

Shri Vishwanath P. G. College Kalan, Sultanpur

(Affiliated)

DR. RAM MANOHAR LOHIA AVADH UNIVERSITY, AYODHYA

Structure of Syllabus for the Program: B.Sc.

Subject: **ZOOLOGY**



SEMESTER-WISE TITLES OF THE PAPERS IN UG ZOOLOGY COURSE

YEAR	SEME-STER	COURSE CODE	PAPER TITLE	THEORY/ PRACTICAL	CREDIT
<i>CERTIFICATE</i>					
FIRST YEAR	I	B050101T	Cytology, Genetics and Infectious Diseases	Theory	04
		B050102P	Cell Biology and Cytogenetic Lab	Practical	02
	II	B050201T	Biochemistry and Physiology	Theory	04
		B050202P/R	Physiological, Biochemical & Hematology Lab	Practical/Field work	02
<i>DIPLOMA</i>					
SECOND YEAR	III	B050301T	Molecular Biology, Bioinstrumentation & Biotechniques	Theory	04
		B050302P	Bioinstrumentation & Molecular Biology Lab	Practical	02
	IV	B050401T	Gene Technology, Immunology and Computational Biology	Theory	04
		B050402P/R	Genetic Engineering and Counseling Lab	Practical/Field work	02
<i>DEGREE</i> IN BACHELOR OF SCIENCE					
THIRD YEAR	V	B050501T	Diversity of Non-Chordates, Parasitology and Economic Zoology	Theory	04
		B050502T	Diversity of Chordates and Comparative Anatomy	Theory	04
		B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	Practical	02
	VI	B050601T	Evolutionary and Developmental Biology	Theory	04
		B050602T	Ecology, Ethology, Environmental Science and Wildlife	Theory	04
		B050603P	Lab on Environmental Science, Behavioral Ecology, Developmental Biology, Wildlife, Ethology	Practical	02

Semester I

Theoretical Paper

B050101T: Cytology, Genetics and Infectious Diseases

Unit	Topics	Total No. of Lectures (60)
I	Structure and Function of Cell Organelles I <ul style="list-style-type: none">• Plasma membrane: chemical structure—lipids and proteins• Cell-cell interaction: cell adhesion molecules, cellular junctions• Endomembrane system: protein targeting and sorting, endocytosis, exocytosis <p style="text-align: center;">Introduction to all national and international Biologists (Zoologists) who have contributed/contributing to Zoological and Life Sciences as a mark of tribute to ancient and modern biology will be included as part of the Continuous Internal Evaluation (CIE)</p>	6
II	Structure and Function of Cell Organelles II <ul style="list-style-type: none">• Cytoskeleton: microtubules, microfilaments, intermediate filaments• Mitochondria: Structure, oxidative phosphorylation• Peroxisome and ribosome: structure and function	6
III	Nucleus and Chromatin Structure <ul style="list-style-type: none">• Structure and function of nucleus in eukaryotes• Chemical structure and base composition of DNA and RNA• DNA super coiling, chromatin organization, structure of chromosomes• Types of DNA and RNA	8
IV	Cell cycle, Cell Division and Cell Signaling <ul style="list-style-type: none">• Cell division: mitosis and meiosis• Cell cycle and its regulation, apoptosis• Signal transduction: intracellular signaling and cell surface receptors, via G-protein linked receptors, JAK-STAT pathway	8
V	Mendelism and Sex Determination <ul style="list-style-type: none">• Basic principles of heredity: Mendel's laws, monohybrid and dihybrid crosses• Complete and Incomplete Dominance• Penetrance and expressivity• Genic Sex-Determining Systems, Environmental Sex Determination, Sex Determination in Drosophila, Sex Determination in Humans• Sex-linked characteristics and Dosage compensation	8
VI	Extensions of Mendelism, Genes and Environment <ul style="list-style-type: none">• Extensions of Mendelism: Multiple Alleles, Gene Interaction• The Interaction Between Sex and Heredity: Sex-Influenced and Sex-Limited Characteristics• Cytoplasmic Inheritance, Genetic Maternal Effects• Genomic Imprinting, Anticipation• Interaction Between Genes and Environment: Environmental Effects on Gene Expression, Inheritance of Continuous Characteristics	8

VII	Human Chromosomes and Patterns of Inheritance <ul style="list-style-type: none"> • Human karyotype • Chromosomal anomalies: Structural and numerical aberrations with examples • Pedigree analysis • Patterns of inheritance: autosomal dominant, autosomal recessive, X-linked recessive, X-linked dominant 	8
VIII	Infectious Diseases <ul style="list-style-type: none"> • Introduction to pathogenic organisms: viruses, bacteria, fungi, protozoa, and worms. • Structure, life cycle, pathogenicity, including diseases, causes, symptoms and control of common parasites: Trypanosoma, Giardia and Wuchereria 	8

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson (2004).
7. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W HFreeman (2007).
8. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. Roitt's Essential Immunology, 13th Edition. Wiley Blackwell (2017).
9. Shetty Nandini Immunology Introductory Textbook. New Age International. (2005)

Practical

B050102P: Cell Biology and Cytogenetic Lab

Unit	Topics	Total No. of Lectures (60)
I	<ol style="list-style-type: none">1. To study different cell type such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue.2. To study the different stages of Mitosis in root tip of onion.3. To study the different stages of Meiosis in grasshopper testis.4. To prepare molecular models of nucleotides, amino acids, dipeptides using bead and stick method.5. To check the permeability of cells using salt solution of different Concentrations.	15
II	<ol style="list-style-type: none">1. Study of parasites (eg. Protozoans, helminths <i>etc.</i>) from permanent slides.2. To learn the procedures for preparation of temporary and permanent stained/unstained slides.	15
III	<ol style="list-style-type: none">1. Study of mutant phenotypes of <i>Drosophila</i>.2. Preparation of polytene chromosomes.3. Study of sex chromatin (Barr bodies) in buccal smear and hair bud cells (Human).4. Preparation of human karyotype and study the chromosomal aberrations with respect to number, translocation, deletion <i>etc.</i> from the pictures provided.5. To prepare family pedigrees.	15
IV	Virtual Labs (Suggestive sites) https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab www.onlinelabs.in www.powershow.com https://vlab.amrita.edu https://sites.dartmouth.edu	15

Semester II

Theoretical Paper

B050201T: Biochemistry and Physiology

Unit	Topics	Total No. of Lectures (60)
I	Structure and Function of Biomolecules <ul style="list-style-type: none">• Structure and Biological importance of carbohydrates (Monosaccharide, Disaccharides, Polysaccharides and Glycoconjugates)• Lipids (saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids)• Structure, Classification and General properties of α-amino acids; Essential and non-essential α-amino acids, Levels of organization in proteins; Simple and conjugate proteins.	8
II	Enzyme Action and Regulation <ul style="list-style-type: none">• Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action• Isozymes; Mechanism of enzyme action• Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of K_m and V_{max}, Lineweaver-Burk plot; Enzyme inhibition;• Allosteric enzymes and their kinetics; Regulation of enzyme action	8
III	Metabolism of Carbohydrates and Lipids <ul style="list-style-type: none">• Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, phosphate pentose pathway• Glycogenolysis and Glycogenesis• Lipids --- Biosynthesis of palmitic acid; Ketogenesis,• β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms	8
IV	Metabolism of Proteins and Nucleotides <ul style="list-style-type: none">• Catabolism of amino acids: Transamination, Deamination, Urea cycle• Nucleotides and vitamins• Review of mitochondrial respiratory chain, Oxidative phosphorylation, and its regulation	6
V	Digestion and Respiration <ul style="list-style-type: none">• 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; 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; Control of respiration	7
VI	Circulation and Excretion <ul style="list-style-type: none">• Components of blood and their functions• Homeostasis: Blood clotting system, Blood groups: Rh factor, ABO and MN• Structure of mammalian heart• Cardiac cycle; Cardiac output and its regulation, Electrocardiogram,	8

	<p>Blood pressure and its regulation</p> <ul style="list-style-type: none"> • Structure of kidney and its functional unit; Mechanism of urine formation 	
VII	<p>Nervous System and Endocrinology</p> <ul style="list-style-type: none"> • Structure of neuron, resting membrane potential • Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers • Types of synapse • Endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them • Classification of hormones; Mechanism of Hormone action 	8
VIII	<p>Muscular System</p> <p>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</p>	7
<p>Suggested Readings:</p> <ol style="list-style-type: none"> 1. Nelson & Cox: Lehninger's Principles of Biochemistry: McMillan (2000) 2. Zubay <i>et al</i>: Principles of Biochemistry: WCB (1995) 3. Voet & Voet: Biochemistry Vols 1 & 2: Wiley (2004) 4. Murray <i>et al</i>: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott: Biochemistry and Molecular Biology: Oxford University Press 		

Practical

B050202P: Physiological, Biochemical & Hematology Lab

Unit	Topics	Total No. of Lectures (60)
I	<ol style="list-style-type: none">1. Estimation of haemoglobin using Sahli's haemoglobinometer2. Preparation of haemin and haemochromogen crystals3. Counting of RBCs and WBCs using Haemocytometer4. To study different mammalian blood cell types using Leishman stain.5. Recording of blood pressure using a sphygmomanometer6. Recording of blood glucose level by using glucometer	20
II	<ol style="list-style-type: none">1. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid2. Recording of simple muscle twitch with electrical stimulation (or Virtual)3. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)	15
III	<ol style="list-style-type: none">1. Ninhydrin test for α-amino acids.2. Benedict's test for reducing sugar and iodine test for starch.3. Test for sugar and acetone in urine.4. Qualitative tests of functional groups in carbohydrates, proteins and lipids.5. Action of salivary amylase under optimum conditions.	10
IV	Virtual Labs (Suggestive sites) <ol style="list-style-type: none">1. https://www.vlab.co.in2. https://zoologysan.blogspot.com3. www.vlab.iitb.ac.in/vlab4. www.onlinelabs.in5. www.powershow.com6. https://vlab.amrita.edu7. https://sites.dartmouth.edu	15

Semester III

Theoretical Paper

B050301T: Molecular Biology, Bioinstrumentation & Biotechniques

Unit	Topic	Total No. of Lectures (60)
I	Process of Transcription <ul style="list-style-type: none">• Fine structure of gene• RNA polymerases• Transcription factors and machinery• Formation of initiation complex• Initiation, elongation and termination of transcription in prokaryotes and eukaryotes	7
II	Process of Translation <ul style="list-style-type: none">• The Genetic code• Ribosome• Factors involved in translation• Aminoacylation of tRNA, tRNA identity, aminoacyl tRNA synthetase• Initiation, elongation and termination of translation in prokaryotes and eukaryotes	7
III	Regulation of Gene Expression I <ul style="list-style-type: none">• Regulation of gene expression in prokaryotes: <i>lac</i> and <i>trp</i> operons in <i>E. coli</i>• Regulation of gene expression in eukaryotes: Role of chromatin in gene expression• Regulation at transcriptional level, Post-transcriptional	8
	modifications: Capping, Splicing, Polyadenylation <ul style="list-style-type: none">• RNA editing.	
IV	Regulation of Gene Expression II <ul style="list-style-type: none">• Regulation of gene expression in eukaryotes:• Regulation at translational level, Post-translational modifications: protein folding etc.• Intracellular protein degradation• Gene silencing, RNA interference (RNAi)	8
V	Principle and Types of Microscopes <ul style="list-style-type: none">• Principle of Microscopy and Applications• Types of Microscopes: light microscopy, dark field microscopy, phase-contrast microscopy,• Fluorescence microscopy, confocal microscopy, electron microscopy	6
VI	Centrifugation and Chromatography <ul style="list-style-type: none">• Principle of Centrifugation• Types of Centrifuges: high speed and ultracentrifuge• Types of rotors: Vertical, Swing-out, Fixed-angle etc.• Principle and Types of Chromatography: paper, ion-exchange, gel filtration, HPLC, affinity	8

VII	Spectrophotometry and Biochemical Techniques <ul style="list-style-type: none"> • Biochemical techniques: Measurement of pH, Preparation of buffers and solutions • Principle of Colorimetry/Spectrophotometry: Beer-Lambert law • Measurement, applications and safety measures of radio-tracer techniques 	8
VIII	Molecular Techniques <ul style="list-style-type: none"> • Detection of nucleic acid by gel electrophoresis • DNA sequencing DNA fingerprinting, RFLP • Polymerase Chain Reaction (PCR) • Detection of proteins, PAGE, ELISA, Western blotting 	8

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002).
5. Watson et al. Molecular Biology of the Gene. Pearson (2004).
6. Lewin. Genes VIII. Pearson (2004).
7. Pierce B. Genetics. Freeman (2004).
8. Sambrook *et al* .Molecular Cloning Vols I, II, III. CSHL (2001).
9. Primrose. Molecular Biotechnology. Panima (2001).
10. Clark & Switzer. Experimental Biochemistry. Freeman (2000)

Practical

B050302P: Bioinstrumentation & Molecular Biology Lab

Unit	Topic	Total No. of Lectures (60)
I	<ol style="list-style-type: none">1. To study the working principle and Simple, Compound and Binocular microscopes.2. To study the working principle of various lab equipments such as pH Meter, Electronic balance, use of glass and micropipettes, Laminar flow, Incubator, Water bath, Centrifuge, Chromatography apparatus, etc.	15
II	<ol style="list-style-type: none">1. To prepare solutions and buffers.2. To measure absorbance in Colorimeter or Spectrophotometer.3. Demonstration of differential centrifugation to fractionate different components in a mixture.	15
III	<ol style="list-style-type: none">1. To prepare dilutions of Riboflavin and verify the principle of spectrophotometry.2. To identify different amino acids in a mixture using paper chromatography.3. Demonstration of DNA extraction from blood or tissue samples.4. To estimate amount of DNA using spectrophotometer.	15
IV	Virtual Labs (Suggestive sites) www.labinapp.com www.uwlax.edu www.labster.com www.onlinelabs.in www.powershow.in https://vlab.amrita.edu info@premiereducationaltechnologies.com https://li.wsu.edu	15

Semester IV

Theoretical Paper

B050401T: Gene Technology, Immunology and Computational Biology

Unit	Topic	Total No. of Lectures (60)
I	Principles of Gene Manipulation <ul style="list-style-type: none">• Recombinant DNA Technology• Selection and identification of recombinant cells• Restriction Enzymes, DNA modifying enzymes, Cloning Vectors, Ligation• Gene transfer techniques, Gene therapy	10
II	Applications of Genetic Engineering <ul style="list-style-type: none">• Single cell proteins• Biosensors, Biochips• Crop and live stock improvement, development of transgenics• Development of DNA drugs and vaccines	8
III	DNA Diagnostics <ul style="list-style-type: none">• Genetic analysis of human diseases, detection of known and unknown mutations• Concept of pharmacogenomics and pharmacogenetics	4
IV	Immune System and its Components <ul style="list-style-type: none">• Historical perspective of Immunology, Innate and Adaptive Immunity, clonal selection, complement system• Structure and functions of different classes of immunoglobulins, Hypersensitivity• Humoral immunity and cell mediated immunity• HLA complex: organization, class I and II HLA molecules	10
V	Biostatistics I <ul style="list-style-type: none">• Calculations of mean, median, mode, variance, standard deviation• Concepts of coefficient of variation, Skewness, Kurtosis• Elementary idea of probability and application	7
VI	Biostatistics II <ul style="list-style-type: none">• Data summarizing: frequency distribution, graphical presentation pie diagram, histogram• Tests of significance: one and two sample tests, t-test and Chi-square test	7
VII	Basics of Computers <ul style="list-style-type: none">• Basics (CPU, I/O units) and operating systems• Concept of homepages and websites, World Wide Web, URLs, using search engines	6
VIII	Bioinformatics <ul style="list-style-type: none">• Databases: nucleic acids, genomes, protein sequences and structures, Bibliography• Sequence analysis (homology): pair wise and multiple sequence alignments-BLAST, CLUSTALW• Phylogenetic analysis	8

Suggested Readings:

1. Primrose & Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003).
2. Hartl & Jones. Genetics: principles & Analysis of Genes & Genomes. Jones & Bartlett (1998).
3. Sambrook *et al.* Molecular Cloning Vols I, II, III. CSHL (2001).
4. Primrose. Molecular Biotechnology. Panima (2001).
5. Clark & Switzer. Experimental Biochemistry. Freeman (2000)
6. Sudbery. Human Molecular Genetics. Prentice-Hall (2002).
7. Wilson. Clinical Genetics-A Short Course, Wiley (2000).
8. Pasternak. An Introduction to Molecular Human Genetics. Fitzgerald (2000).
9. Biostatistical Analysis (Fourth Edition) by Jerrold H. Zarr, Pearson Education Inc., Delhi.
10. Statistical Methods (Eighth Edition) by G. W. Snedecor and W. G. Cochran, Wiley Blackwell
11. Biostatistics (Tenth Edition) by W.W. Daniel and C. L. Cross, Wiley
12. Introductory Biological Statistics (Fourth Edition) by John E. Havel, Raymond E. Hampton and Scott J. Meiners
13. Westhead *et al* Bioinformatics: Instant Notes. Viva Books (2003).

Practical

B050402P: Genetic Engineering and Counseling Lab

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:0-0-4		
Unit	Topic	Total No. of Lectures (60)
I	1. Measure the pre and post clitellar lengths of earthworms and calculate mean, median, mode, standard deviation etc. 2. Measure the height and weight of all students in the class and apply statistical measures.	10
II	1. Determination of ABO Blood group 2. To perform bacterial culture and calculate generation time of bacteria. 3. To study Restriction enzyme digestion using teaching kits. 4. To detect genetic mutations by Polymerase Chain Reaction (PCR) using teaching kits. 5. Demonstration of agarose gel electrophoresis for detection of DNA. 6. Demonstration of Polyacrylamide Gel Electrophoresis (PAGE) for detection of proteins. 7. To calculate molecular weight of unknown DNA and protein fragments from gel pictures.	20
III	1. To learn the basics of computer applications 2. To learn sequence analysis using BLAST 3. To learn Multiple sequence alignment using CLUSTALW 4. To learn about Phylogenetic analysis using the programme PHYLIP. 5. To learn how to perform Primer designing for PCR using available software's etc.	15
IV	Virtual Labs (Suggestive sites) 1. Gel Documentation System- https://youtu.be/WPpt3-FanNE 2. Colorimeter- https://youtu.be/v4aK6G0bGuU 3. PCR Part 1- https://youtu.be/CpGX1UFSI4A 4. PCR Part 2- https://youtu.be/6IcHAYPTAEw 5. DNA isolation Part 1- https://youtu.be/QE7UI0JnY9 A 6. DNA isolation part 2- https://youtu.be/-efr_HFeHxM 7. DNA curve- https://youtu.be/ubL8QxTeuG4 8. Spectrophotometer- https://youtu.be/ubL8QxTeuG4 9. Agarose Part 1- https://youtu.be/7gvHPFww--g 10. Agarose part 2- https://youtu.be/j_bOZCHNsSg 11. Use softwares like Primer3, NEB cutter 12. NCBI, BLAST, CLUSTAL W, PHYLIP	15

Semester V

Theoretical Paper -I

B050501T: Diversity of Non-Chordates and Economic Zoology

Unit	Topic	Total No. of Lectures (60)
I	Protozoa to Coelenterate <ul style="list-style-type: none">• Protozoa – <i>Paramecium</i> (Morphology and Reproduction)• Porifera – <i>Sycon</i>(Canal System)• Coelenterata – <i>Obelia</i> (Morphology and Reproduction)	7
II	Ctenophora to Nematelminthes <ul style="list-style-type: none">• Ctenophora - Salient features• Platyhelminthes - <i>Taenia</i> (Tape worm) (Morphology and Reproduction)• Nematelminthes –<i>Ascaris lumbricoides</i> (Morphology and Reproduction)	7
III	Annelida <ul style="list-style-type: none">• Annelida –<i>Hirudinaria</i> (Leech) (Morphology and Reproduction)	8
IV	Arthropoda <ul style="list-style-type: none">• Arthropoda – <i>Palaemon</i> (Prawn) (Morphology, Appendages, Nervous System and Reproduction)	8
V	Mollusca to Hemichordata <ul style="list-style-type: none">• Mollusca – <i>Pila</i>(Morphology, Shell, Respiration, Nervous System and Reproduction)• Echinodermata –<i>Pentaceros</i> (Morphology and Water Vascular System)	8
VI	Vectors and pests Life cycle and their control of following pests: Gundhi bug, Sugarcane leafhopper, Rodents. Termites and Mosquitoes and their control	8
VII	Economic Zoology-1 Animal breeding and culture: Pisciculture	7
VIII	Economic Zoology- 2 Sericulture, Apiculture, Lac-culture, Vermiculture	7

Suggested Readings:

1. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell
2. Hunter: Life of Invertebrates (1979, Collier Macmillan)
3. Marshall: Parker & Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)
4. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)
5. Brusca and Brusca (2016) Invertebrates. Sinauer
6. Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill

Theoretical Paper-II

B050502T: Diversity of Chordates and Comparative Anatomy

Unit	Topic	Total No. of Lectures (60)
I	Origin of Chordates & Hemichordata <ul style="list-style-type: none"> • Origin of Chordates. Classification of Phylum Chordata upto the class. • Hemichordata: General characteristics, classification and detailed study of <i>Balanoglossus</i> (Habit and Habitat, Morphology, Anatomy, Physiology and Development). 	6
II	Cephalochordata and Urochordata <ul style="list-style-type: none"> • Cephalochordata : General characteristics, classification and detailed study of <i>Branchiostoma (Amphioxus)</i> (Habit and Habitat, Morphology, Anatomy, Physiology). • (ii)Urochordata : General characteristics, classification and detailed study of <i>Herdmania</i> (Habit and Habitat, Morphology, Anatomy, Physiology and Post Embryonic Development). 	6
III	Classification and General Characteristics of Vertebrates <ul style="list-style-type: none"> • General characters and Classification of different classes of vertebrates (Pisces, Amphibia, Reptilia, Aves, Mammalia) upto the order with examples. • Poisonous and Non Poisonous Snakes and biting mechanism. • Neoteny and Paedogenesis • Migration in birds • Dentition in Mammals 	8
IV	Comparative Anatomy and Physiology of Vertebrates Integumentary System Structure, functions and derivatives of integument Skeletal System Overview of axial and appendicular skeleton, Jaw suspensum, Visceral arches	8
V	Digestive System Alimentary canal and associated glands, dentition	8
VI	Respiratory System Skin, gills, lungs and air sacs; Accessory respiratory organs	8
VII	Circulatory System General plan of circulation, evolution of heart and aortic arches Urinogenital System Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	8
VIII	Nervous System Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals Sense Organs Classification of receptors Brief account of visual and auditory receptors in man	8

Suggested Readings:

1. Harvey et al: The Vertebrate Life (2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboneed animals through time (5th ed 2002, Wiley - Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
5. McFarland et al: Vertebrate Life(1979, Macmillan Publishing)

Practical

B050503P: Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology

Unit	Topic	Total No. of Lectures (60)
I	Study of animal specimens of various animal phyla. 1. To prepare permanent stained slide of septal nephridia of earthworm. 2. To take out the nerve ring of earthworm. 3. To take out hastate plate from <i>Palaemon</i> .	15
II	1. Study of animal specimens of various animal phyla 2. Study on use and ethical handling of model organisms (Mice, rats, rabbit and pig). 3. To prepare stained/unstained slide of placoid scales. 1. Comparative study of bones of different vertebrates. 2. Comparative study of histological slides of different tissues of vertebrates.	15
III	1. Permanent Preparation of: <i>Euglena</i> , <i>Paramecium</i> 2. Study of prepared slides/specimens of <i>Entamoeba</i> , <i>Giardia</i> , <i>Leishmania</i> , <i>Trypanosoma</i> , <i>Plasmodium</i> , <i>Fasciola</i> , <i>Cotugnia</i> , <i>Taenia</i> , <i>Rallietina</i> , <i>Polystoma</i> , <i>Schistosoma</i> , <i>Echinococcus</i> , <i>Enterobius</i> , <i>Ascaris</i> and <i>Ancylostoma</i> 3. Permanent Preparation of <i>Cimex</i> (bed bug)/ <i>Pediculus</i> (Louse), <i>Haematopinus</i> (cattle louse), fresh water annelids, arthropods; and soil arthropods. 4. Larval stages of helminths and arthropods. 5. Permanent mount of wings, mouth parts and developmental stages of mosquito and house fly. Permanent preparation of ticks/ mites, abdominal gills of aquatic insects viz. Chironomus larva, dragonfly and mayfly nymphs, preparation of antenna of housefly. 6. Identification of pests. 7. Life history of silkworm, honeybee and lac insect. 8. Different types of important edible fishes of India. 9. Slides of plant nematodes 10. Study of an aquatic ecosystem, its biotic components and food chain 11. Project Report/ model chart making 12. Dissections : through multimedia / models 9. Cockroach : Central nervous system 10. Cockroach : Central nervous system 11. Wallago: Afferent and efferent branchial vessels, 13. Cranial nerves, Weberian ossicles	15
IV	Virtual Labs (Suggestive sites) https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab www.onlinelabs.in www.powershow.com https://vlab.amrita.edu https://sites.dartmouth.edu	15

Suggested Readings:

1. Harvey et al: The Vertebrate Life (2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002, Wiley - Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
5. McFarland et al: Vertebrate Life (1979, Macmillan Publishing)

Semester VI

Theoretical Paper- I

B050601T: Evolutionary and Developmental Biology

Unit	Topic	Total No. of Lectures (60)
I	Theories of Evolution <ul style="list-style-type: none">• Origin of Life• Historical review of evolutionary concept: Lamarckism, Darwinism (Natural, Sexual and Artificial selection)• Modern synthetic theory of evolution• Patterns of evolution (Divergence, Convergence, Parallel, Co evolution)	8
II	Population Genetics <ul style="list-style-type: none">• Microevolution and Macroevolution: allele frequencies, genotype frequencies, Hardy-Weinberg equilibrium and conditions for its maintenance• Forces of evolution: mutation, selection, genetic drift	8
III	Direct Evidences of Evolution Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse	7
IV	Species Concept and Extinction <ul style="list-style-type: none">• Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)• Mass extinction (Causes, Names of five major extinctions)	7
V	Gamete Fertilization and Early Development <ul style="list-style-type: none">• Gametogenesis, Fertilization• Cleavage pattern• Gastrulation, fate maps• Developmental mechanics of cell specification• Morphogenesis and cell adhesion	6
VI	Developmental Genes <ul style="list-style-type: none">• Genes and development• Molecular basis of development• Differential gene expression	8
VII	Early Vertebrate Development <ul style="list-style-type: none">• Early development of vertebrates (fish, birds & mammals)• Metamorphosis, regeneration and stem cells• Environmental regulation of development	8
VIII	Late Developmental Processes <ul style="list-style-type: none">• The dynamics of organ development• Development of eye, kidney, limb• Metamorphosis: the hormonal reactivation of development in amphibians, insects• Regeneration: salamander limbs, mammalian liver, Hydras• Aging: the biology of senescence	8

Suggested Readings:

1. Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
2. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. ColdSpring, Harbour Laboratory Press.
3. Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
4. Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
5. Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.

Theoretical Paper-II

B050602T: Ecology, Ethology, Environmental Science and Wildlife

Unit	Topic	Total No. of Lectures (60)
I	Introduction to Ecology <ul style="list-style-type: none"> • History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors 	4
II	Organization of Ecosystem <ul style="list-style-type: none"> • Levels of organization, Laws of limiting factors, Study of physical factors, • Population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion ,Exponential and logistic growth, • Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, , Food web, Energy flow through the ecosystem, • Ecological pyramids and Ecological efficiencies, Nutrient and biogeochemical cycle with one example of Carbon cycle 	12
III	Community Ecology Community characteristics: species richness, dominance, diversity, abundance, Ecological succession with one example	7
IV	Environmental Hazards <ul style="list-style-type: none"> • Sources of Environmental hazards • Climate changes • Greenhouse gases and global warming • Acid rain, Ozone layer destruction 	7
V	Effects of Climate Change <ul style="list-style-type: none"> • Effect of climate change on public health • Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, • Nuclear waste handling and disposal, Waste from thermal power plants, • Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath. 	6
VI	Behavioural Ecology and Chronobiology <ul style="list-style-type: none"> • Origin and history of Ethology, • Instinct vs. Learnt Behavior • Associative learning, classical and operant conditioning, Habituation, Imprinting, • Circadian rhythms; Tidal rhythms and Lunar rhythms • Chronomedicine 	8
VII	Introduction to Wild Life <ul style="list-style-type: none"> • Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies. 	8

VIII	Protected areas <ul style="list-style-type: none"> • National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve 	8
Suggested Readings: <ol style="list-style-type: none"> 1. Ecology: Theories & Applications. Peter D. Stiling, 2001, Prentice Hall. 2. Ecological Modeling. 2008. Grant, W.E. and Swannack, T.M., Blackwell. 3. Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs, 2016, Pearson Education Inc. 4. Elements of Ecology. T.M. Smith and R.L. Smith, 2014, Pearson Education Inc. 5. Environmental Chemistry. 2010. Stanley and Manahan, E. CRC, Taylor & Francis. London. 6. Environment. Raven, Berg, Johnson, 1993, Saunders College Publishing. 7. Essentials of Ecology. G.T. Miller, Jr. & Scott. E. Spoolman, 2014, Brooks/Cole, Cengage Learning. 8. Freshwater Ecology: A Scientific Introduction. 2004. Closs, G., Downes, B. and Boulton, A. Wiley-Blackwell publisher, Oxford. 9. Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M. Oxford 		

Practical

B050603P: Lab on Ecology, Environmental Science, Behavioral Ecology & Wildlife

Unit	Topic	Total No. of Lectures (60)
I	1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided. 2. Study of population dynamics through numerical problems. 3. Study of circadian functions in humans (daily eating, sleep and temperature patterns).	26
II	Report on a visit to National Park/Biodiversity Park/Wild life sanctuary	4
III	<ol style="list-style-type: none">1. Demonstration of basic equipments needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)2. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.3. Demonstration of different field techniques for flora and fauna	15
IV	Virtual Labs (Suggestive sites) https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab	15