Wolpert L, Beddington R, Jessell T, Lawrence P, Meyerowitz E and Smith J (2002) Principles of Development. 1st Edition, Oxford University Press, New York.

MAJOR ELECTIVE (DSE)

Major Elective -2: Microbiology **Credits 04(Full Marks: 75)**

About the Course

The course is designed to enrich students with knowledge and understanding of the structure of microbes, the pathogenicity of microbes, microbial genetics, and related topics. It enables the student to become competent in applying microbiology knowledge and skills to analyze problems involving microbes and undertake remedial measures.

Course Outcomes

1. Students will gain knowledge about the different microorganisms and their detailed functions.
2. Students will also study the growth and control of microbes as well as different bacteriological techniques involved in microbiology.
3. Students will learn about the biomolecules by studying their structures and types.
4. As Microbiology is an interdisciplinary subject, the students might have to take inputs from other areas of expertise.

MJ DSE-2T: Microbiology (Theory) **Credits 03**

Course Contents	Hours
Unit 1: Introduction to Microbiology Historical Perspective of Microbiology with the three-domain system; Bacterial Taxonomy Hackel and Whittaker's Kingdom concept; Basic concept on communicable, non-communicable, endemic, epidemic, pandemic, and sporadic diseases.	6 hrs
Unit 2: Morphology of Bacteria and Viruses Cell Wall: Structure of peptidoglycan; Cell membrane; Differences between Gram-positive and Gram-negative bacteria; Glycocalyx; Plasmids and episomes; Differences between bacterial chromosome and eukaryotic chromosome; Preliminary idea on prions, viroids, and viruses.	10 hrs
Unit 3: Pathogenicity of Microorganisms Bacterial pathogenesis: Entry and adherence to host cells, invasiveness; Bacterial toxins: Exotoxins & endotoxins; Viral Pathogenesis: Initial infections, routes of entry and dissemination to secondary sites, typical secondary sites of localization; Name of pathogen, symptoms, pathogenesis, mode of action & preventive measures of following diseases: Bacterial (Polio, Tuberculosis, Typhoid, Staphylococcal Food Poisoning) & Viral (Hepatitis, AIDS).	12 hrs
Unit 4: Diagnostic Microbiology and Bacterial Culture Simple staining, Gram-staining & acid-fast staining; Growth requirements and Growth factors; Role of oxygen; Culture media: Simple media, complex media, selective media and enriched media.	8 hrs
Unit 5: Bacterial genetics Transformation; Conjugation- F^+, F^-, Hfr & F' strain; Transduction- Generalised & specialized types.	8 hrs

MJ DSE-2P: Microbiology (Practical) **Credits 01**

1. Simple staining, Gram's staining of bacteria, and acid-fast staining.
2. Preparation of liquid media (broth) and solid media for routine cultivation of bacteria.
3. PowerPoint Presentation of Project Report on disease-causing microbes.
4. Microbiological examination of milk (Methylene blue reductase test).
5. Sugar fermentation test.
6. Linkage maps based on supplied data from conjugation, transformation, and transduction.

Suggested Readings

1. Alexander, M. (1977). Introduction to Soil Microbiology. John Wiley and Sons, New York.
2. Atlas, R. M. and Bartha, R. (1997). Microbial Ecology: Fundamentals and Applications, 4th ed.
3. Benjamin/ Cummings. Black, J. G. (2011). Microbiology: Principles and Explorations. 8th ed. John Wiley and Sons, New York.
4. Campbell, R. (1983). Microbial Ecology. 2nd ed. Oxford, Blackwell.
5. Presscott, L. M., Harley, J. P. and Klein, D. A. (2011). Microbiology, 8th ed. McGraw Hill, New York.
6. Schlegel, H. G. (1993). General Microbiology. 7th ed. Cambridge University Press.
7. Slonczeweski, J.L. and Foster, J.W. (2009). Microbiology- An Evolving Science. Norton.
8. Stanier, R. Y., Adelberg, E. A. and Ingraham, J. L. (1986). General Microbiology. 5th ed. Macmillan.
9. Talaro, K. and Talaro, A. (1999). Foundations in Microbiology. 3rd ed. Dubuque, McGraw Hill.
10. Tortora, G. J., Funke, B. R., and Case. C. L. (2008). Microbiology. An Introduction. 9th ed. Benjamin/Cummings Publishing. Menlo Park Calif.
11. Voyleys, B. A. (2002). The biology of viruses, 2nd ed. McGraw-Hill.

OR

Major Elective -2: Animal Behavior & Chronobiology Credits 04(Full Marks: 75)

About the Course

This course is designed at the graduate level to study animal behavior that will make a significant contribution and play an essential role in the basic biological system. The content of this topic introduces various aspects of animal behavior, such as different kinds of animal behavior, homing behavior, patterns of animal behavior, and parental care in animals.

Course Outcomes

The students will be able to

1. Key concepts of animal Behavior, such as social Behavior, sexual Behavior, etc.
2. The fascinating range and complexity of Behaviour in animals.
3. Enhance their observation, analysis, interpretation, and documentation skills by taking short projects pertaining to Animal behavior and chronobiology.
4. Learn about the biological rhythm and its application in pharmacology and modern medicine.
5. Understand how animals learn and communicate, reproductive Behavior.
6. Realize, appreciate, and develop a passion for biodiversity, nature, and the environment.

MJ DSE-2T: Animal Behavior & Chronobiology (Theory) Credits 03

Course contents	Hours
Unit 1: Introduction to Animal Behavior Contribution of Lorenz, Von Frisch, and Tinbergen; Definition and types of behavior.	2 hrs
Unit 2: Patterns of Behavior Innate Behavior: Definition and examples, Stereotyped Behavior (Orientation and Reflex), Fixed Action Pattern in Stickleback; Learned Behavior: Associative learning- Classical and operant conditioning; Non-associative learning- Habituation and sensitization; Imprinting: Filial and sexual imprinting. Egocentric Behavior: Definition, types & examples.	7hrs
Unit 3: Social Behavior Advantages of group living: Eusociality; Social organization in termites; Kinship theory: Relatedness & inclusive fitness; Altruism, Hamilton's rule; Reciprocal altruism; Cooperation and cooperative Behaviors: Group hunting in Hyenas; Territoriality & social dominance; Territorial Behavior in monkeys; Schooling in fish; Flocking in birds.	7 hrs
Unit 4: Sexual Behavior Sexual dimorphism; Courtship Behavior and mate choice; Good genes model in sexual selection; Runaway sexual selection hypothesis. Intra-sexual selection (male rivalry in Red Deer); Inter-sexual selection (female choice in peacock).	7 hrs
Unit 5: Evolutionary Strategies Concept of Parental care and parental investment: Parental care in fishes and amphibia; Parent-offspring conflict, Sexual conflict in parental care; Evolutionary Stable strategies (ESS): Hawk-Dove Model.	7 hrs
Unit 6: Biological Rhythm Types and characteristics of biological rhythms; Photic and non-photic zeitgebers; Adaptive significance of biological clocks. Circannual rhythm: Bird migration; Human biological clock (SCN and melatonin); Sleep-wake cycle and its hormonal regulation; Concept of biological cycle disorders in humans.	7 hrs

Unit 7: Communication Basic components, modes, and adaptive values of communication; Chemical Communication: Classification, chemical nature & functions of pheromones; Pheromones in insects and big cats; Tactile Communication: Grooming in monkeys; Visual Communication: Bee dance language; Auditory Communication: Echolocation in bats; Bioluminescence in insects	8 hrs

MJ DSE-2P: Animal Behavior & Chronobiology (Practical) Credits 01

1. Demonstration of nests and nesting behavior of the bird through photographs (Pigeon, Crow, Tailor bird, Weaver Bird) and social insects through photographs (Termite, Ant and Honey bee).
2. Study of geotaxis behavior in earthworms and phototaxis behavior in insect larvae.
3. Identification of common behavior (by photographs/video) of Fixed Action pattern in Stickleback & Greylag goose, social grooming in spider monkey, group hunting in Hyenas, schooling in fishes, flocking in birds, male rivalry in red Deer, parental care in Hippocampus, parental care in tree frog, territorial marking in tiger, following response in chicks (At least one).
4. To study circadian functions in humans (daily eating, sleep, and temperature patterns).

Suggested Readings

1. Alcock J. 2013. Animal Behavior, Sinauer Associate Inc., USA.
2. Drickamer LC , Vessey SH . 2001. Animal Behavior. McGraw-Hill
3. Dujatkin LA. 2014. Principles of Animal Behavior. 3rd Edn. W.W.Norton and Co.
4. Dunlap JC, Loros JJ, DeCoursey PJ. 2004. Chronobiology Biological Timekeeping. Sinauer Assoc.
5. Krebs J. R. & N. B. Davies – An introduction to Behavioral Ecology – Blackwell Scientific.
6. Kumar V. 2002. Biological Rhythms. Narosa Publishing House, New Delhi.
7. Macfarland, D. 1999. Animal Behavior (3rd Edition), Addission Wesley Longman Ltd. England.
8. Mandal F. 2010. A Text Book of Animal Behavior. Pentice Hall India.
9. Mathur R. 2005. Animal Behavior. Rastogi Pub.
10. Sherman PW, Alcock J. 2013. Exploring Animal Behavior, Sinauer Assoc Inc., Massachusetts, USA.

OR

MINOR (MI)

Minor (MI)-6: Ecology, Ethology, and Wildlife Biology Credits 04(Full Marks: 75)

About the Course

The objective of this course is to take students on a journey through the survival of populations and communities in different habitats and interactions between the organisms and environments in nature. It highlights some of the important aspects of animal Behaviors and wildlife biology.

Course Outcomes

After completion of this course, the students will be able to -

1. Know the structural and functional aspects of ecology.
2. Learn the fascinating range and complexity of Behavior in animals.
3. Learn about the biological rhythm and its application in pharmacology and modern medicine.
4. Familiar with the wildlife-related problems, like conflicts of wild animals with humans and to identify the causes of the depletion of wildlife
5. Understand how to use the fundamental principles of wildlife ecology and management issues.

Minor (MI)-6T: Ecology, Ethology, and Wildlife Biology (Theory) Credits 03

Course Contents	Hours
Unit 1: Introduction to Ecology, Ecosystem, and Biome Definition of ecology and ecosystem: Types, components, and function of ecosystem; Concept of food chain, food web, ecological pyramids & energy flow, concept of Biome; Concept of habitat & Niche.	8hrs
Unit 2: Population Ecology Unique and group attributes of population: Density, natality, mortality, life tables, fecundity schedule, survivorship curves; age distribution, Exponential and logistic growth; biotic potential; dispersal & dispersion. Population regulation: density-dependent and independent factors.	10 hrs
Unit 3: Biotic Community: Community characteristics: stratification; dominance, diversity, species richness, abundance; Ecotone and edge effect; Ecological succession; Gause's Principle with laboratory and field examples.	9 hrs
Unit 4: Animal Behavior Patterns of behavior: Instinct Behavior, Learned Behavior - Habituation, sensitization & imprinting; Sexual behavior: Intra-sexual selection (male rivalry in Red Deer) and inter-sexual selection (female choice in peacock); Social behavior: Eusociality; Altruism; Reciprocal altruism; Types and characteristics of biological rhythms.	10 hrs
Unit 5: Wildlife Biology Definition and categories of wildlife; Values of wildlife; Causes of extinction of wildlife; Fundamental process of wildlife management; The Wildlife Protection Act (1972); Wildlife corridors; Human-wildlife conflict.	8 hrs

Minor (MI)-6P: Ecology, Ethology, and Wildlife Biology (Practical) Credits 01

1. Estimation of free carbon dioxide, dissolved oxygen & transparency of any water body
2. Estimation of any terrestrial ecosystem/biome through ecological methods like quadrat sampling, determination of the minimum size of the quadrat. Calculation of density, abundance & frequency of any suitable population/community/ecosystem through field work or a hypothetical community.
3. Demonstration of nests and nesting behavior of the bird through photographs (Pigeon, Crow, Tailor bird, Weaver Bird) and social insects through photographs (Termite, Ant, and Honey bee).
4. To study circadian functions in humans (daily eating, sleep, and temperature patterns).
5. Identification and study of selective wild flora and wild fauna from the field.
6. Identification of animals through pug marks, hoof marks, scats, pellet groups, nests, antlers, etc.
7. Submission of a field report after studying any ecosystem/zoological garden/National Park/Sanctuary/Biosphere Reserve.

Suggested Readings

1. Odum, E.P. (1983) Basic Ecology. Saunders College Publishing.
2. Odum, E.P., (2008) Fundamentals of Ecology. Indian Edition. Brooks/Cole.
3. Ricklefs, R.E. (2000) Ecology (5th edition) Chiron Press.
4. Kormondy, E.J. (2000) Concepts of Ecology (4th edition) Prentice Hall of India Pvt. Ltd.
5. Chapman, J.L. and Reiss, M. J. (2002) Ecology Principles & Applications (2nd edition) Cambridge University Press.
6. Sharma, P.D. (2011) Ecology and Environment. Rastogi Publication.
7. Cain M L, Bowman W D and Hacker S D. 2013. Ecology. 3rd ed. Sinauer associates.
8. Smith TM, Smith R L. 2006. Elements of Ecology. 6th Ed. Pearson Education.
9. Odum EP, Barret GW. 2017. Fundamentals of Ecology. 15th Indian reprint. Cengage learning India Pvt. Ltd.
10. Alcock J. 2013. Animal Behavior, Sinauer Associate Inc., USA.
11. Drickamer LC, Vessey SH. 2001. Animal Behavior. McGraw-Hill.
12. Dujatkin LA. 2014. Principles of Animal Behavior. 3rd Edn. W.W.Norton and Co.
13. Macfarland, D. 1999. Animal Behavior (3rd Edition), Addission Wesley Longman Ltd. England.
14. Mandal F. 2010. A Text Book of Animal Behavior. Pentice Hall India.
15. Mathur R. 2005. Animal Behavior. Rastogi Pub.
16. Caughley, G., and Sinclair, A.R.E. (1994) Wildlife Ecology and Management. Blackwell Science.
17. Saha, G. and Mazumar S. (2017). Wildlife Biology: An Indian Perspective. PHI. Learning Pvt. Ltd. Delhi.