



UNIVERSITY OF CALCUTTA

Notification No. CSR/75/2024

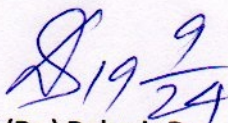
It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in the exercise of her powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 12.09.2024 approved the new revised syllabus (Semester- 1 to 6) of Zoology (4-year Honours & Honours with Research and Three-year MDC & Minor) under CCF, under this University, as laid down in the accompanying pamphlet.

The above shall take effect from the Odd Semester Examinations, 2024 and onwards.

SENATE HOUSE

Kolkata-700073

19.09.2024


Prof.(Dr.) Debasis Das

Registrar

Outline Structure of NEP Curriculum for Zoology Major, C.U.

PART I; SEM I			
SUBJECT CODE	NAME OF PAPER	THEORY	PRACTICAL
ZOOM CC 1 Th/P	Cell Biology	75	25
ZOOM SEC-1 Th/P	Applied Entomology	75	25
IDC Th/P	The University will offer Zoology related IDC as the Paper of Animal Science which will be selected by Students pursuing Major and Minor Courses other than Zoology	50	25
PART I; SEM II			
ZOOM CC 2 Th/P	Biochemistry	75	25
ZOOM SEC-2 Th/P	Aquaculture	75	25
IDC Th/P	The University will offer Zoology related IDC as the Paper of Animal Science which will be selected by Students pursuing Major and Minor Courses other than Zoology	50	25
PART II; SEM III			
ZOOM CC 3 Th/P	Genetics	75	25
ZOOM CC 4 Th/P	Cells and Tissue Structure	75	25
ZOOM SEC-3 Th/P	Poultry farming and Animal Husbandry	75	25
IDC Th/P	The University will offer Zoology related IDC as the Paper of Animal Science which will be selected by Students pursuing Major and Minor Courses other than Zoology	50	25
PART II; SEM IV			
ZOOM CC 5 Th/P	Non-chordate structure and function	75	25
ZOOM CC 6 Th/P	Parasitology	75	25
ZOOM CC 7 Th/P	Molecular Biology	75	25
ZOOM CC 8 Th/P	Ecology	75	25
PART III; SEM V			
ZOOM CC 9 Th/P	Chordate structure and function	75	25
ZOOM CC 10 Th/P	Endocrinology and Reproductive biology	75	25
ZOOM CC 11 Th/P	Animal Physiology	75	25
ZOOM CC 12 Th/P	Biodiversity and Conservation Biology	75	25
PART III; SEM VI			
ZOOM CC 13Th/P	Developmental Biology	75	25
ZOOM CC 14Th/P	Taxonomy, Evolution and Adaptation	75	25
ZOOM CC 15Th/P	Animal Behaviour	75	25
CU Summer Internship	As per University & UGBoS Instructions	75 [3 credits]	
PART IV; SEM VII			
ZOOM CC 16 Th/P	Biotechnology and its Application	75	25
ZOOM CC 17 Th/P	Neurobiology	75	25
ZOOM CC 18 Th/P	Toxicology	75	25
ZOOM CC 19 Th/P	Immunology	75	25
	DISSERTATION/ RESEARCH WORK	100[4 Credits]	
PART IV; SEM VIII			
ZOOM CC 20 Th/P	Scientific Communication and Research Methodology	75	25
ZOOM CC 21 Th/P	Animal Models in Research	75	25
ZOOM CC 22 Th/P	Industrial Microbiology	75	25
	DISSERTATION/RESEARCH WORK	200[8 credits]	

ABBREVIATIONS:

CC: Core Course (Major ZOOM;Minor ZOOMN) IDC: inter-Disciplinary Course; SEC: Skill Enhancement Course. Multidisciplinary (MZOO)

NOTE: Marks = 25 marks per credit. Candidates who will not pursue Dissertation/Research have to submit 1 Review paper along with Seminar Presentation at End of Semester-7 and 2 review paper along with Seminar Presentation at end of Semester-8.

Outline Structure of NEP Curriculum for Zoology Minor, C.U.

PART I; SEM I			
SUBJECT CODE	NAME OF PAPER	THEORY	PRACTICAL
ZOOMN CC1Th/P	Cell Biology	75	25
PART I; SEM II			
ZOOMNCC2 Th/P	Biochemistry	75	25
PART II; SEM III			
ZOOMN CC1Th/P	Cell Biology	75	25
PART II; SEM IV			
ZOOMN CC2Th/P	Biochemistry	75	25
<p>Note: Students who will opt other than Zoology as major in combination with minor Zoology in SEM I and in SEM II will take Cell biology and Biochemistry in SEM I and SEM II, respectively. Students who will opt other than Zoology as major in combination with minor other than Zoology in SEM III and in SEM IV, they will take Cell biology and Biochemistry as minor Zoology in SEM III and SEM IV, respectively.</p>			
PART III; SEM V			
ZOOMN CC3Th/P	Cell and Tissue structure	75	25
PART III; SEM VI			
ZOOMN CC4 Th/P	Non-Chordate structure and function	75	25

Outline Structure of NEP Curriculum for Zoology Multidisciplinary course (MDC), C.U.

PART I; SEM I				
SUBJECT CODE	CC1/CC2	Minor	THEORY	PRACTICAL
MZOO CC1 Th/P	Cell Biology		75	25
PART I; SEM II				
MZOOCC2 Th/P	Biochemistry		75	25
PART II; SEM III				
MZOOCC3 Th/P	Cells and Tissue Structure	Cells and Tissue Structure	75	25
PART II; SEM IV				
MZOO CC4Th/P	Non-chordate structure and function	Non-chordate structure and function	75	25
MZOO CC5Th/P	Ecology		75	25
PART III; SEM V				
MZOO CC6Th/P	Chordate structure and function	**Chordate structure and function	75	25
MZOO CC7Th/P	*Biodiversity and Conservation Biology	Biodiversity and Conservation Biology	75	25
PART III; SEM VI				
MZOO CC7Th/P	**Biodiversity and Conservation Biology	Animal Behaviour	75	25
MZOO CC8Th/P	Taxonomy, Evolution and Adaptation	Taxonomy, Evolution and Adaptation	75	25
CU Summer Internship	As per University and college Instructions	As per University and college Instructions	75 [3 credits]	

MDC students will take SEC paper SEC-G Applied Zoology in any of SEMI/ SEMII/ SEMIII.

Students taking Zoology as major subject will have option to study MZOO CC7Th/P either in SEMV or in SEMVI. Students who will opt Zoology as minor they will study only 6 papers as mentioned in the table.

PART I: SEMESTER-I

CORE COURSE-1: Cell Biology

CC1 THEORY

Full Marks 75	3 Credits	46 Hours
Unit 1: Plasma Membrane		7
Structure of the Plasma Membrane: Lipid Bilayer (Phospholipids and Cholesterol), Peripheral and Integral Membrane proteins, Glycolipids and Glycoproteins (<i>basic concept of Glycocalyx</i>), Fluid Mosaic Model with special reference to Lipid rafts, Mobility of membrane lipids (FRAP assay) and Mobility of Membrane Proteins (Frye-Edidin Experiment); Cell-cell junctions; Transport through plasma membrane.		
Unit 2: Cytoplasmic organelles I		7
Basic concepts on Ultrastructure of ER, Golgi and Lysosome; Overview of Protein sorting; ER Morphology, Targeting proteins to ER, The Signal hypothesis; Insertion of proteins into ER membrane, Protein folding and processing in ER, Export of proteins and lipids from ER ; Golgi Apparatus; Morphology, Protein glycosylation within Golgi, Protein sorting and export from Golgi apparatus; Lysosome: Polymorphism, Lysosomal acid hydrolases, Endocytosis and lysosome formation.		
Unit 3: Cytoplasmic organelles II		4
Mitochondria: Structure; Mitochondrial Respiratory Chain, Chemiosmotic hypothesis and Oxidative Phosphorylation with reference to ATP Synthase and ATP synthesis Centrosome and its organization		
Unit 4: Cytoskeleton		4
Structure and Types: Microtubules, Actin filaments, and Intermediate filaments; Composition and function of ECM		
Unit 5: Nucleus		5
Nuclear envelope, nuclear pore complex (transport not included), Kinetochore and centromeric DNA; Chromatin and levels of its packaging. Euchromatin & Heterochromatin.		
Unit 6: Cell Cycle		10
Cell Cycle: Phases of the eukaryotic cell cycle, Protein Kinases and Cell cycle regulation, MPF, Growth factors and regulation of G1-Cdks, S phase and regulation of DNA replication; Cell Death: Extrinsic (Death receptors) and Intrinsic Pathways (apoptosome); Cancer: Concept of Protooncogene [Ras] & Tumor suppressor genes [Rb and p53], Different ways of activation of a protooncogene to Oncogene.		
Unit 7: Cell Signalling		5
Signalling system: Modes of cell-cell signalling; Types of Signalling molecules Signalling receptors: Types and example with special reference to regulation of G protein, Adenyl cyclase-cAMP, Enzyme linked Receptors: RTK (ras-raf) and JAK/STAT		
Unit 8: Tools and Techniques in Cell Biology		4
<ul style="list-style-type: none"> • Animal Cell Culture: Primary cell culture and Cell line. • Subcellular fractionation and Ultracentrifugation. • Freeze fracture Replication and Freeze Etching • Working Principle of Light Microscope: Bright field, Phase contrast microscope, Fluorescence Microscope with reference to FRET; Working Principle of SEM & TEM. 		

Cell Biology Lab; ZOOA-CC-1-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> 1. Cell viability study by Trypan Blue Exclusion method. 2. Standardization of Ocular and Stage Micrometer and Measurement of cell or microscopic specimen such as <i>Paramecium</i> sp. 3. Preparation of squamous epithelial cell with staining. 4. Isolation of Bone Marrow Cells from Rat/Mouse and Giemsa Staining. 5. LNB 		

PART I: SEMESTER-I

SEC-1: Applied Entomology

SEC-1 THEORY

Full Marks 75	3 Credits	43 Hours
Unit 1 Basics of Entomology		11
<p>Morphological adaptation of insects: Head and antenna—Mouthparts of honey bee and cockroach; Thorax and thoracic appendages- legs and wings [General concept].</p> <p>Physiological adaptation in cockroach: Digestive system: Alimentary canal and digestive glands, digestion; Respiratory organs and mechanism of gaseous exchange; Sense organs compound eyes, chemoreceptors.</p> <p>General Characteristics of Class Insecta and living orders with examples: Orthoptera, Dictyoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera, Hymenoptera, Anoplura (Imms, A.D., 1938)</p>		
Unit 2 Medical Entomology		11
<p>Concept of Vectors: Carrier and biological vectors, modes of transmission with special reference to Malaria Dengue, and Filaria; Control measures of vectors</p> <p>Ticks as Causative agents and Vectors: Rickettsiosis, Tick-borne encephalitis; General outline of Mites and their medical significance.</p> <p>Phlebotomus sp: Characteristics, Biology and mode of transmission of visceral leishmaniasis; control measures.</p>		
Unit 3 Agricultural Entomology		11
<p>Insect Pest: Definition and types; Economic Injury Level (EIL), Economic Threshold Level (ETL), Dynamics of EIL;</p> <p>Pests of major crops (Life cycle, Nature of damage and control measures): Pests of Paddy, <i>Scirpophaga incertulus</i>; Pests of Jute, <i>Anomis sabulifera</i>; Pests of brinjal, <i>Leucinodes orbonalis</i>; Stored grain pest: <i>Sitophilus oryzae</i>;</p> <p>Insect Pest control: Chemical (classification and mode of action) and Biological control measures; Integrated Pest Management (IPM)</p>		
Unit 4 Sericulture		5
Types of Silk Moths with special reference to their scientific name, geographical distribution, and host plants; Life cycle of <i>Bombyx mori</i> ; Structure of Silk Gland; Voltinism; Rearing of mulberry silkworm; Reeling and extraction of silk; Mulberry cocoon management; Common diseases and pests of mulberry silkworm and their control measures; Prospects of Sericulture in India.		
Unit 5 Apiculture		5
Various species of Honeybee; Social organization and life cycle of Honeybee; Modern method of Beekeeping: Newton Box; Apiculture products and their uses; Extraction of honey and composition of honey; Diseases and their control measures.		

Applied Entomology Lab: SEC-1-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> Dissection and temporary mounting of: - Mouth parts of Cockroach and Mosquito Methods of collection, preservation, and identification of economically important insects. Identification (Order and specimen characters only) with economic importance of following insect pests: <i>Scirpophaga incertulus</i>; <i>Sitophilus oryzae</i>; <i>Callosobruchus chinensis</i>; <i>Leucinodes orbonalis</i>. Life history stages of <i>Apis</i> sp and <i>Bombyx mori</i>. Identification and medical significance of following insects (adults) through permanent slides: <i>Aedes aegypti</i>, <i>Aedes albopictus</i>., <i>Culex</i> sp., <i>Anopheles</i> sp. [for mosquito, larvae and both sexes of adults], <i>Musca</i> sp., <i>Phlebotomus</i> sp.. Accomplish any one from the followings related to applied entomological significance (submission of a report): <ol style="list-style-type: none"> Visit to Agricultural field related to damage caused by any pest and pest management. Make a report on it. Visit to any Sericulture farm to study silkworm rearing, silk reeling, silk processing and make a report on it. Visit an Apiary and to make a report on it. Visit to any rural or urban health centre to study various aspects of vector surveillance and vector borne diseases of that locality. Make a report on it. 		
7. LNB		

PART I: SEMESTER-II

CORE COURSE-2: Biochemistry CC2 THEORY

Full Marks 75	3 Credits	45 Hours
Unit 1: Carbohydrates		8
Structure, classification and properties of Monosaccharides (aldose and ketose), Disaccharides, Polysaccharides; Isomerism of monosaccharides (D and L, optical isomers, furanose and pyranose, α and β anomers, epimers); Reducing and non – reducing sugars. Physiological importance of Monosaccharides, Disaccharides, Polysaccharides		
Unit 2: Proteins		7
Amino acids: Structure, Classification, General and Electro chemical properties of α -amino acids; Essential and non-essential amino acids; Structures of Protein: Primary, secondary, tertiary and quaternary) of protein, Classification of proteins.		
Unit 3: Lipids		4
Classification of lipids; Saturated and unsaturated fatty acids, essential and non – essential fatty acids. Structure and formation of Triglyceride; Iodine number and saponification number of fats.		
Unit 4: Enzymes		8
Nomenclature, classification and properties; Cofactors and coenzymes, Effect of Temperature, pH, substrate concentration, enzyme concentration on enzyme action, Isozymes and Proenzyme, Mechanism of enzyme action (Lock and key model, Induced fit model). Enzyme kinetics: Derivation of Michaelis-Menten equation with its significance, Lineweaver-Burk plot and its significance. Enzyme inhibition – competitive, non- competitive, allosteric / feedback and its effect on Vmax and Km		
Unit 5: Carbohydrates Metabolism		6
Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis from lactate and glycerate, Glycogenesis and Glycogenolysis. (Pathways with name of enzymes and significance)		
Unit 6: Protein Metabolism		4
Transamination, Deamination and its types (Pathways with name of enzymes and significance) Fate of C-skeleton of Glucogenic and Ketogenic amino acids.		
Unit 7: Lipid Metabolism		4
β -oxidation of fatty acids - a. Palmitic acid {saturated (C 16:0)}, b. Linoleic acid {unsaturated (C 18:2)}; Fatty acid biosynthesis		
Unit 8: Nucleic acid Metabolism		3
Degradation of purine; Purine Salvage pathway and significance.		
Unit 7: Free radicals and Antioxidants		1
Concept of free radicals and antioxidants with examples.		

Biochemistry Lab; CC-2-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
Group A	10 Hours	15 Marks
Qualitative tests for carbohydrates, proteins and lipids		
1. For carbohydrate (Glucose, Fructose, Maltose, Sucrose, Starch) – Molisch test, Barfoed test, Benedict test, Fehling test, Seliwanoff test, Hydrolysis test for sucrose, Iodine test		
2. For Protein (Albumin, Gelatine, Peptone) –Biuret test, Million's test, Xanthoproteic test, Ninhydrin test		
3. For lipid – Grease spot test		
Group B	10 Hours	10 Marks
Colorimetric estimation of the following		
a) Protein by Lowry's method		
b) Activity of amylase		
LNB		

PART I: SEMESTER-II

SEC-2 Aquaculture

SEC-2-TH

Full Marks 75	3 Credits	43 Hours
Unit 1 Basics of Idea of Fish Biology		3
Qualities of Cultivable fish, Indigenous and Exotic		
Unit 2 Sustainable Aquaculture System		15
Sustainable Aquaculture Culture System: Extensive, Semi intensive, Extensive Water quality in culture ponds and factors controlling water quality. Preparation and Management of Fish Culture Ponds in Composite Fish Culture Cage Culture, Pen Culture, Raceways. Flow through system. Biofloc. Cold water fishery. Jeol Fishery. Sewage fed fishery. Mariculture with special emphasis on sea weed culture. (Basic concept) Induced Breeding of Carps. Synthetic Hormones in Hypophysation. Management of Fin Fish Hatcheries. Glass Jar Hatchery, Chinese Hatchery.		
Unit 3 Recent Advancement of Aquaculture		15
Aquarium Fisheries; Preparation and Management of Fish Aquarium; Biology of Common Ornamental Fish: Guppy, Swordtail, Angel, Blue morph fish. Anemone fish, Butterfly fish, Molly. Fish Nutritional Requirements: Feed Formulations and Preparation of Compound Diets. Capture Fishery: Fishing Crafts and Gears, Post harvesting Technology. Fish Transport and Marketing. Fish Preservation and By-products. Fish Biotechnology: Transgenic Fish, Sex Reversal in Fish. Aquaponics, Application of GIS and Remote Sensing in Fisheries, Fishery Laws and Regulations.		
Unit 4 Fin Fish pathology		5
Name of Infective Disease. Causative Agents, Symptoms, Control. Bacteria- Dropsy, Fin and Tail rot. Protozoa- White Spot Disease; Fungal-Saprolegniasis; Ectoparasite-Gyrodactylosis, Dactylogyrosis. Virus- Rhabdovirus		
Unit 5 Applied Aquaculture		5
Breeding Techniques in Shrimps and Prawns: Eyestalk Ablation in Shrimp and Salinity shock in Prawns. Techniques of Artificial Pearl Culture.		

Aquaculture Lab: SEC-2-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> Identification of different fish species using Meristic characters. (Systematic position, specimen characters) <i>Rohu, Catla, Cirrhinus, Puntius, Amblypharyngodon, Channa punctatus, Lates, Mystus, Notopterus, Cyprinus, Hypophthalmichthys, Ctenopharyngodon, Oreochromis niloticus, Oreochromis mossambicus, Anabas, Clarias, Heteropneustes, Mugil, Macrobrachium, Penaeus.</i> Visit to nearby fish market and identification of economically important fishes, survey on market economy and preparation of report on it. LNB 		

SUGGESTED REFERENCES

CORE COURSE-1: CELL BIOLOGY

1. **The Cell (8th Edition) G. M. Cooper** and R.E. Hausman
2. **Karp's Cell and Molecular Biology: Concepts and Experiments 8th edition**
3. **Lewin's CELLS (3rd Edition) David Sharp, Eric Sikorski, George Plopper**
4. **Molecular Biology of the Cell Bruce Alberts 6th Edition**
5. **Lehninger, Principles of Biochemistry 4th edition**
6. **The World of the Cell : Becker, 6th edition**
7. **Cell and Molecular Biology 8th Edition De Robertis**
8. **Thrive in Cell Biology, Oxford University Press, 2013**

CORE COURSE-2: BIOCHEMISTRY

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. **D. Das Biochemistry**
4. 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.
5. Hames, B.D. and Hooper, N.M. (2000). **Instant Notes in Biochemistry**, II Edition, BIOS Scientific Publishers Ltd., U.K.

SEC-1: APPLIED ENTOMOLOGY

1. **Chapman, R.F. (2012)**. The Insects: Structure and function 5th Edition, Cambridge University Press.
2. Triplehorn, C.A. and Johnson, N.F. (2005). **Borror and DeLong's Introduction to the study of Insects**. 7th Edition, Thompson Brooks/Cole, USA
3. **Atwal, A.S. (1986)**. Agricultural Pests of India and South-East Asia. 2nd Edition, Kalyani Publishers, New Delhi.
4. **Pedigo, L.P. and Rice, M.E. (2009)**. Entomology and Pest Management. 6th Edition, Pearson Prentice Hall.
5. **Hati, A.K. (2010)**. **Medical Entomology**. Allied Book Agency.
6. Shukla, A. (2009) A handbook on Economic Entomology. Daya Publishing House, DelhiEntomology. 3rd Edition, Academic Press, United Kingdom
7. Imms, A.D. (1938). A General Text Book of Entomology. Chapman and Hall

SEC-2: AQUACULTURE

1. Chaudhuri,S.(2017) Economic Zoology, NCBS.
2. Sarkar, S.,Kundu,G. Chaki,K.C. (2017) Introduction to Economic Zoology. NCBA
3. Khanna,S.S. and Singh, H.R.(2017) A Text Book of Fish Biology and Fisheries. Narendra Publishing House.
4. Menon, A.G.K. (1999) the Freshwater Fishes of India, A Handbook. Z.S.I
5. Das, M.K. and Das, R.K. (1997) Fish and Prawn Diseases in India- Diagnosis and Control. Inland Fisheries Society in India, Barrackpore, West Bengal.
6. Jhingran, V.G. (2007) Hindustan Publishing Corporation. 3rd Edition.
7. Pillai, T.V.R. and Kuttly. (2007) Fishing News Book. 2nd Edition.
8. Lutz. C.G.() Practical Genetics for Aquaculture. Fishing News Book. Oxford.
9. Govindan,T.K.(2008) Fish Processing Technology.Oxford and IBH Publishing Co. Pvt. Ltd. Kolkata.
10. Dunham, R.A. (1985) Aquaculture and Fisheries Biotechnology. Genetic Approaches. CABI.
11. Pierre Boundry, Andy Beaumont, Kathryn Hoare. (2010) Biotechnology and Genetics in Fisheries and Aquaculture. Wiley Blackwell.
12. Das,S. (2022) Aquarium Fishery.

IDC-1: ANIMAL BIOLOGY

1. Manna, S. , Bhowal, S. K. , Ghosh, R., Ghosh, N., Mukherjee, A. (2024) A Concise Book of Animal Biology. (Ed. S. Manna), Techno World, Kolkata.ISBN 978-81-19777-08-2.

The University will offer Zoology related IDC as the Paper of Animal Science which will be selected by Students pursuing Major and Minor Courses other than Zoology

PART I: SEMESTER-I/II/III

IDC-1: Animal Biology

IDC-1-TH

Full Marks 50	3 Credits	45 Hours
Unit 1: Animal Diversity		10
Phylum Characters and example: [Non-chordates-Porifera, Cnidaria, Ctenophora, Platyhelminthes, Nematelminthes, Annelida, Arthropoda, Mollusca and Echinodermata]; Chordata		
Unit 2: Genetics		12
<ol style="list-style-type: none"> 1. Mendelian Principles and Laws of inheritance 2. Linkage and Recombination basic Concepts 3. Sex Determination with reference to <i>Drosophila</i> [only genic balance theory] 4. Chromosomal Aberration [Structural and Numerical] 		
Unit 3: Biodiversity and Wildlife		10
<ol style="list-style-type: none"> 1. Biodiversity: Definition, types and value 2. Biodiversity: Indices [Shannon & Simpson] 3. Conservation: <i>in situ</i> and <i>ex situ</i> [outline idea] 4. Conservation Priority: Hotspot, Megadiversity, Sensitive Ecosystem 5. Indigenous Knowledge and PBR: Basic Concepts 		
Unit 4: Insect Vectors		8
<ol style="list-style-type: none"> 1. Concept of Vector: Biological and Mechanical Vectors with examples 2. Disease cycle & Reservoir Concept 3. Major Vectors: Mosquito (<i>Anopheles</i> sp. & <i>Aedes</i> sp.) and Sand fly [Lifecycle and Control Measures] 		
Unit 5: Laboratory techniques and Instrumentation		5
<ol style="list-style-type: none"> 1. Basics of Light Microscopy 2. Principles and Application of Colorimetry 3. Principles and application of Ultracentrifugation 		

Animal Biology Lab: IDC-1-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> 1. Karyotype analysis of Klinefelter, Down, Turner, Edward & Patau Syndrome 2. Identification (Phylum and specimen characters): <i>Amoeba</i>, <i>Paramecium</i>, <i>Sycon</i>, <i>Neptune's Cup</i>, <i>Taenia</i>, <i>Ascaris</i>, <i>Nereis</i>, <i>Pheretima</i>, <i>Pila</i>, <i>Lamellidens</i>, <i>Penaeus</i>, <i>Macrobrachium</i>, <i>Musca</i>, <i>Anopheles</i>, <i>Culex</i>, <i>Asterias</i>. 3. Identification of different ecosystems through photographs: Marine ecosystem, Mangrove ecosystem, Lake ecosystem, Rainforest ecosystem, Desert ecosystem, Grassland ecosystem. 4. LNB 		

SEC G For MDC

Applied Zoology-Theory

Full Marks 75	3 Credits	45 Hours
Unit I: Agricultural Entomology		5
Pest- definition and types (major and minor pests with example); Lifecycle, nature of damage and control of Pests: <i>Nilaparvata lugens</i> of paddy, <i>Anomis sabulifera</i> of Jute, <i>Bandicoota</i> – stored house pest; Insect Pest control: Chemical, Mechanical, Cultural and Biological control measures; Integrated Pest Management (IPM).		
Unit II: Sericulture		7
Types of Silkworms with special reference to their scientific name, geographical distribution and host plants; <i>Bombyx mori</i> : Silk gland, Composition of silk, Uses of silk; Lifecycle; Rearing, Extraction and Reeling of mulberry silk; Silkworm diseases, pests and their control.		
Unit III: Apiculture		6
Various domesticated species of Honeybee; Social organization of Honeybee; Bee keeping; Langstroth Box for rearing of honey bee, Extraction and processing of honey; Composition of honey, apiculture by products and their uses; Pests and Diseases of bees and their control measures		
Unit IV: Vermiculture		6
Scope of Vermiculture; Habit categories of earthworms; methodology of vermicomposting: containers for culturing, raw materials required, preparation of bed, environmental pre-requisites, feeding, harvesting and storage of vermicompost; Advantages of vermicomposting; Diseases and pests of earthworms.		
Unit V: Aquaculture		8
Principles, definition and scope; Prawn culture: Penaeid and Palaemonid features with examples; Semi-intensive method of prawn culture; Application of prawn culture; Difference between major and minor carps with examples; Composite fish farming: General concepts, advantages and disadvantages; Induced breeding: method and advantages; Integrated fish farming.		
Unit VI: Live Stock Management		7
Dairy: Introduction to common dairy animals: Types of Cattle breeds and their distribution in India; Exotic cattle breeds; Principles and methods of breeding – inbreeding, outbreeding, crossbreeding; Artificial insemination and MOET; cattle feed: Roughage and Concentrate; dairy by products, preservation and uses. Dairy pathology and vaccination programme. Poultry: Types of breeds (fowl) with features and examples; Rearing method: Deep litter system; feed formulation for chicks; poultry by products with economic importance; Diseases of poultry and their control measures.		
Unit VII: Lac Culture		6
Life cycle, host plants and strains of Lac insect; Lac cultivation: Local practice, improved practice, propagation of Lac insect, inoculation period, harvesting of Lac; Lac composition, processing, products and uses; Natural enemies of lac insect and their management		

Applied Zoology Lab

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> 1. Identification of various castes of Honey bee, life stages of <i>Bombyx mori</i>, various life stages of <i>Kerria lacca</i>, various earthworm species used in vermiculture and ectoparasites of Poultry birds 2. Identification of the following fish and prawn specimens (Specimen characters only): <i>Labeo rohita</i>, <i>Catla catla</i>, <i>Cirrhinus mrigala</i>, <i>Cyprinus carpio</i>, <i>L. bata</i>, <i>Penaeus monodon</i>, <i>Macrobrachium rosenbergii</i> 3. Collection of any two pests and submission of specimen it along with a small report on its identifying features, life cycle, nature of damage and control: <i>Sitophilus oryzae</i>, <i>Tribolium castaneum</i>, <i>Nilaparvata lugens</i>, <i>Anomis sabulifera</i> and <i>Leucinodes orbonalis</i> 4. LNB 		

PART II: SEMESTER-III

CORE COURSE-3: Genetics CC3 THEORY

Full Marks 75	3 Credits	44 Hours
Unit 1: Chromosome		4
Structural organization of Chromosomes; Polytene, Lampbrush and Satellite chromosomes; Human Karyotyping.		
Unit 2: Allele concept		8
Epistasis, Multiple alleles (ABO blood group in human), Isoallele (White eye mutations in <i>Drosophila</i>), Pseudoallele (Lozenge Locus in <i>Drosophila</i>) & Cis-trans test for allelism, Lethal alleles, Pleiotropy, Penetrance & Expressivity		
Unit 3: Genetic Fine Structure		2
Complementation test in Bacteriophage (Benzer's experiment on rII locus)		
Unit 4: Linkage, Crossing over and linkage mapping		10
Linkage and Crossing over; Complete and Incomplete Linkage; Holliday model of recombination; Linkage map construction using three point crosses; Sex linkage in <i>Drosophila</i> (White eye locus) & Human (Haemophilia)		
Unit 5: Mutations & Chromosomal aberrations		10
Types of gene mutations (Substitution and Frameshift); Types of chromosomal aberrations (Structural and Numerical); Non-disjunction of X chromosome in <i>Drosophila</i> , Non-disjunction of human chromosome 21; Molecular basis of mutations induced by UV light and chemical mutagens; mutation detection in <i>Drosophila</i> by attached X and CLB method; Biochemical mutation detection in <i>Neurospora</i>		
Unit 6: Extra-chromosomal inheritance		2
Kappa particle in <i>Paramecium</i> , Shell spiralling in snail		
Unit 7: Transposable Genetic elements		4
IS element in bacteria; Ac-Ds elements in maize; P elements in <i>Drosophila</i> ; LINE, SINE, Alu elements in human		
Unit 8: Quantitative Genetics		4
Concept of quantitative traits (Examples – Kernel colour in wheat, Ear length in Corn); Polygenic inheritance; Heritability – Concept and types (Broad sense heritability and Narrow sense heritability)		

Genetics Lab; CC-3-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> Chi-Square Test - Test for Goodness of fit – Mendelian monohybrid and di-hybrid ratios, *Epistatic ratios; Contingency Chi-Square Test Identification of Chromosomal aberration in <i>Drosophila</i> (Deletion, Duplication, Inversion and Translocation) and Human (Karyotype of Down Syndrome, Turner Syndrome, Patau Syndrome, Edward Syndrome and Klinefelter Syndrome) from photograph. Pedigree Analysis of some inherited traits in Human (Autosomal, X-linked and Y-linked). Temporary squash preparation of Grasshopper testis to study various stages of meiosis. LNB 		
*Only for major course students		

PART II: SEMESTER-III

CORE COURSE-4: Cells and Tissue Structure CC4 THEORY

Full Marks 75	3 Credits	42 Hours
Unit 1: Stain, Dye and Histochemistry		8
Difference between stain and dye. Components and classification of dye. Principle and chemistry of PAS and Feulgen reaction.		
Unit 2: Epithelial Tissue		8
Salient features; Classification with location and diagram (based on structure and functions) Glandular epithelium in details. Cell polarity-Apical domain and modifications; Lateral domain. Clinical correlation: Epithelial metaplasia.		
Unit 3: Connective Tissue		14
Salient features with respect to cell types and fibers; Classification. Structure and function with diagram of Adipose tissue – brown fat and white fat Areolar tissue (diagram, location, components, and their functions); Bone tissue (cell types, extra cellular matrix and ossification with diagram); Cartilage tissue (structure, types with location and diagram); Blood tissue (composition with function) Brief idea on epithelial membrane: cutaneous membrane, mucous membrane Clinical correlation with respect to bone tissue: Osteoarthritis and Osteoporosis		
Unit 4: Muscle tissue		5
Salient features. Types based on function and striations. Ultrastructure of skeletal muscle. Features of single unit and multiunit smooth muscle, cardiac muscle. Difference between white muscle fiber and red muscle fiber. Clinical correlation: Duchene muscular dystrophy.		
Unit 5: Nervous Tissue		5
Salient features; Structure of neurons and types based on origin, myelin sheath and processes; Neuroglia and functions; Clinical correlation: Multiple sclerosis		
Unit 6: Tissue repair		2
Steps of tissue (skin as an example) repair: 1. Inflammation 2. Organization 3. Regeneration and/ or Fibrosis. Factors affecting it: 1. Type of tissue 2. Type of injury. 3. Adequacy of blood supply. 4. State of health. 5. Age.		

Cells and Tissue Structure Lab; CC-4-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> 1. Preparation, staining and mounting of the following <ol style="list-style-type: none"> a. Epithelial tissue from vaginal smear of rat using methylene blue. b. Connective tissue from blood film of rat using Giemsa. c. Muscle tissue from thigh muscle of cockroach using methylene blue. 2. Identification with reasons the following mammalian histological sections – lung, liver, stomach, kidney. 3. Tissue preparation, block making and sectioning of any organ of rat/mice. 4. LNB 		

PART II: SEMESTER-III

SEC-3: Poultry Farming and Animal Husbandry

SEC-3 THEORY

Full Marks 75	3 Credits	42 Hours
Unit 1: Common Breeds of Fowl and their Characteristics		6
American Class, Asiatic Class, Mediterranean Class, English Class, Indigenous breeds. Commercial strains of chickens: Broiler, Layer, Grower		
Unit 2: Rearing methods in Poultry Housing and Equipment		6
Essential of good housing; housing requirements; Poultry equipment (egg collector, incubator, chick cage); Housing systems: Free range system, Semi intensive system, Folding unit system, Deep litter system, Cage system (battery).		
Unit 3: Poultry nutrition:		4
Nutrition, Feed formulation for chicks		
Unit 4: Diseases of Poultry and their control measures:		3
Viral disease, Parasitic disease, Fungal disease and their control		
Unit 5: Poultry market in India:		2
Size, growth and trends; poultry market opportunity and challenges		
Unit 6: Animal Husbandry: Important cattle breed and their characteristics		5
Cattle breeds in India, Cattle population, Milch breeds, Dual purpose breeds, Draught breed, Cross breed cattle strain		
Unit 7: Livestock feeds:		4
Cattle feed – Roughage and Concentrate		
Unit 8: Breeding program:		4
Artificial insemination and MOET in cattle.		
Unit 9: Dairying:		4
Composition of Milk, Dairy products, National Dairy Development Board and Operation Flood Program.		
Unit 10: Dairy Pathology		4
Viral disease, bacterial disease, and parasitic disease and control		

Poultry Farming and Animal Husbandry Lab; SEC-3-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> 1. Identification of following poultry breeds (only coloured photograph): Plymouth rock, Rhode Island red, New Hampshire, Cochin, Brahma, Leghorn, Cornish, Aseel, Kadaknath, Chittagong. 2. Identification of following cattle breeds (only coloured photograph): Sahiwal, Red Sindhi, Gir, Malvi, Hariana, Tharparkar, Jersey. 3. Visit to a poultry farm or animal husbandry and make a report on that study. 4. LNB 		

PART II: SEMESTER-IV

CORE COURSE-5: Non-Chordate Structure and Function CC5 THEORY

Full Marks 75	3 Credits	45 Hours
Unit 1: Kingdom Protista		4
Subkingdom Protozoa: General characteristics and Classification up to phylum (Levine et. al., 1980); Locomotion in <i>Euglena</i> , <i>Paramecium</i> and <i>Amoeba</i> ; Asexual reproduction and Conjugation in <i>Paramecium</i>		
Unit 2: Kingdom Animalia		4
Basic structural organization of animals: Body symmetry; Body cavities with reference to pseudocoelom and coelom, Protostomes and Deuterostomes; Origin of Metazoa.		
Unit 3: Phylum Porifera		4
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Canal system in sponge; Spicules in sponges.		
Unit 4: Phylum Cnidaria		4
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.), Metagenesis in <i>Obelia</i> ; Polymorphism in Siphonophora; Coral reef: types, formation, threats and Conservation.		
Unit 5: Phylum Helminths		4
General characteristics and Classification up to classes of Phyla Platyhelminthes and Nematoda (Ruppert and Barnes, 1994, 6th Ed.); Type study (description of digestive, excretory and reproductive): <i>Fasciola hepatica</i> , <i>Ascaris lumbricoides</i>		
Unit 6: Phylum Annelida		4
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Excretion in Annelida; Metamerism in Annelida.		
Unit 7: Phylum Onychophora		2
Affinities and Systematic position of Onychophorans		
Unit 8: Phylum Arthropoda		6
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Type study: <i>Macrobrachium</i> (respiration and excretion)		
Unit 9: Phylum Mollusca		5
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Type study <i>Pila</i> sp. (Nervous system and respiratory) and <i>Octopus</i> sp. (Nervous system); Torsion in Gastropoda.		
Unit 10: Phylum Echinodermata		5
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Water vascular system in Starfish; Echinoderm larva and affinities with chordates.		
Unit 11: Phylum Hemichordata		3
General characteristics of Phylum Hemichordata; Affinities and systematic position of Hemichordates.		

Non-Chordate Structure and Function Lab; CC-5-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> Identification with reason & Systematic position of <i>Entamoeba</i>, <i>Trypanosoma</i>, <i>Sycon</i>, <i>Obelia</i>, <i>Aurelia</i>, <i>Metridium</i>, <i>Madrepora</i>, <i>Fasciola</i>, <i>Taenia</i>, <i>Ascaris</i>, <i>Nereis</i>, <i>Chaetopterus</i>, <i>Hirudinaria</i>, <i>Peripatus</i>, <i>Limulus</i>, <i>Buthus</i>, <i>Macrobrachium</i>, <i>Balanus</i>, <i>Eupagurus</i>, <i>Julus</i>, <i>Scolopendra</i>, <i>Patella</i>, <i>Chiton</i>, <i>Pila</i>, <i>Sepia</i>, <i>Octopus</i>, <i>Asterias</i>, <i>Ophiura</i>, <i>Echinus</i>, <i>Cucumaria</i>, <i>Antedon</i> and <i>Balanoglossus</i>. Anatomical study: Earthworm: Mounting of Nerve ring; Periplaneta sp.: Nervous system, Male and female Reproductive systems. Laboratory culture and whole mount of <i>Paramecium</i>/<i>Euglena</i>/<i>Amoeba</i> LNB 		

PART II: SEMESTER-IV
CORE COURSE-6: Parasitology
CC6 THEORY

Full Marks 75	3 Credits	42 Hours
Unit 1: Introduction to Parasitology		4
Parasitism: parasite, parasitoid, parasitic castration; Vectors and reservoir concept; Zoonosis		
Unit 2: Parasitic Protists		7
Study of Epidemiology, Morphology, Life Cycle, Pathogenicity, Diagnosis and Control mechanisms of <i>Entamoeba histolytica</i> , <i>Leishmania donovani</i> , <i>Plasmodium vivax</i> , <i>Plasmodium falciparum</i>		
Unit 3: Parasitic Platyhelminthes		8
Study of Epidemiology, Morphology, Life Cycle, Pathogenicity, Diagnosis and Control mechanisms of <i>Schistosoma haematobium</i> and <i>Echinococcus granulosus</i>		
Unit 4: Parasitic Nematodes		8
1. Study of Epidemiology, Morphology, Life Cycle, Pathogenicity, Diagnosis and Control mechanisms of <i>Ascaris lumbricoides</i> and <i>Ancylostoma duodenale</i> 2. Study of structure, lifecycle and importance of <i>Meloidogyne incognita</i> (root-knot nematode)		
Unit 5: Parasitic Arthropods		8
Biology, importance and control of ticks (<i>Ixodes</i> sp.), mites (<i>Sarcoptes</i> sp.), Lice (<i>Pediculus</i> sp.)		
Unit 6: Parasitic Vertebrates		3
Brief account of parasitic nature of Cookiecutter Shark, Hood Mocking bird, Vampire bat		
Unit 7: Parasitic Adaptation and host relation		4
1. Parasitic adaptation in Helminths 2. Host parasitic interactions		

Parasitology Lab; CC-6-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
1. Identification of <i>Entamoeba histolytica</i> , <i>Leishmania donovani</i> , <i>Plasmodium vivax</i> through permanent slides/microphotographs		
2. Identification of <i>Schistosoma haematobium</i> , <i>Echinococcus granulosus</i> through permanent slides/microphotographs		
3. Identification of <i>Ascaris lumbricoides</i> , <i>Ancylostoma duodenale</i> , <i>Wuchereria bancrofti</i> through permanent slides/photographs		
4. Isolation, Fixation, Staining and Mounting of Protozoa (<i>Nyctotherus</i> sp/ <i>Balantidium</i> sp.) and Helminth (<i>Leidynema</i> sp.) from gut of Cockroach (<i>Periplaneta americana</i>)		
5. LNB		

PART II: SEMESTER-IV
CORE COURSE-7: Molecular Biology
CC7 THEORY

Full Marks 75	3 Credits	45 Hours
Unit 1: Nucleic Acids		3
Structure and composition of DNA: Chargaff's Rule; Hypo and Hyperchromic shift; Watson and Crick Model of the Three-Dimensional Structure of DNA. Different forms of DNA-A, B and Z DNA (comparative overview) RNA as the Genetic Material, Types and Function.		
Unit 2: DNA Replication		8
Meselson–Stahl Experiment, DNA Replication in Prokaryotes [Bidirectional and discontinuous]; Enzymes/Proteins associated with Replication -Polymerase [I, II & III], Primase, Helicase, SSB, DNA ligase; RNA priming; End replication Problem and Replication of telomeres in eukaryotes.		
Unit 3: Transcription		6
Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.		
Unit 4: Post Transcriptional Modifications and Processing of Eukaryotic RNA		6
Capping and Poly A tail formation in mRNA; Concept of introns and exons and Split genes; Splicing mechanism [Intron Removal by Spliceosome]; RNA editing (gRNA mediated and cytidine deaminase mediated)		
Unit 4: Translation		6
Genetic code; Characteristics of the Genetic Code; Aminoacylation of a tRNA molecule; Mechanism of protein synthesis in prokaryotes.		
Unit 6: Gene Regulation		8
Regulation of Transcription in prokaryotes: <i>lac</i> operon and <i>trp</i> operon (Attenuation control); Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing. Epigenetic Regulation: DNA Methylation (by DNMT), Histone Methylation (by HMT) & Acetylation (by HAT and HDAC).		
Unit 7: DNA Repair Mechanisms		4
Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair		
Unit 8: Molecular Techniques		4
<ul style="list-style-type: none"> • Principle and use of Agarose Gel Electrophoresis • Principle and use of SDS PAGE • Blot Technique: Southern, Northern and Western Blot • PCR: Basic Principle, Reverse Transcriptase-PCR 		

Molecular Biology Lab; CC-7-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> 1. Isolation of genomic DNA from Goat Liver by phenol-chloroform method. 2. Quantification of DNA by diphenylamine (DPA) method. 3. Agarose Gel Electrophoresis. 4. Concept of buffer preparation and related calculation and dilution. 5. Instruments and accessories used to be shown by photographs for the following techniques: PCR, SDS PAGE, Western Blot, Southern Blot. 6. LNB 		

PART II: SEMESTER-IV

CORE COURSE-8: Ecology CC8 THEORY

Full Marks 75	3 Credits	44 Hours
Unit 1: Introduction to Ecology		5
Autecology/Synecology. Laws of Limiting factor. Temperature as limiting factor (effect on plant and animal metabolism, Bergman's rule, Jordan's rule, Allen's rule, Rensch's rule). Light as limiting factor (photo periodism in plants and animals).		
Unit 2: Energy Flow in Ecosystem		8
Functional components of Ecosystem: Energy flow (Universal model and Y shaped model, Ten percent law of energy flow); Productivity (Primary and secondary) and ecological efficiencies. Types of Ecological Pyramids with examples; Food chain (Detritus Food Chain and Grazing Food Chain); Food web and types; Bio geochemical cycles (Nitrogen cycle).		
Unit 3: Population Ecology.		7
Definition and properties (Natality, mortality, Density, Biotic potential, Age structure, survivorship curves, Growth curves with equations); Population regulation (density dependent and independent); r- and k – strategies.		
Unit 4: Niche and Competition		8
Definition of Habitat and Niche, Types of Niche, N-dimensional niche concept; Niche overlap and resource partitioning, Competition and exclusion principle, Gause's and Connell's Field experiment, niche segregation and character displacement, Lotka Volterra equation for competition. Habitat Ecology – Metabolism and Ecosystem services of Tropical Rain forest and Wetlands.		
Unit 5: Community Ecology		4
Community; Definition and types; Stratification, species richness and Evenness; Dominance – Diversity Analysis, Interspecific interaction within equilibrational communities (definition and examples).		
Unit 6: Ecological Succession		4
Definition of succession, Types of succession, Seral stages of succession with special reference to Hydrosere and Lithosere; Models of ecological succession; Resource-Ratio Hypothesis.		
Unit 7: Pollution Biology		8
Definition, Types of Pollutants (primary and secondary with examples); Causes and effects of acid rain, photochemical smog, ozone layer depletion and eutrophication; Cause and effects of heavy metal pollution in water (Pb, As, Hg); Groundwater Pollution; Concept of Bioconcentration and Biomagnification.		

Ecology Lab; CC-8-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> 1. Quantitative Estimation of Dissolved O₂ (Winkler's method), Free CO₂, Alkalinity from the provided water sample and comment on the observation. 2. Estimation of pH value of the provided water sample. 3. Identification with reasons of the following zooplanktons: <i>Daphnia</i>, <i>Cyclops</i>, <i>Cypris</i> 4. Identification with reasons of the following soil arthropods: Collembola, termite worker, ant 5. Study of life table and survivorship curve from a hypothetical data set and comment on the results. 6. LNB 		

SUGGESTED REFERENCES

CORE COURSE-3: GENETICS

1. Genetics-**Strickberger** 3rd edition
2. iGenetics-**Russell** 3rd edition
3. Genetics-**Benjamin A Pierce** 7th Edition
4. Concepts of Genetics- **Klug and Cummings** 12th Edition
5. Principles of Genetics, 7th Edition, **Snustad and Simmons**.
6. An Introduction to Genetic Analysis, 12th Edition, **Griffith et al.**
7. Schaum's Outlines of Genetics, 5th Edition, **Stansfield**.
8. Problems on Genetics, Molecular Genetics and Evolutionary Genetics, 2nd Revised edition, **P.K. Banerjee**

CORE COURSE-4: CELLS AND TISSUE STRUCTURE

1. Junqueira LC, Carneiro J. 2005. Basic histology text and atlas
2. Ross M H, Pawlina W. 2010. Histology: A Text and Atlas. Lippincott Williams and Wilkins
3. Don W. Fawcett and William Bloom 1998: a textbook on histology
4. John D. Bancroft 2019: Theory and practice of histology
5. Kiernan J. A. 2001: Histology and histochemical methods 3rd edition

SEC-3: POULTRY FARMING AND ANIMAL HUSBANDRY

1. J. Prasad (2015) Poultry Production and Management, Kalyani Publisher
2. N. Ghosh (2015) Poultry Science and Practice, CBS Publishers and Distributors
3. I. B. Singh (2000) Poultry, Fisheries, Bee Keeping and Sericulture in India, Pushal Publications and Distributors, Varanasi
4. P.V. Sreenivasaiah (2015) Text Book of Poultry Science, published by Hitesh Mittal for Write and Print Publications, H.13, Balinagar, New Delhi
5. G.C. Banerjee (2000) A Text Book of Animal Husbandry, 8th Edn., Oxford and IBH Publishing Company Pvt. Ltd., New Delhi
6. D.N. Pandey (1995-1996) Animal Husbandry and Veterinary Science, 15th Edn., Published by Jai Prakash Nath and Company, Meerut.
7. P.R. Gupta (2007) Dairy India Yearbook

CORE COURSE-5: NON-CHORDATE STRUCTURE AND FUNCTION

1. E. E. Ruppert and R.D. Barnes (1994) Invertebrate Zoology, 6th Edition. Harcourt Asia PTE Ltd. Singapore.
2. R. C. Brusca and G.J. Brusca (2003) Invertebrates, 2nd Edition, Sinauer Associates, Inc., Publishers, USA
3. Chapman, R.F. (2012). The Insects: Structure and function 5th Edition, Cambridge University Press. UK
4. L. L. Jordan and P. S. Verma (2002) Invertebrate Zoology. S. Chand and Company Ltd., New Delhi
5. K. K. Chaki, G. Kundu and S. Sarkar (2005) Introduction to General Zoology. New Central book Agency (P) Ltd. Kolkata.
6. R.L. Kotpal (2012) Modern Text Book of Zoology Invertebrates (Animal Diversity I) Rastogi Publications, Meerut 250002, India.

CORE COURSE-6: PARASITOLOGY

1. Ahmed N, Dawson M, Smith C, Wood Ed. 2007. Biology of Disease. Taylor and Francis Group.
2. Arora D R, Arora B. 2001. Medical Parasitology. II Edition. CBS Publications and Distributors
3. Bogitsch, B J, Carter CE, Oeltmann TN. (2013): Human Parasitology. 4th Edn. Elsevier.
4. Bose M (2017). Parasitoses and zoonoses. New Central Book Agency. 1:3-808
5. Chakraborty, P. (2016): Textbook of Medical parasitology, 3rd edition. New Central Book Agency.
6. Chatterjee K D. 2009. Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers
7. Cheng, T.C., (1986): General Parasitology. Academic Press.
8. Dailey MD. 1996. Meyer, Olsen & Schmidt's Essentials of Parasitology. W.C. Brown Publishers
9. Gunn A, Pitt SJ. 2012. Parasitology: an Integrated Approach. Wiley Blackwell.
10. Hati AK. 1979. Medical Entomology. Allied Book Agency
11. John DT, Petri WA. 2006. Markell and Voge's Medical Parasitology. Elsevier.
12. Roberts, L.S and Janovy, J. (2009). Smith & Robert's Foundation of Parasitology. 8th. Edn. McGraw Hill
13. Smyth JD (2012): Introduction to animal parasitology. Cambridge Low Priced Edition.

CORE COURSE-7: MOLECULAR BIOLOGY

1. Genetics-**Strickberger** 3rd edition
2. iGenetics-**Russell** 3rd edition
3. Genetics-**Benjamin A Pierce** 4th Edition
4. Concepts of Genetics- **Klug and Cummings** 12th Edition
5. Molecular Biology of the Gene-**Watson** 7th Edition
6. Cell Bruce-Alberts 6th Edition
7. Molecular Biology- **Weaver** 5th Edition
8. Principles and techniques of Biochemistry and Molecular Biology- **Walker and Wilson** 8th Edition

CORE COURSE-8: ECOLOGY

1. Allen Cain M L, Bowman W D and Hacker S D. 2013. Ecology. 3rd ed. Sinauer associates.
2. Begon M, Harper J L. Townsend CR. 2006. Ecology: Individuals, Populations & communities. 4th Ed.
3. Chapman RL, Reiss MJ. 2000. Ecology-Principles & Application. Cambridge University Press.
4. Colinvaux P. 1993. Ecology 2. John Wiley & Sons, Inc. New York.
5. Faurie C., Ferra C., Medori P., Devaux J. 2001. Ecology-Science and Practice. Oxford & IBH Pub. Company.
6. Kormondy E.J. 2002. Concepts of Ecology. 4th Indian Reprint, Pearson Education.
7. Maiti,P.K. and Maiti,P. 2023. Biodiversity, Perception, Peril and Preservation. PHI, Learning Pvt, Ltd.
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10. Ricklefs . R.E. Miller, G.L. 2000. Ecology. 4th Ed. W. H. Freeman and Company.
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12. Smith T.M, Smith R L. 2006. Elements of Ecology. 6th Ed. Pearson Education.
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14. Townsend, C.; J. L. Harper, M. Begon – Essentials of Ecology, Blackwell Publishing.

FOR LABORATORY COURSE.

1. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
2. Manna, B and Manna, S. (2019): Advanced Laboratory Manual of Parasitology and Immunoparasitology, New Central Book Agency, Kolkata
3. Poddar, T., Mukherjee, S., Das, S.K. (2003) Macmillan Publishers India Limited. An Advanced Laboratory Manual Of Zoology.
4. Mazumder, Bhowal, Chatterjee, Saha (2020) Zoology in Laboratory. Satra Publication.
5. D.K. Som, S. K. Bhowal, N. Ghosh, and A. Mukherjee (2024) A Concise Text Book on Practical Zoology. 1st Edition, Rainbow Publishers, Kolkata 700014, India.
6. S. S. Lal (2012) Practical Zoology. Volume 1 Rastogi Publications, Meerut 250002, India.
7. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
8. Manna, B and Manna, S. (2019): Advanced Laboratory Manual of Parasitology and Immuno-parasitology, New Central Book Agency, Kolkata
9. Sinha J K, Chatterjee A K. and Chattopadhyay P. – Advanced Practical Zoology .New Central Book Agency

PART III: SEMESTER-V

CORE COURSE-9: Chordate Structure and Function CC 9 THEORY

Full Marks 75	3 Credits	45 Hours
Unit 1: Introduction to Phylum Chordata		4
Theories of Origin of chordates with reference to Dipleurula concept and the Echinoderm theory; General characteristics and outline classification (J.Z. Young, 1981).		
Unit 2: Protochordata, Agnatha and Pisces		8
Protochordata and Agnatha: General characters and classification up to class (J.Z. Young, 1981); Structure of pharynx and feeding in <i>Branchiostoma</i> ; Retrogressive metamorphosis in <i>Ascidia</i> ; Pisces: General characters and classification of Chondrichthyes and Osteichthyes upto class (J.Z. Young, 1981); Swim bladder in fishes; Structure of gills in cartilaginous and bony fishes; Accessory respiratory organs; Olfactory apparatus in <i>Tilapia</i> ; Electric organ in <i>Torpedo</i> .		
Unit 3: Amphibia and Reptilia		7
Origin of Tetrapods (Evolution of terrestrial ectotherms); General characteristics and classification of Amphibia and Reptilia up to living Orders (J.Z. Young, 1981); Structure, function and derivatives of integument in amphibia; Paedomorphosis in Axolotl; Poisonous and Non-Poisonous snake; Poison apparatus and Biting mechanism in Snake.		
Unit 4: Aves and Mammalia		8
General characteristics and classification of Aves and Mammalia up to living Sub-Classes (J.Z. Young, 1981); Exoskeleton in Birds; Air-sacs in Pigeon, Aerodynamics of flight in birds; Exoskeleton derivatives of mammals; Dentition in mammals; Ruminant stomach; Echolocation in Microchiropterans.		
Unit 5: Comparative anatomy in chordates		10
Heart and Aortic arches; Brain with reference to cerebrum & cerebellum; kidneys and urino-genital ducts.		
Unit 6: Skeletal system		8
Jaw suspension in vertebrates; A brief account of axial skeleton and appendicular skeleton: types of skull with reference to temporal vacuities; vertebrae (structure, types based on centrum and regional specialization in mammals); structure of girdles (pectoral and pelvic girdles of Pigeon and Guinea pig) and limb bones (Toad, Pigeon and Guinea pig).		

Chordate Structure and Function Lab; CC-9-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> 1. Identification (upto order) with Reasons (Preserve specimen or Photograph) Protochordata: <i>Herdmania</i>, <i>Branchiostoma</i>, Agnatha: <i>Petromyzon</i>, <i>Myxine</i>; Pisces: <i>Scoliodon</i>, <i>Pristis</i>, <i>Hippocampus</i>, <i>Echeneis</i>, <i>Tetradon</i>, <i>Taractes</i>; <i>Tenulosa</i>, <i>Wallagu</i>, <i>Ompok</i>; Amphibia: <i>Necturus</i>, <i>Duttaphrynus</i>, <i>Rhacophorus</i>, <i>Hoplobatrachus</i>, <i>Ambystoma</i>, <i>Tylotriton</i>, ; Reptilia: <i>Chelone</i>, <i>Hemidactylus</i>, <i>Varanus</i>, <i>Calotes</i>, <i>Chamaeleon</i>, <i>Draco</i>, <i>Vipera</i>, <i>Hydrophis</i>, <i>Bungarus</i>; Aves: <i>Columba</i>, <i>Psittacula</i>, <i>Passer</i>, <i>Alcedo</i> Mammalia: <i>Sorex</i>, Bat (Insectivorous and Frugivorous), <i>Funambulus</i>, <i>Cavia</i>. 2. Mounting of Placoid, Cycloid and Ctenoid scales. 3. Osteology: Identification of Limb bones, vertebrae and girdles of <i>Duttaphrynus</i>, <i>Columba</i>, <i>Cavia</i>; skull of <i>Duttaphrynus</i>, <i>Trionyx</i>, <i>Columba</i>, <i>Cavia</i>, <i>Canis</i>. 4. Comparative study of heart and brain, with the help of model/pictures. 5. Anatomy study: Brain, pituitary, olfactory apparatus (ex situ), digestive and urino-genital system of <i>Tilapia</i> 6. Pecten from Fowl head. 7. LNB 		

PART III: SEMESTER V

CORE COURSE-10: Endocrinology and Reproductive Biology CC 10 THEORY

Full Marks 75	3 Credits	40 Hours
Unit 1: Introduction to Endocrinology		2
General idea of Endocrine system; Classification (with examples) & Transport of Hormones.		
Unit 2: Hypothalamo-Hypophyseal Axis		5
Hypothalamic nuclei: Name, Secretion and Function; Feedback mechanism with Hypothalamo-hypophyseal – gonadal axes. Chromophobes and chromophils of anterior pituitary with their hormone and functions, Posterior pituitary: hormones and functions in brief, Hypothalamo-hypophyseal portal system.		
Unit 3: Regulation of Hormone Action		5
Receptors: Steroid hormone receptor, Isoreceptor, Orphan receptor Mechanism of action of steroidal, non-steroidal hormones with receptors (cAMP, IP3-DAG)		
Unit 4: Thyroid gland and parathyroid gland		5
Histology of thyroid gland (LM and TEM study); Biosynthesis of thyroxine; Role of thyroxin in calorigenesis and metabolism (carbohydrate, protein and fat). Role of thyrocalcitonin and parathormone in calcium homeostasis with special emphasis on vitamin D3.		
Unit 5: Adrenal gland		5
Histology of adrenal gland (LM study), Corticoid hormones with source, structure and function, Biosynthesis of adrenaline and nor adrenaline, Function of adrenaline; Generalised Adaptation Syndrome.		
Unit 6: Pancreas		5
Histology of pancreas (LM study) mentioning cell types with their hormone and function, Biosynthesis of insulin, Role of insulin and glucagon on carbohydrate homeostasis.		
Unit 7: Pineal gland		3
Histology of pineal gland (TEM study), Melatonin: Biosynthesis and its role in vitellogenesis in fish.		
Unit 8: Reproductive endocrinology		5
Histology of testis and ovary (LM study), Biosynthesis of estrogen and testosterone, Effect of testosterone on prostate function, Effect of estrogen on uterus. Lactation and its hormonal control Parturition and its hormonal control		
Unit 9: Endocrine disorders		2
Cause, Symptoms and Treatment: Graves' disease, Type I and type II diabetes, Cushing Syndrome		
Unit 10: Endocrine regulation of insect metamorphosis		3
Endocrine glands; hormones and physiology of metamorphosis in insects		

Endocrinology and Reproductive Biology Lab; CC-10-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> 1. Demonstration to localize thyroid, pancreas, adrenal, ovary and testis in rat. 2. Identification with reasons: Histological section of thyroid, pancreas, adrenal, ovary and testis of rat. 3. Analysis and interpretation of clinical condition from the provided blood sample data <ol style="list-style-type: none"> a) T₃, T₄, TSH and TPO b) Insulin, blood glucose and HbA1C 4. Haematoxylin-Eosin (HE) staining of histological section: Mammalian thyroid, adrenal, pancreas, testis and ovary. 5. LNB 		

PART III: SEMESTER V

CORE COURSE-11: Animal Physiology

CC 11 THEORY

Full Marks 75	3 Credits	45 Hours
Unit 1: Physiology of Digestion		6
Anatomy of alimentary system in human; Mechanical digestion and chemical digestion of Carbohydrates, Lipids and Proteins in Human; Absorption of simple sugars, amino acids and fat; Role of GI hormones in digestion: source and function of Gastrin, Secretin, CCK – PZ, Motilin.		
Unit 2: Physiology of Respiration		6
Anatomy of respiratory system in human; Mechanism of breathing; Pulmonary volumes and capacities; Transport of Oxygen and Carbon dioxide in blood; Oxygen Dissociation curve and the factors influencing it (Bohr effect and Haldane effect); Carbon monoxide poisoning.		
Unit 3: Physiology of Circulation		8
Structure of hemoglobin, R and T form of hemoglobin; Hemostasis and Mechanism of blood clotting [pathways and clotting factors (I -XIII)]; Hematopoiesis: Basic steps; Blood groups: ABO and Rh factor; Erythroblastosis foetalis, Bombay phenotype; Structure of human heart and conducting system of human heart; Cardiac Cycle and its events: Cardiac output and Strokes volume.		
Unit 4: Renal Physiology		8
Anatomy of Kidney and histology of nephron with reference to JGA; Ammonotelic, ureotelic and Uricotelic animals with examples; Steps of urea cycle; Mechanism of urine formation: Glomerular filtration, obligatory and facultative water reabsorption and sodium dependent reabsorption, Counter-current mechanism; Role of ADH and RAAS in urine formation; Osmoregulation in marine (elasmobranch and teleost) and freshwater (teleost) fishes; Case study: Osmoregulation in Eel and Salmon.		
Unit 5: Neurophysiology		5
Structure of neuron; Mechanism of impulse propagation across the myelinated and non-myelinated nerve fibres; Synapse: Chemical and Electrical; Mechanism of Synaptic transmission.		
Unit 6: Muscular physiology		5
Structure of muscle protein and their role along with calcium and ATP in muscle contraction (excitation-contraction-coupling); Muscle twitch, Muscular fatigue.		
Unit 7: Thermoregulation		3
Definition and example of Aestivation and hibernation; Thermoregulation in camel, polar bear.		
Unit 8: Reproductive physiology		4
Menstrual cycle: stages with ovarian, uterine and hormonal changes. Estrous cycle: Stages with ovarian, vaginal and hormonal changes.		

Animal Physiology Lab; CC-11-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> 1. Determination of ABO Blood group and Rh factor. 2. Identification of blood cells from human blood film (permanent slide). 3. Staining, mounting and identification of haemocytes from cockroach haemolymph. 4. Preparation of haemin crystals from rat blood. 5. Demonstration of blood pressure by digital meter. 6. Qualitative tests for Ammonia, Urea and Uric acid in given sample. 7. LNB 		

PART III: SEMESTER V

CORE COURSE-12: Biodiversity and Conservation Biology CC 12 THEORY

Full Marks 75	3 Credits	45 Hours
Unit 1: Introduction to Biodiversity		10
Definition, Biodiversity Values: Direct and Indirect values, Types of Biodiversity, Depicting Species Diversity at alpha diversity, beta diversity and gamma diversity; Biodiversity indices: Shannon diversity index, Simpson's diversity indices; Genetic Diversity: significance in Biodiversity persistence, Consequences of loss of Genetic diversity; Ecosystem diversity: Basic concept of Structural and Functional Diversity with significance; Mega-diversity countries; Concept of endemism and Biodiversity Hot spot; Indicator Species, Flagship species, Keystone species, Umbrella species (definition with examples).		
Unit 2: Threats to biodiversity		7
Habitat loss, Habitat Degradation, Habitat Fragmentation and Edge effects in Ecotonal communities; Overexploitation of Natural Resource; Concept of Exotic or Invasive Species; Climate change: Cause and effects on Forest and Marine Ecosystems; Climate change effect on Indian Fauna.		
Unit 3: Wild life conservation. In situ Conservation.		15
Definition of Conservation; Red data book (Extinct, Threatened, Endangered, Rare, and Vulnerable); Indian Wild life Protection Act, 1972 and Schedules I -V (mammalian examples any 2); Concept of Population Viability Analysis. Wildlife Conservation methods: In Situ Conservation; Concept and Design of Protected Areas, National Park, Wildlife Sanctuary, Biosphere reserves (with examples); Tiger Project; Elephant Project; (History, Objective, Implementation, Tiger Crisis); Concept of Corridors; Advantages and disadvantages of Wildlife corridors; Causes and consequences of Human-wildlife conflicts; Mitigation of conflict – an overview; Joint Forest Management; People's Biodiversity Register.		
Unit 4: Ex situ Conservation.		7
Captive breeding of wild animals: Concept of captive breeding; Advantages and challenges of Captive Breeding; Re-introduction.		
Unit 5: Wildlife Laws		7
Convention on Biodiversity; Biodiversity Act, 2002 and Rules 2004 (Basic Concept); Wildlife trade and impacts: The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and Wildlife Trade Monitoring Network (TRAFFIC); IUCN, WWF (Basic concept).		

Biodiversity and Conservation Biology Lab; CC-12-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none">1. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance: Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various DSLR Camera.[Photographs may be used]3. Familiarization and study of animal secondary evidences (through photographs); Identification of animals through pug marks of tiger and leopard, hoof marks of deer and elephant, scats of tiger and elephant, antler and horn4. Biodiversity study of in any one of the ecosystems of West Bengal (Study A is mandatory and any two studies from the rest)<ol style="list-style-type: none">A. Check list of fauna should be prepared along with calculation of any diversity index.B. Bird Count using line transect.C. Tree height measurement,D. Measurement of canopy cover.E. Butterfly Sampling.F. Pitfall samplingG. Quadrat Sampling5. LNB		

PART III: SEMESTER-VI

CORE COURSE-13: Developmental Biology CC 13 THEORY

Full Marks 75	3 Credits	43 Hours
Unit 1: Gametogenesis		5
Origin and fate of Primordial Germ Cells; Structure of mammalian sperm and ovum; Spermatogenesis in mammals, Stages of Spermiogenesis, Spermiation; Oogenesis in mammal; Composition of yolk and polarity and types of egg (based on amount of yolk and its distribution).		
Unit 2: Fertilization		4
Internal and external fertilization; Phases of fertilization in sea urchin and mammal.		
Unit 3: Post Fertilization events		10
Cleavage: Types based on plane and pattern, Role of yolk in cleavage. Blastula formation in chick. Gastrulation: Definition, Morphogenetic movement (epiboly, emboly, invagination, ingression, involution, delamination) with special reference to Nieuwkoop centre and Koller's sickle; Process of gastrulation in chick; Process of Gastrulation in frog; Fate map in chick embryo, fate mapping using vital dye technique. Extra embryonic membranes in chick and their functions.		
Unit 4: Organogenesis		8
Induction and its types; Organizer concept, Competence, Spemann and Mangold experiment as Origin of organizer concept; Concept of molecular nature of organizer molecules (signaling/molecular mechanism excluded). Development of eye in chick: retina, optic cup, lens with special reference to induction. Development of Kidney: Different phases and reciprocal induction.		
Unit 5: Implantation		4
Implantation in humans: Types and hormonal control. Placenta: Structure, types based on histological association and distribution of villi; functions of placenta.		
Unit 6: Infertility and ART		4
Causes of infertility; Types of ART (ZIFT, GIFT, ICSI, IUI); Cryopreservation of gametes; IVF: method, advantages and disadvantages.		
Unit 7: Stem cells and its application		4
Definition, Types with examples, concept of potency, applications of stem cell therapy in bone marrow transplantation and cartilage regeneration.		
Unit 8: Regeneration		4
Regeneration: Morphallaxis and Epimorphosis in <i>Hydra</i> ; Epimorphic limb regenerations in Salamander.		

Developmental Biology Lab; CC-13-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> Study of whole mounts of developmental stages of chick embryo through permanent slides: 24, 48, 72 and 96 hours of incubation Study of the developmental stages and life cycle of <i>Drosophila</i> and frog using photographs Study of different sections of placenta (photograph) Identification of larva through slides – <i>Nauplius</i>, <i>Zoea</i>, <i>Veliger</i>, <i>Glochidium</i>, <i>Megalopa</i>, <i>Mysis</i>, <i>Trochophore</i>. Mounting of rat sperm and fish ova LNB 		

PART III: SEMESTER VI

CORE COURSE-14: Taxonomy, Evolution and Adaptation CC 14 THEORY

Full Marks 75	3 Credits	45 Hours
Unit 1: Taxonomy 1: Basics of Taxonomy and Systematics		5
<p>Taxonomy and Systematics: definition and importance; Binomial and Trinomial nomenclature; Law of priority; Homonymy and Synonymy: definition with example. Taxonomic types: Holotype, Paratype, Allotype, Lectotype, Neotype and Syntype: definition with example; Linnean Hierarchy; Biological Species concept and its limitations.</p>		
Unit 2: Taxonomy 2: Character and Character states		3
<p>Types of characters with examples: Primitive, Advance, convergence, parallelisms, reversal of characters; Outgroup and ingroup; Homology versus Analogy; Monophyly, Polyphyly and Paraphyly: definition with examples.</p>		
Unit 3: Taxonomy 3: Approaches in Classification		6
<p>Classification: Definition; Phenetics: Definition, OTU, Single linkage clustering and construction of phenogram; Cladistics: Definition, brief concept on parsimony; DNA Barcoding and application.</p>		
Unit 4: Evolution 1: Gene frequency in a Population and Factors influencing gene frequency		8
<p>Hardy-Weinberg Principle: Assumption, proof of equilibrium, calculation of gene frequency and genotype frequency (for autosomal gene only), testing for equilibrium; Equilibrium destabilizing forces: concept and mathematical expression of Selection (against deleterious recessive allele only); Mutation (changes from dominant to recessive allele only) and Migration.</p>		
Unit 5: Evolution 2: Concept of Organic Evolution		7
<p>Biochemical Origin of life: concept of Protenoids, Microspheres and Protobionts; RNA-world Hypothesis; Darwinism and its limitations; Modern Synthetic Theory of Evolution: Sources of variation; Natural selection (types with example); Genetic drift and population bottle neck; Isolation (types with examples); Speciation: types and examples.</p>		
Unit 6: Evolution 3: Evidences		7
<p>Biogeographical realms: definition, names of six realms; geographical limit, climate and important vertebrate fauna of Oriental, Palaeartic and Australian realms; Geological time scale (only outline idea; detail description not needed); Fossil: types and age determination by Carbon dating; Evolution of horse; Evolution of Man.</p>		
Unit 7: Adaptation 1: Basics of adaptation		4
<p>Adaptation: definition; adaptive convergence, adaptive divergence: definition with examples; Adaptive radiation in marsupial mammals and Darwin's finches.</p>		
Unit 8: Adaptation 2: Form of adaptation		5
<p>Cursorial adaptation; Fossorial adaptation; Desert adaptation; Primary and secondary aquatic adaptation, Colouration and Mimicry.</p>		

Taxonomy, Evolution and Adaptation Lab; CC-14-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none"> Study of fossils from models/ pictures: <i>Dickinsonia</i>, <i>Paradoxides</i> (Trilobita), <i>Asteroceras</i> (Ammonoid), <i>Pentremites</i> (Blastoid Echinoderm), Ichthyosaur, <i>Archaeopteryx</i>, Cynodont. Study (from preserved specimen or photographs) of features and their adaptive significance : <i>Labeo rohita</i>, <i>Exocoetus</i> sp.(Flying fish), <i>Cynoglossus</i> sp. (Flat fish, Bengal tongue-sole), <i>Torpedo</i> sp. (Electric ray), <i>Himantura</i> sp. (Sting-ray of Bay of Bengal), <i>Sphyrna</i> sp. (hammer-headed shark), <i>Ichthyophis</i> sp., 		

Axolotl larva of *Ambystoma* sp., *Hyla* sp., *Phrynosoma* sp., *Crocodylus* sp., *Naja* sp., *Pipistrellus* sp. (Indian common Microchiroptera), *Bandicota* sp., *Platinista* sp. (Gangetic dolphin), *Semnopithecus* sp. (Hanuman Langur).

3. *Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony, Construction of dendrogram following principles of phenetics & cladistics from a data table.
4. *Calculation of change in gene frequency in population due to Selection (against deleterious recessive trait only), Mutation (changes from dominant to recessive trait only), Migration.
5. **LNB.**

*Only for major course students

PART III: SEMESTER VI

CORE COURSE-15: Animal Behaviour CC 15 THEORY

Full Marks 75	3 Credits	44 Hours
Unit 1: Introduction to Animal Behaviour		5
Contribution of Konrad Lorenz, Karl Von Frisch and Niko Tinbergen; Three foundations of behaviour study: Natural selection, individuals learning and cultural transmission; Approaches in behaviour study: Conceptual, theoretical and empirical.		
Unit 2: Patterns of Behaviour		6
Stereotyped Behaviours (Orientation and Reflex): Primary and secondary orientation; Kinesis-orthokinesis, klinokinesis; Taxis: tropotaxis and klinotaxis, menotaxis (light compass orientation). Sign stimulus and Fixed Action pattern in Stickleback; Individual Behavioural patterns; Instinct vs. Learned Behaviour; Associative learning, classical and operant conditioning; Habituation and Sensitisation; Imprinting: Filial and sexual imprinting.		
Unit 3: Social Behaviour		7
Advantage of group living; Eusociality, Social organisation in termites and Lion pride. Kinship theory: Relatedness & inclusive fitness. Altruism, Selfishness, Hamilton's rule, Reciprocal altruism. Cooperation and co-operative behaviours: Social grooming in Spider monkey, Group Hunting in Hyenas; Aggregations: schooling in fishes, flocking in birds.		
Unit 4: Sexual Behaviour		7
Sexual dimorphism; Courtship behaviour 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); Definition with example: Monogamy, polygamy and Polyandry.		
Unit 5: Evolutionary Strategies		8
Concept of Parental care and parental investment: Parental care in fishes: oviparity, viviparity and ovoviviparity, nest building behavior of fish and amphibia; Cost and benefit of parental care by male fish; Parent-offspring conflict, Infanticide; sexual conflict in parental care; Territorial behaviour in monkey. Evolutionary Stable strategies (ESS): Hawk–Dove Model.		
Unit 6: Biological Rhythm		5
Types and characteristics of biological rhythms; Photic and non-photic zeitgebers; Concept of synchronization and masking; Biological oscillation: the concept of Average, amplitude, phase and period; Adaptive significance of biological clocks. Circa annual rhythm: Case Study-Bird migration; Human biological clock (SCN and melatonin); Sleep-wake cycle and its hormonal regulation; Concept of biological cycle disorders in human (brief idea).		
Unit 7: Communication		6
Adaptive value of Communication: Example of yelling Raven and related hypothesis. Cost-benefits of Signal producer: Singer birds' advantage, coping with illegitimate receiver by frog. Chemical Communication: Pheromones in social insects: (trail, alarm, sexual, home range making and queen pheromones); Pheromones in Big-cat; Definition and examples of kiromones, Synomones, info-chemicals, semio-chemicals; Bruce effect, Lee boot effect and Whitten effect of pheromones. Tactile Communication: Bee dance language.		

Animal Behavior Lab; CC-15-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
<ol style="list-style-type: none">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 earthworm 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.4. To study circadian functions in humans (daily eating, sleep and temperature patterns).5. LNB		

SUGGESTED REFERENCES

CORE COURSE-9: CHORDATE STRUCTURE AND FUNCTION

1. Gaslow GE. Analysis of Vertebrate Structure, John Wiley and Sons
2. Jordan EL, Verma PS. 2003. Chordate Zoology. S. Chand & Company Ltd. New Delhi.
3. Kardong K V. 2005. Comparative Anatomy of Vertebrates, Function and Evolution; McGraw-Hill
4. Norman, J.R. A history of Fishes, Hill and Wang Publishers
5. Parker TJ, Haswell W. 1972. Text Book of Zoology, Volume II: Marshall and Willam Eds. Macmillan Pr.
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CORE COURSE-10: ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY

1. Gardner DG, Shoback D. 2011. Greenspan's Basic and Clinical Endocrinology. McGraw Hill Lange.
2. Hadley ME, Levine JE. 2009. 6th Edn. Pearson
3. Melmed S, Polonsky K, Larsen PR, Kronenberg H. 2016. William's Text Book of Endocrinology. Elsevier.
4. Molina PE. 2013. Endocrine Physiology. McGraw Hill Lange.
5. Norris DO. 2007. Vertebrate Endocrinology. 4th Edn. Elsevier Academic Press
6. Strauss JF, Barbieri RL. 2014. Yen & Jaffe's Reproductive Endocrinology. Elsevier Saunders

CORE COURSE-11: ANIMAL PHYSIOLOGY

1. Ganong's Review of Medical Physiology; McGraw Hill
2. Hall JE. 2015. Guyton and Hall Textbook of Medical Physiology. Saunders publication.
3. Hill RW, Wyse GA, Anderson M. 2012. Animal Physiology. 3rd Edn. Sinauer Asso
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5. Sembulingam K, Sembulingam P. 2012. Essentials of Medical Physiology. Jaypee Pub, New Delhi
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7. Tortora, G.J. and Derrickson, B.H.; 2009. Principles of Anatomy and Physiology, XII Ed, Wiley and Sons, Inc.

CORE COURSE-12: BIODIVERSITY AND CONSERVATION BIOLOGY

1. Caughley G, Sinclair ARE. 1994. Wildlife Ecology and Management. Blackwell Science
2. Hunter ML, Gibbs JB, Sterling EJ. 2008. Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing
3. Hunter, M. L., J. James & P. Gibbs – Fundamentals of Conservation Biology – John Willey & Sons.
4. Maiti, P. K. and P. Maiti (2017) Biodiversity: Perception, Peril and Preservation in the Indian Perspective. PHI. Leaning Pvt. Ltd. New Delhi. ISBN 978 – 81-203-4380-1, (3rd Eds)
5. Majupuria T. C. – Wildlife of India – Techpress, Bangkok
6. Mukherjee A. K. – Endangered animals of India – Z.S.I
7. New T. R. – Invertebrate Surveys for Conservation – Oxford Univ. Pr
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14. Wilson, E. O. – Biodiversity – National Academic Press Woodroffe R., Thirgood S, Rabinowitz A. 2005. People and Wildlife, Conflict or Co-existence? Cambridge Univ. P 2111

CORE COURSE-13: DEVELOPMENTAL BIOLOGY

1. Carlson BM. 2014. Human Embryology and Developmental Biology. 5th Edn. Elsevier.
2. Gilbert S.F. 2010. Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers,
3. Slack JMW. 2012. Essential Developmental Biology. Wiley-Blackwell.

4. Wolpert L. 2002. Principles of Development. 2nd Edn. Oxford Univ. Press.

CORE COURSE-14: TAXONOMY, EVOLUTION AND ADAPTATION

1. Mayr, E. and Ashlock, P.D. (1992) Principles of Systematic Zoology (2ND Edn.). McGraw Hill, New York
2. Quicke, D.L.J. (1997) Principles and Techniques of Contemporary Taxonomy. (1st Edn) Blackie Academic & Professional, an imprint of Chapman & Hall, London
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CORE COURSE-12: ANIMAL BEHAVIOR

1. Alcock J. 2013. Animal Behaviour, Sinauer Associate Inc., USA.
2. Drickamer LC , Vessey SH . 2001. Animal Behaviour. McGraw-Hill
3. Dugatkin LA. 2014. Principles of Animal Behaviour. 3rd Edn. W.W. Norton and Co.

UNIVERSITY OF CALCUTTA

MODALITIES OF INTERNSHIP IN ZOOLOGY

Guidelines for the Summer Internship/Apprenticeship Programme (of 3 years Credits) for the students of Zoology

DURATION OF INTERNSHIP:

15 days (60 working hours) from 16th May to 30th May each year

FULL MARKS: 75 MARKS

Students may undergo internship/apprenticeship in a farm/industry/organization or training in the laboratories under the supervision of any faculty members/researchers in their OWN/other HEIs/research Institutions/ during the summer term. One/two/more of the following activities can be chosen during the training period.

ACTIVITIES

1. Biodiversity study of birds/butterfly/insects - campus/local area
2. Laboratory exposure [self/other HEI Institutes] inclusive of
 - a. Laboratory reagents Preparation
 - b. Handling of Instruments
 - c. Museum maintenance [preserving and cataloging specimens]
 - d. Data analysis
 - e. Report Preparation
3. Field based survey/minor projects to study any branch of Zoology/Allied sciences [like Ecological survey/Epidemiological study/Nutritional assessment of the local area of the candidate.
4. Service-Learning projects involving community on any aspect of Zoology [examples: Water quality assessment of community; Assessment of vectors of a particular locality for any given human diseases etc.]

FOR EXAMINATION:

- On completion of the Summer Internship Programme, the students will submit a report with relevant photographs as part of the report and inclusive of an Attendance Document and an **Authenticated Certificate** jointly signed by the **Supervisor/Mentor** and the **Head of the Institution**.
- The report is to be signed by the Supervisor/Mentor with official seal.
- A viva-voce will be conducted by the Department with 1 Faculty acting as Internal Examiner and 1 External Examiner Appointed from Calcutta University
- **The following Marks distribution is to be followed for evaluation**
 1. Submission of report: **50 marks**
 2. Viva Voce: **25 marks**