

Outline Structure of NEP Curriculum for Zoology, C.U

PARTI;SEMI

SUBJECT CODE	COURSE	NAMEOFPAPER	THEORY	PRACTICAL
DSCC1	ZOOM	Cell Biology	75	25
SEC-1	ZOOM	Applied Entomology	75	25
MN1	MZOO	Cell Biology	75	25
CC1	MZOO-MDC-CORE	Cell Biology	75	25
SEC-G	MZOO-MDC-CORE	Applied Zoology	75	25
IDC1	ZOOD	Animal Biology	50	25

PARTI;SEMII

SUBJECT CODE	COURSE	NAMEOFPAPER	THEORY	PRACTICAL
DSCC2	ZOOM	Biochemistry	75	25
SEC-2	ZOOM	Aquaculture	75	25
MN2	MZOO	Biochemistry	75	25
CC2	MZOO-MDC-CORE	Biochemistry	75	25
SEC-G	MZOO-MDC-CORE	Applied Zoology	75	25
IDC2	ZOOD	Animal Biology	50	25

PARTII;SEMIII

SUBJECT CODE	COURSE	NAMEOFPAPER	THEORY	PRACTICAL
DSCC3	ZOOM	Genetics	75	25
DSCC4	ZOOM	Cells & Tissue Structure	75	25
SEC-3	ZOOM	Poultry farming & Animal Husbandry	75	25
MN1	MZOO	Cell Biology	75	25
CC3	MZOO-MDC-CORE	Cells & Tissue Structure	75	25
CC1	MZOO-MDC-Minor	Cell Biology	75	25
IDC-3	ZOOD	Animal Biology	50	25

PARTII;SEMIV

SUBJECT CODE	COURSE	NAMEOFPAPER	THEORY	PRACTICAL
DSCC5	ZOOM	Non-chordate structure & function	75	25
DSCC6	ZOOM	Parasitology	75	25
DSCC7	ZOOM	Molecular Biology	75	25
DSCC8	ZOOM	Ecology	75	25
MN2	MZOO	Biochemistry	75	25
CC4	MZOO-MDC-CORE	Non-chordate structure & function	75	25
CC5	MZOO-MDC-CORE	Ecology	75	25
CC2	MZOO-MDC-Minor	Biochemistry	75	25

PARTIII;SEM V

SUBJECT CODE	COURSE	NAMEOFPAPER	THEORY	PRACTICAL
DSCC9	ZOOM	Chordate structure & function	75	25
DSCC10	ZOOM	Endocrinology & Reproductive biology	75	25
DSCC11	ZOOM	Animal Physiology	75	25
DSCC12	ZOOM	Biodiversity & Conservation Biology	75	25

MN3	MZOO	Cells & Tissue Structure	75	25
MN4	MZOO	Non-chordate structure & function	75	25
CC6	MZOO-MDC-CORE	Chordate structure & function	75	25
CC7	MZOO-MDC-CORE	Biodiversity & Conservation Biology	75	25
CC3	MZOO-MDC-Minor	Cells & Tissue Structure	75	25
CC4	MZOO-MDC-Minor	Non-chordate structure & function	75	25

PARTIII;SEMVI

SUBJECT CODE	COURSE	NAMEOF PAPER	THEORY	PRACTICAL
DSCC13	ZOOM	Developmental Biology	75	25
DSCC14	ZOOM	Taxonomy , Evolution & Adaptation	75	25
DSCC15	ZOOM	Animal Behavior	75	25
MN3	MZOO	Cells & Tissue Structure	75	25
MN4	MZOO	Non-chordate structure & function	75	25
CC7	MZOO-MDC-CORE	Biodiversity & Conservation Biology	75	25
CC8	MZOO-MDC-CORE	Taxonomy, Evolution & Adaptation	75	25
CC5	MZOO-MDC-Minor	Ecology	75	25
CC6	MZOO-MDC-Minor	Chordate structure & function	75	25
CUSUMMER INTERNSHIP		ASPERUGBOSINSTRUCTIONS	75[3 credits]	

PARTIV;SEMVII

SUBJECT CODE	COURSE	NAMEOF PAPER	THEORY	PRACTICAL
DSCC16	ZOOM	Biotechnology & its Application	75	25
DSCC17	ZOOM	Neurobiology	75	25
DSCC18	ZOOM	Toxicology	75	25
DSCC19	ZOOM	Immunology	75	25
DSCC20	ZOOM	Animal Models in Research	75	25

PARTIV;SEMVIII[WITHOUTRESEARCH]

SUBJECT CODE	COURSE	NAMEOF PAPER	THEORY	PRACTICAL
DSCC21	ZOOM	Research Methodology I	75	25[VIVA]
DSCC22	ZOOM	Research Methodology II	75	25[VIVA]
DSCC23	ZOOM	Biophysics & Lab Techniques	75	25
DSCC24	ZOOM	Disease Biology & Public Health	75	25
DSCC25	ZOOM	PROJECT	75	25

PARTIV;SEMVIII[WITHRESEARCH]

SUBJECT CODE	COURSE	NAMEOF PAPER	THEORY	PRACTICAL
DSCC21	ZOOM	Research Methodology I	75	25[VIVA]
DSCC22	ZOOM	Research MethodologyII	75	25[VIVA]
DSCC23	ZOOM	Research Internship [Dissertation Oriented Technique]	75	25
DSCC24	ZOOM	Dissertation Individual Based Projects	150	50

**OUTLINE STRUCTURE OF NEP CURRICULUM FOR MULTIDISCIPLINARY COURSE (MDC)
SUBJECT ; ZOOLOGY (CORE/MINOR)**

PRAT I, SEM I						
	MDC ZOOLOGY CORE		MDC ZOOLOGY MINOR			
CC1	CELL BILOGY				75	25
PART I, SEM II						
CC2	BIOCHEMISTRY				75	25
PART II, SEM III						
CC3	CELL AND TISSUE STRUCTURE		CC1	CELL BIOLOGY	75	25
PART II, SEM IV						
CC4	NONCHORDATE STRUCTURE AND FUNCTION		CC2	BIOCHEMISTRY	75	25
CC5	ECOLOGY				75	25
PART III, SEM V						
CC6	CHORDATE STRUCTURE AND FUNCTION		CC3	CELL AND TISSUE STRUCTURE	75	25
CC7	BIODIVERSITY AND CONSERVATION BIOLOGY		CC4	NONCHORDATE STRUCTURE AND FUNCTION	75	25
PART III, SEM VI						
CC7	BIODIVERSITY AND CONSERVATION BIOLOGY		CC5	ECOLOGY	75	25
CC8	TAXONOMY, EVOLUTION AND ADAPTATION		CC6	CHORDATE STRUCTURE AND FUNCTION	75	25
CU SUMMER INTERNSHIP	AS PER UNIVERSITY AND COLLEGE INSTRUCTION		CU SUMMER INTERNSHIP	AS PER UNIVERSITY AND COLLEGE INSTRUCTION	75 [3CREDITS]	

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

Students who will take Zoology as **Core subject** will have option to study MZOO-CC7 "Biodiversity and Conservation Biology" either in SEM V (if opted as **Core Course 1**) or in SEM VI (if opted as **Core Course 2**), and they have to study total eight (8) paper . Students who will opt Zoology as minor subject will study six (6) papers as mentioned in the table.

PART I: SEMESTER-I

CORE COURSE-1: Cell Biology [DSCC-1 Theory]

Full Marks 75	3 Credits	46 Hours
Unit 1: Plasma Membrane		8
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		8
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: 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 7: DNA Replication		10
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 8: Tools and Techniques in Cell Biology		4
- 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; DSCC-1-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
- Cell viability study by Trypan Blue Exclusion method. - Standardization of Ocular and Stage Micrometer and Measurement of cell or microscopic specimen such as <i>Paramecium</i> sp. - Preparation of squamous epithelial cell with staining. - Isolation of Bone Marrow Cells from Rat/Mouse and Giemsa Staining. - LNB		

PART I: SEMESTER-I

SEC-1: Applied Entomology Theory

Full Marks 75	3 Credits	43 Hours
Unit 1 Basics of Entomology		11
Morphological adaptation of insects: Head and antenna; Mouthparts of honey bee and cockroach; Thorax and thoracic appendages- legs and wings [General concept]. Physiological adaptation in cockroach: Digestive system: Alimentary canal and digestive glands, digestion; Respiratory organs and mechanism of gaseous exchange; Sense organs compound eyes, chemoreceptors. General Characteristics of Class Insecta and living orders with examples: Orthoptera, Dictyoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera, Hymenoptera, Anoplura (Imms, A.D., 1938)		
Unit 2 Medical Entomology		11
Concept of Vectors: Carrier and biological vectors, modes of transmission with special reference to Malaria Dengue, and Filaria; Control measures of vectors Ticks as Causative agents and Vectors: Rickettsiosis, Tick-borne encephalitis; General outline of Mites and their medical significance. Phlebotomus sp: Characteristics, Biology and mode of transmission of visceral leishmaniasis; control measures.		
Unit 3 Agricultural Entomology		11
Insect Pest: Definition and types; Economic Injury Level (EIL), Economic Threshold Level (ETL), Dynamics of EIL; 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> ; Insect Pest control: Chemical (classification and mode of action) and Biological control measures; Integrated Pest Management (IPM)		
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		
- 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): - 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 [DSCC-2 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 V_{max} and K_m		
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 9: Free radicals and Antioxidants		1
Concept of free radicals and antioxidants with examples.		

Biochemistry Lab; DSCC-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, Benedict test, Barfoed 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 Theory

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		
Identification of different fish species using Meristic characters. (Systematic position, specimen characters) Rohu, Catla, Cirrhinus, Puntius, Amblypharyngodon, Channa punctatus, Lates, Mystus, Notopterus, Cyprinus, Hypophthalmichthys, Ctenopharyngodon, Oreochromis niloticus, Oreochromis mossambicus, Anabas, Clarias, Heteropneustes, Mugil, Macrobrachium, Penaeus. Visit to nearby fish market and identification of economically important fishes, survey on market economy and preparation of report on it. LNB		

SUGGESTED REFERENCES

DISCIPLINE SPECIFIC 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**

DISCIPLINE SPECIFIC 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 Kuty. (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	2 Credits	45 Hours
Unit 1: Animal Diversity		10
Phylum Characters and example: [Non-chordates-Porifera, Cnidaria, Ctenophora, Platyhelminthes, Nemathelminthes, Annelida, Arthropoda, Mollusca and Echinodermata]; Chordata		
Unit 2: Genetics		12
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
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
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
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		
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		
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 [DSCC-3 Theory]

Full Marks 75	3 Credits	46 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		8
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: Sex Determination in mammals		4
Sex determination in man and Dosage Compensation in mammals		
Unit 9: 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; DSCC-3-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
1. Chi-Square Test - Test for Goodness of fit – Mendelian monohybrid and di-hybrid ratios, *Epistatic ratios; Contingency Chi-Square Test		
2. 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.		
3. Pedigree Analysis of some inherited traits in Human (Autosomal, X-linked and Y-linked).		
4. Temporary squash preparation of Grasshopper testis to study various stages of meiosis.		
5. LNB		
*Only for major course students		

PART II: SEMESTER-III

CORE COURSE-4: Cells and Tissue Structure [DSCC-4 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 and modifications; Apical domain, Basal domain & Lateral domain. Clinical correlation: Epithelial metaplasia.		
Unit 3: Connective Tissue		14
Salient features with respect to cell types and fibers and Extracellular Matrix in context to Connective tissue; 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; DSCC-4-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
1. Preparation, staining and mounting of the following - Epithelial tissue from vaginal smear of rat using methylene blue. - Connective tissue from blood film of rat using Giemsa. - 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 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		
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, Haryana, 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 [DSCC-5 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>Paramoecium</i> and <i>Amoeba</i> ; Asexual reproduction and Conjugation in <i>Paramoecium</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; DSCC-5-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
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: <i>Periplaneta</i> sp.: Salivary apparatus with hypothalamus, Mouth parts, Nervous system, Male and female Reproductive systems. Laboratory culture and whole mount of <i>Paramoecium</i>/<i>Euglena</i>/<i>Amoeba</i> LNB		

PART II: SEMESTER-IV

CORE COURSE-6: Parasitology [DSCC-6 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; DSCC-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>Leidyneema</i> sp.) from gut of Cockroach (<i>Periplaneta americana</i>)		
5. LNB		

PART II: SEMESTER-IV

CORE COURSE-7: Molecular Biology [DSCC-7 Theory]

Full Marks 75	3 Credits	48 Hours
Unit 1: Transcription		6
Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.		
Unit 2: 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 3: Translation		6
Genetic code; Characteristics of the Genetic Code; Aminoacylation of a tRNA molecule; Mechanism of protein synthesis in prokaryotes.		
Unit 4: 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 6: Cell Cycle		9
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 Signaling		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 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
- 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; DSCC-7-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
Isolation of genomic DNA from Goat Liver by phenol-chloroform method. Quantification of DNA by diphenylamine (DPA) method. Agarose Gel Electrophoresis. Concept of buffer preparation and related calculation and dilution. Instruments and accessories used to be shown by photographs for the following techniques: PCR, SDS PAGE, Western Blot, Southern Blot. LNB		

PART II: SEMESTER-IV

CORE COURSE-8: Ecology [DSCC-8 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 equilibria 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; DSCC-8-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
Quantitative Estimation of Dissolved O₂ (Winkler's method), Free CO₂, Alkalinity from the provided water sample and comment on the observation. Estimation of pH value of the provided water sample. Identification with reasons of the following zooplanktons: <i>Daphnia</i>, <i>Cyclops</i>, <i>Cypris</i> Identification with reasons of the following soil arthropods: Collembola, termite worker, ant Study of life table and survivorship curve from a hypothetical data set and comment on the results. 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
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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
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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.
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9. Gunn A, Pitt SJ. 2012. Parasitology: an Integrated Approach. Wiley Blackwell.
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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

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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.
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FOR LABORATORY COURSE.

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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.
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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 [DSCC-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 Micro-chiropterans.		
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; DSCC-9-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
- 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>Tenuialosa</i>, <i>Wallagu</i>, <i>Ompok</i>; Amphibia: <i>Necturus</i>, <i>Duttaphrynus</i>, <i>Rhacophorus</i>, <i>Hoplobatrachus</i>, <i>Ambystoma</i>, <i>Tylototriton</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>. - Mounting of Placoid, Cycloid and Ctenoid scales. - 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>. - Comparative study of heart and brain, with the help of model/pictures. - Anatomy study: Brain, pituitary, olfactory apparatus (ex situ), digestive and urino-genital system of <i>Tilapia</i> - Pecten from Fowl head. LNB		

PART III: SEMESTER V

CORE COURSE-10: Endocrinology and Reproductive Biology [DSCC-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 thyroxine in calorogenesis 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; DSCC-10-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
- Demonstration to localize thyroid, pancreas, adrenal, ovary and testis in rat. - Identification with reasons: Histological section of thyroid, pancreas, adrenal, ovary and testis of rat. - Analysis and interpretation of clinical condition from the provided blood sample data - T₃, T₄, TSH and TPO - Insulin, blood glucose and HbA1C - Haematoxylin-Eosin (HE) staining of histological section: Mammalian thyroid, adrenal, pancreas, testis and ovary. - LNB		

PART III: SEMESTER V

CORE COURSE-11: Animal Physiology [DSCC-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; DSCC-11-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
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 [DSCC-12 Theory]

Full Marks 75		3 Credits	46 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; DSCC-12-P

Full Marks 25		1 Credit	20 Hours
List of Practical			
1. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community 2. 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 horn 4. Biodiversity study of in any one of the ecosystems of West Bengal (Study A is mandatory and any two studies from the rest) 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 sampling G. Quadrat Sampling 5. LNB			

PART III: SEMESTER-VI

CORE COURSE-13: Developmental Biology [DSCC-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). Induction in : Neural Tube Formation and Development of Brain; Development of eye: retina, optic cup and lens. 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; DSCC-13-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
- 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 [DSCC-14 Theory]

Full Marks 75	3 Credits	45 Hours
Unit 1: Taxonomy 1: Basics of Taxonomy and Systematics		5
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.		
Unit 2: Taxonomy 2: Character and Character states		3
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.		
Unit 3: Taxonomy 3: Approaches in Classification		6
Classification: Definition; Phenetics: Definition, OTU, Single linkage clustering and construction of phenogram; Cladistics: Definition, brief concept on parsimony; DNA Barcoding and application.		
Unit 4: Evolution 1: Gene frequency in a Population and Factors influencing gene frequency		8
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.		
Unit 5: Evolution 2: Concept of Organic Evolution		7
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.		
Unit 6: Evolution 3: Evidences		7
Biogeographical realms: definition, names of six realms; geographical limit, climate and important vertebrate fauna of Oriental, Palaearctic 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.		
Unit 7: Adaptation 1: Basics of adaptation		4
Adaptation: definition; adaptive convergence, adaptive divergence: definition with examples; Adaptive radiation in marsupial mammals and Darwin's finches.		
Unit 8: Adaptation 2: Form of adaptation		5
Cursorial adaptation; Fossorial adaptation; Desert adaptation; Primary and secondary aquatic adaptation, Colouration and Mimicry.		

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

Full Marks 25		1 Credit	20 Hours
List of Practical			
- 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 <i>Ambystoma</i> sp., <i>Hyla</i> sp., <i>Phrynosoma</i> sp., <i>Crocodylus</i> sp., <i>Naja</i> sp., <i>Pipistrellus</i> sp. (Indian common Microchiroptera), <i>Bandicota</i> sp., <i>Platinista</i> sp. (Gangetic dolphin), <i>Semnopithecus</i> sp. (Hanuman Langur). *Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony, Construction of dendrogram following principles of phenetics & cladistics from a data table. *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. LNB.			
*Only for major course students			

PART III: SEMESTER VI

CORE COURSE-15: Animal Behaviour [DSCC-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; Situation 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 Behaviour Lab; DSCC-15-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
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
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CORE COURSE-10: ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY

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2. Hadley ME, Levine JE. 2009. 6th Edn. Pearson
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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.
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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 Wiley & 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. Majumuria T. C. – Wildlife of India – Techpress, Bangkok
6. Mukherjee A. K. – Endangered animals of India – Z.S.I
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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.
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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
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CORE COURSE-12: ANIMAL BEHAVIOR

1. Alcock J. 2013. Animal Behaviour, Sinauer Associate Inc., USA.
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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. Attendance: **15 marks**
 2. Assessment on work done during the Internship: **15 marks**
 3. Submission of report: **20 marks**
 4. Viva Voce: **25 marks**

PART IV: SEMESTER-VII

CORE COURSE-16: BIOTECHNOLOGY & ITS APPLICATION [DSCC-16 Theory]

Full Marks 75	3 Credits	46 Hours
Unit 1: Introduction and Molecular Techniques in Gene manipulation		8
Organization of <i>E.coli</i>; Recombinant DNA Technology, Restriction endonucleases. Cloning Vectors & their features: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, and HAC. Shuttle and Expression Vectors. Construction of Genomic libraries and cDNA libraries. Transformation techniques: Cloning in bacteria and detection technique of clone. Polymerase chain reaction: DNA Fingerprinting		
Unit 2: Genetically Modified Organisms		5
Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection.		
Unit 3: Culture Techniques and Applications		5
Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle Cell Anaemia). Dolly & Polly cloning. Gene Therapy		
Unit 4: Introduction to Bioinformatics		9
Overview of Bioinformatics: Definition, scope, and significance in modern biology and biotechnology; Types of molecular biological data: Genomic sequences; Protein sequences and structures; Gene expression data Biological Databases and Data Sources • Nucleotide Sequence Databases: NCBI GenBank; NCBI RefSeq (Ref.Sequence Database) • Protein Structure and Sequence Databases: RCSB PDB (Protein Data Bank) • Functional Gene Databases: GeneCards® – The Human Gene Database • Expression Data Repositories: NCBI GEO (Gene Expression Omnibus)		
Unit 5: Tools of Bioinformatics		9
Sequence Alignment and Comparative Genomics: Importance and applications in functional and evolutionary biology; Key Concepts: Similarity vs Homology; Homology, Paralogy, Orthology, Analogy, Xenology Sequence Alignment Techniques • Pairwise Alignment: Local and global alignment; Dot matrix method • Multiple Sequence Alignment (MSA): Purpose and significance; Tools: ClustalW Sequence Search • BLAST (Basic Local Alignment Search Tool): Working principle and types of BLAST • FASTA Format: Representation and structure for nucleotide and amino acid sequences Phylogenetic Analysis • Using sequence data to infer evolutionary relationships • Distance-Based Methods: ○ UPGMA (Unweighted Pair Group Method with Arithmetic Mean) ○ Neighbour Joining (NJ)		
Unit 6: Microbial Biotechnology		5
Food Production-Dairy products & probiotics, Pharmaceuticals-production of antibiotics and antifungals and Biofuel production		
Unit 7: Biosafety		5
Biosafety Principle: Primary and Secondary Barriers; Types of Risk (occupational, environmental, ethical) & Risk management process; Biosafety level (BSL-1 to BSL-4), Biosafety Cabinet, (I, II, III) Occupational health support of Biomedical Research, Personal Protective equipment (PPE)		

BIOTECHNOLOGY & ITS APPLICATION LAB; DSCC-16-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
7. Plasmid DNA isolation (pUC 18/19) from <i>E. coli</i> 8. BLAST Analysis - Performing BLASTn for nucleotide sequence similarity search. - Performing BLASTp for protein sequence similarity search. - Understanding and interpreting BLAST results: E-value, identity, and alignment score 9. Melting Temperature (T_m) Calculation of PCR Primers: Designing short oligonucleotide primers for PCR; Calculating melting temperature (T_m) using standard formulas or online tools. 10. Phylogenetic Tree Construction: Application of distance matrix methods-UPGMA (Unweighted Pair Group Method with Arithmetic Mean); Neighbour Joining (NJ) method 11. LNB Note: Each college department should have computer lab with software and internet support for the theory item Unit 5 and the the practical item of serial no. 2,3,4.		

PART IV: SEMESTER VII

CORE COURSE-17: NEUROBIOLOGY [DSCC-17 Theory]

Full Marks 75	3 Credits	45 Hours
Unit 1: Structures of Nervous System		9
Types of Invertebrates nervous system: Nervous system in Cnidarians (Nerve net of Hydra, medusa nerve net and pacemaker nerve in Aurelia), Ladder Annelida (Earth worm), and Insects (Cockroach), Mollusca (Octopus), Echinodermata (Asterias). General plan and organizations of central, peripheral and autonomic nervous system in Vertebrate. Different nuclei/lobes/areas and function of thalamus, hypothalamus, cerebellum, cerebral cortex and brainstem in Human.		
Unit 2: Nerve And Nerve-Muscle Physiology		5
Structure of neuromuscular junction and mechanism of neuromuscular transmission. Modulation of Synaptic transmission.		
Unit 3: Sensory Nervous System		8
Structure of retina, Photochemistry of vision and visual pathways, Modern concept of color vision, Structure and function of organ of Corti, Auditory pathways, Structure of gustatory and olfactory organs. Gustatory and olfactory pathways. Neuronal pathways carrying pain, thermal, touch and kinesthetic impulses. Corticospinal, corticobulbar and bulbo-spinal tracts carrying motor information from the brain to the periphery.		
Unit 4: Neurodevelopment And Higher Brain Functions		8
Neurogenesis, neuronal migration and neuronal differentiation in vertebrate models. Human Brain evolution. Brain and cognitive development. Neural control of Learning and Behaviour, Higher Brain Functions: Sleep, Memory, Emotions and Speech.		
Unit 5: Neurochemistry And Neuroendocrine System		5
Cellular and Molecular foundation of Neuro-biochemistry (Human): Neurotransmitters and Neuromodulators [Acetyl cholin, Dopamine, GABA, Serotonin, Nor-epinephrine and Glutamine and receptors for Acetylcholine., Blood brain barrier		
Unit 6: Tools In Neuroscience		5
Techniques and tools applicable in neuroscience: CT, MRI, PET, Optogenetics, Patch Clamp, EEG, Neural stimulation, Brain-computer interface.		
Unit 7: Neuropathology		5
Degeneration and regeneration of nerve fibers in Peripheral and Central Nervous System. Cellular and Molecular Mechanisms and genetics of the Neurological Diseases: Alzheimer's disease, Parkinson's Disease, Cerebral Stroke, Epilepsy, Muscular Dystrophy.		

NEUROBIOLOGY LAB; DSCC-17-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
1. Identification of CNS and PNS structures in animal models (Mouse/ Chick/ Zebrafish/ Drosophila). 2. Gross anatomy of Human brain and its different parts (with models). 3. Studying early, mid and late developmental stages of CNS in animal models (Chick, Zebrafish). 4. Identification of different brain areas in CT and MRI images. 5. LNB		

PART IV: SEMESTER VII
CORE COURSE-18: TOXICOLOGY [DSCC-18 Theory]

Full Marks 75	3 Credits	47 Hours
Unit 1: Introduction to Toxicology		10
Definition and Types of Toxin, Pollutants, Contaminants, Toxicants. Classification of toxic agents and their effects: Natural toxins, toxin derived from Plants [Alkaloids, Terpenes, Lectins, Saponins] and Animals [Neurotoxins, Hemotoxins, Cytotoxins]; Heavy metals [Chromium & Cadmium] Pesticides [Organochlorine and organophosphates], Microplastics. Acute toxicity, chronic toxicity, systemic toxicity, local toxicity (concept only); Scope of Toxicology		
Unit 2: Toxicants: Routes, Dose Toxicity test and influencing factors		10
Exposure to Toxicants. Routes and Sites of Exposure (Inhalation, Injection, Intestinal) Factors influencing toxicity. Species, Strains, Age, Sex, Nutritional Status, Environmental Stressors. Dose of toxicants: Measurement of Dose response relationship. Graded and Quantal Response; Cumulative response, Threshold limit, Toxicokinetics (Basic concept) Toxicity test – Acute toxicity test, Chronic toxicity test, Subacute toxicity test Concept of LC50, LD50 and EC50		
Unit 3: Xenobiotic Classification and Metabolism		7
Xenobiotics: Definition, types and significance Target organ toxicity: Hematotoxicity; Hepatotoxicity; Nephrotoxicity; Neurotoxicity Phases of Xenobiotic Metabolism [Phase-I; Phase-II; Phase-III Reaction; enzymes involved and 1 example for each]		
Unit 4: Action of Toxicants		10
Receptors, Mechanism of action of Lead, DDT Bioremediation in soil and aquatic system. Therapeutic Index Potency and Efficacy.		
Unit 5: Environmental Contaminants		6
Food additives [Metanll yellow, Argemone oil, Rhodamine B]; Bioindicators [Chironomid larva, Dragonfly, <i>Tubifex sp.</i>]. Genotoxicology: Definition, Effects, Molecular mechanisms and prevention of Acrylamide, Ethylene oxide, Formaldehyde, Acridine Orange and EMS.		
Unit 6: Endocrine Disruptors		4
Source, Types, Effects, Mechanism of action on behavior and neuroendocrine system: Phthalate; BPA; PCB; DDT; DES; and PAH		

TOXICOLOGY LAB; DSCC-18-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
- Study of Acute, Subacute and Chronic toxicity of Fomaldehyde on <i>Drosophila</i> larva. - Study of LC50 for 24, 48, 72, 96 hours of Temephos on mosquito larva. - Micronucleus study from Buccal Smear. - Demonstration of instruments used in monitoring air [air quality analyzers/ air filters/ measurement of SPM] and water pollution [water quality meters/TDS] through online images/videos. LNB		

PART IV: SEMESTER VII

CORE COURSE-19: IMMUNOLOGY [DSCC-19 Theory]

Full Marks 75	3 Credits	47 Hours
Unit 1: Introduction		5
Cells and Organs [Primary, Secondary and Tertiary] of the Immune system		
Unit 2: Innate and Adaptive Immunity		7
Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity [PAMPS & PRR], Adaptive immunity (Overview of the pathway of activation for Cell Mediated Immunity and Humoral Immunity).		
Unit 3: Antigens		4
Antigenicity and Immunogenicity, Immunogens, Adjuvants and Haptens, Factors influencing immunogenicity, B and T-Cell epitopes		
Unit 4: Immunoglobulins		7
Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA, RIA and Immunoprecipitation), Monoclonal antibody production		
Unit 5: Major Histocompatibility Complex		6
Structure and functions of MHC molecules. Processing of exogenous and endogenous antigens [Pathway only] Structure of T cell Receptor and its Signaling, T cell development & selection		
Unit 6: Cytokines		3
Types, properties and functions of cytokines.		
Unit 7: Complement System		4
Components and pathways of complement activation.		
Unit 8: Hypersensitivity		6
Gell and Coombs' classification and brief description of various types of hypersensitivities; Autoimmunity: Major factors that contribute to the development of autoimmunity; Genetic susceptibility and environmental triggers. Examples- Rheumatoid arthritis & Systemic lupus erythematosus.		
Unit 9: Vaccines & Immunotherapy		5
Various types of vaccines. Active & Passive immunization (Artificial and natural); Cancer immunotherapy: i) MABs in treating cancer; ii) cytokine augmentation; iii) therapeutic vaccines.		

IMMUNOLOGY LAB; DSCC-19-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
1. Widal test. 2. Demonstration of Lymphoid Organs (by picture). 3. Histological study of Bursa of Fabricius, Spleen, Thymus and Lymph nodes through slides/ photographs 4. Demonstration of ELISA, Immunoprecipitation and Ouchterlony method through photographs 5. LNB		

PART IV: SEMESTER VII
CORE COURSE-20: ANIMAL MODELS IN RESEARCH
[DSCC-20 Theory]

Full Marks 75	3 Credits	48 Hours
Unit 1: Concept of Animal Model and their Application in Research		6
Different Animal Models and their Advantage and Limitations Cnidaria; <i>C. elegans</i> ; <i>Drosophila</i> ; Starfish and Sea urchin; Zebra fish; Mouse, Rat and Monkey		
Unit 2: Cnidaria		6
- Classic Hydra Regeneration Experiments <i>Spemann, H. (1938). Embryonic Development and Induction. Yale University Press.</i> <i>Lenhoff, H.M., & Lenhoff, S.G. (1986). Hydra and the Birth of Experimental Biology: 1744. Boxwood Press.</i> - GFP Discovery in <i>Aequorea Victoria</i>; <i>Shimomura, O., Johnson, F.H., Saiga, Y. (1962). J. Cell. Comp. Physiol., 59(3), 223–239.</i>		
Unit 3: <i>C. elegans</i>		6
- Genetic Regulation of Organ Development & Programmed Cell Death). Nobel Prize: 2002 in Physiology or Medicine <i>Yuan, J., Shaham, S., Ledoux, S., Ellis, H.M., Horvitz, H.R. (1993). "The <i>C. elegans</i> cell death gene <i>ced-3</i> encodes a protein similar to mammalian interleukin-1β-converting enzyme." Cell, 75(4), 641–652.</i> - RNA Interference (RNAi) Discovery Nobel Prize: 2006 in Physiology and Medicine. <i>Fire, A., Xu, S., Montgomery, M.K., Kostas, S.A., Driver, S.E., & Mello, C.C. (1998). Potent and specific genetic interference by double-stranded RNA in <i>Caenorhabditis elegans</i>. Nature, 391(6669), 806–811.</i>		
Unit 4: <i>Drosophila</i>		10
- Sex determination and Dosage compensation - Cytological Demonstration of Crossing over [Sterns Experiment]; - Mullers experiment for Balanced -lethal system; Concept of Balancer; - Position effect variegation. - Concept of axis formation and homeotic gene in <i>Drosophila</i> - Characterization of BX-C: Discovery Nobel Prize. 1995 in Physiology or Medicine. <i>Lewis, E.B. (1978). A gene complex controlling segmentation in <i>Drosophila</i>. Nature, 277(5688), 565–570.</i>		
Unit 5: Starfish and Sea-urchin		6
Starfish: - Classic Starfish Larva Phagocytosis Experiment By Élie Metchnikoff. [Nobel Prize in Physiology or Medicine, 1908] <i>Metchnikoff, E. (1905). Immunity in Infective Diseases. Cambridge University Press.</i> Sea Urchin: - Tim Hunt – Discovery of Cyclins: Nobel Prize in Physiology or Medicine, 2001 (with Leland Hartwell & Paul Nurse) <i>Evans, T., Rosenthal, E.T., Youngblom, J., Distel, D., & Hunt, T. (1983). Cyclin: A protein specified by maternal mRNA in sea urchin eggs that is destroyed at each cleavage division. Cell, 33(2), 389–396.</i> - Understanding of acetyl-CoA as the universal intermediate in metabolism; cornerstone of the Krebs cycle. <i>Hans Adolf Krebs & Fritz Lipmann – Discovery of Coenzyme A. Nobel Prize in Physiology or Medicine, 1953. Lipmann, F. (1945). J. Biol. Chem., 160, 173–190.</i>		
Unit 6: Zebra fish		6
Establishing the zebrafish developmental staging series.		

Kimmel, C.B., Ballard, W.W., Kimmel, S.R., Ullmann, B., & Schilling, T.F. (1995). Stages of embryonic development of the zebrafish. <i>Developmental Dynamics</i>, 203(3), 253–310. https://doi.org/10.1002/aja.1002030302. Large-scale mutagenesis screens led by Christiane Nüsslein-Volhard and Wolfgang Driever, which became a landmark in zebrafish genetics. Haffter, P., Granato, M., Brand, M., Mullins, M.C., Hammerschmidt, M., Kane, D.A., Odenthal, J., van Eeden, F.J.M., Jiang, Y.J., Heisenberg, C.P., Kelsh, R.N., Furutani-Seiki, M., Vogelsang, E., Beuchle, D., Schach, U., Fabian, C., & Nüsslein-Volhard, C. (1996). The identification of genes with unique and essential functions in the development of the zebrafish, <i>Danio rerio</i>. <i>Development</i>, 123(Suppl.), 1–36.	
Unit 7: Mouse/Rat and Monkey/Horse	8
- Concept of gene knockout , knock down and knock in. Mice: Treated with anti-CTLA-4 antibodies experienced tumor rejection and long-term immunity against re-inoculation with the same tumor type. [Experiment demonstration of vaccine immunogenicity; The Experiment — James P. Allison’s CTLA-4 Blockade (mid-1990s) -2018 Nobel Prize in Physiology or Medicine] ; <i>Leach DR, Krummel MF, Allison JP. Enhancement of antitumor immunity by CTLA-4 blockade. Science. 1996 Mar 22;271(5256):1734-6. doi:10.1126/science.271.5256.1734.</i> Monkey: Primate visual cortex physiology (Hubel & Wiesel)- Nobel Prize in Physiology or Medicine, 1981] <i>Hubel DH, Wiesel TN. "Receptive fields and functional architecture of monkey striate cortex." J Physiol 195:215–243 (1968).</i> Horse : Immunization of horses (to raise anti-venom antibodies)]	

ANIMAL MODELS IN RESEARCH LAB; DSCC-20-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
1. Identification of X-linked and autosomal dominant and recessive mutation in <i>Drosophila</i> 2. Use of mutation in inheritance study through genetic crosses. 3. Demonstration of different imaginal disc and expression of genes through photographs. 4. Demonstration of developmental stages of Zebra fish through photographs. 5. LNB		

PART IV: SEMESTER-VIII

CORE COURSE-21: RESEARCH METHODOLOGY-1 [DSCC-21 Theory]

Full Marks 75	3 Credits	45 Hours
Unit 1: Plan And Design of Research Framework:		7
(Basic concept) Formulation of research problem, Types of investigation; Aim, Objective, Hypothesis; Items, Observation, Sample and types of sampling, Population, Treatment, variables, Test and controls, Replica, Repeatability, Questionnaires, Focus group, Determination of Sample size, Collection of data, Criteria of good research. Problems encountered by researchers in India.		
Unit 2: Data:		7
Type of Data : Qualitative, Quantitative, Descriptive, Discrete, Continuous, Rankable, Nominal, Ordinal, Interval, Derived Variable. Distribution of Data (basic idea): Normal distribution, Binomial distribution, Poisson distribution, Exponential distribution. Parametric and Non-parametric data.		
Unit 3: Estimate Of The Central Tendency:		5
Concept and calculation of mean, median and mode (only for normal distribution). Estimation of variance and standard distribution of normally distributed data.		
Unit 4: Hypothesis Testing:		10
Types of hypothesis, sampling error, test statistics, P-value, one-tailed and two-tailed test, degree of freedom, chi-squared goodness of fit test, Student's t-test (matched and unmatched data).		
Unit 5: Correlation And Regression:		6
Correlation co-efficient, Positive and negative correlation, co-variance, Linear regression and regression line, concept of outlier.		
Unit 6: Research Ethics:		5
Basic codes for research ethics, Objective of research ethics, Emergence of concept of biomedical research ethics, Types of biomedical research (Basic, Preclinical, Clinical, translational), International guideline (WMA guideline Helsinki International, 1964) for biomedical research involving human subjects. ICMR guideline for biomedical research in India. Research ethics committee on human subject and its duty. Preclinical Research: Indian regulations of animal ethics, Animal ethics committee. Animal Welfare Board in India (AWBI) and its activity, CCASEA guideline in India.		
Unit 7: Biological Research And Society:		5
Societal perception on biomedical research, contemporary factors shaping societal perception, Public mistrust and strategies for trust building, science-society dialogue; Socio-economic, political, commercial aspect of biomedical research.		

PART IV: SEMESTER VIII

CORE COURSE-22: RESEARCH METHODOLOGY-2 [DSCC-22 Theory]

Full Marks 75	3 Credits	46 Hours
Unit 1: Writing Of A Scientific Paper:		8
Concept and importance of scientific research and review paper; shape and organization of scientific paper, ethics in scientific publishing, concept of types of plagiarisms and data piracy , organization of a paper, selection of title, authorship criteria, abstract, material and methods, results and its interpretation, discussion. Acknowledgement, Citation and its style. Writing a dissertation report.		
Unit 2: Literature Review:		8
Definition, Purpose, types (narrating, systemic, scoping, meta-analyses, annotated bibliography), steps of literature review, criteria of good literature review, common pit-fall to avoid, Web resources for literature review : attribute and use of Google scholar, Semantic scholar, PubMed, ScienceDirect, Scopus, Web of Science, Sodhganga/INFLIBNET, National Digital Library of India.		
Unit 3: Bibliography:		4
Definition, types, purpose, branches of bibliography, components of a bibliography, Indian National bibliographies, Bibliographical controls. Online bibliographical tools: Use and key features of Zotero, JabRef, CiteFast, Mendeley, EndNote. UGC-care list.		
Unit 4: Presentation Of Research:		10
Definition, criteria of a good presentation, Basic structure of scientific power-point presentation, slide designing principle, presenting scientific data, scientific writing style on slide, strategy for verbal presentation, Common mistake to avoid, evaluation of good scientific presentation.		
Unit 5: Writing A Research Proposal For Grant And Preparing Its Report:		7
Component of grant proposal: Abstract/Summary, Introduction and Background, Aims & objective, Hypothesis, Methodology, Work-plan and Timeline (Gantt Chart), Budget estimate and justification, Expected outcome and deliverables, Grant report format and importance of grant report. Indian Grant agencies and their project format : DST-SERB, DBT, ICMR.		
Unit 6: Intellectual Property Right (IPR)		4
Definition of IP and IPR, Categories of IP, Scope of IP, Types of IP, Importance of IPR, Evolution of IP acts and treaties, Agencies responsible for IP registration, Issues affecting IP internationally.		
Unit 7: Copyright And Patent:		5
Copyright definition, importance, originality of material, Indian copyright act, copyright registration and its application. Patent definition, types of patent, Foundation of patent law, patent search in India, patent status, Basic criteria for patentability,		

PART IV: SEMESTER VIII
CORE COURSE-23: BIOPHYSICS AND LABORATORY TECHNIQUES
[DSCC-23 Theory]

Full Marks 75	3 Credits	40 Hours
Unit 1 : Elements of Biophysics		6 Hours
Concept of energy and entropy in biological systems; Forces stabilizing macromolecular structures (hydrogen bonds, van der Waals forces, hydrophobic interactions); Membrane potential and Nernst equation; Donnan membrane equilibrium; Electrostatics in biological systems – Poisson-Boltzman equation.		
Unit 2 : Chromatography		6 Hours
Principles and Applications: Paper Chromatography, Thin-layer Chromatography, Adsorption chromatography, Affinity Chromatography, Ion-exchange Chromatography, Molecular sieve Chromatography, High performance liquid Chromatography, Gas Chromatography		
Unit 3 : Spectroscopy		10 Hours
Difference between Absorption and Emission Spectroscopy; Principles of Absorption Spectroscopy (Lambert's Law, Beer's Law, Absorbance, Transmittance); Principles and Applications: UV/VIS absorption Spectroscopy, Infrared and Raman Spectroscopy, X-Ray Spectroscopy, Spectrofluorimetry, Circular Dichroism Spectroscopy, NMR, ESR, Atomic Absorption Spectroscopy, Mass Spectrometry		
Unit 4 : Flow Cytometry		5 Hours
Basic components of a flow cytometer (Fluidics, Optics and Electronics system); Concept of Fluorescence Activated Cell Sorting (FACS); Analysis of Apoptosis and Cell Cycle through Flow Cytometry		
Unit 5 : Basic Laboratory Instruments		4 Hours
Applications of Water distillation plant, Dry bath and Water bath, BOD incubator, pH meter, Vortex, Magnetic stirrer, Weighing balance (manual and digital), Autoclave		
Unit 6: Polymerase Chain Reaction (PCR)		5 Hours
Basic concept; Stages in PCR; PCR primer designing; Types of PCR (Allele specific PCR, RT-PCR, qRT-PCR, RAPD PCR), Applications of PCR		
Unit 7: Medical Diagnostic Tools		4 Hours
Working Principles and Applications of Blood Pressure machine (manual and digital), Glucometer, Pulse Oximeter, Electrocardiogram (with brief idea on data analysis), X-Ray.		

BIOPHYSICS AND LABORATORY TECHNIQUES LAB: DSCC-23-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
1. Analysis of: - a) Apoptosis and b) Cell Cycle from flow cytometry datasheets.[PI & Annexin V] 2. Packing and Sterilization of glass and plastic wares using Autoclave. 3. Paper Chromatography – Demonstration and R_f value calculation. [amino acids] 4. Estimation of Random blood sugar using a Glucometer. 5. Estimation of blood oxygen saturation using Pulse oximeter. 6. Analysis of Electrocardiogram datasheets. 7. LNB.		

PART IV: SEMESTER VIII
CORE COURSE-24: DISEASE BIOLOGY AND PUBLIC HEALTH
[DSCC-24 Theory]

Full Marks 75	3 Credits	46 Hours
Unit 1: Introduction		7
Definition and Types of disease with example (communicable and non-communicable disease, Epidemic endemic and pandemic); modes of transmission of diseases – routes of entry and different agents with examples.		
Unit 2: Zoonosis		7
Definition, List Of Zoonotic Diseases, Concept of Zoonosis with respect to Taeniasis, Chikungunya, Typhus, Dengue.		
Unit 3: Communicable diseases		4
Causes, Symptoms, Epidemiology, Prevention, Diagnostic Techniques of AIDS, Hepatitis B, Tuberculosis, and its Types, SARS, MARS, Ebola, Zika		
Unit 4: Non- Communicable diseases		10
Causes, Types, Symptoms, Epidemiology, Prevention, Risk Factors of Obesity and Hypertension.		
Unit 5: Occupational disease		6
Definition and detail of Silicosis, Anthracosis, Byssinosis, Asbestosis, Farmer's Lung, Lead poisoning and Occupational dermatitis.		
Unit 6: Mental health		3
Types according to ICD 10, their causes and prevention.		
Unit 7: Nutrition and health		5
Nutrients classification with sources and functions; Dietary fibres – types and functions; Malnutrition – definition and types; Deficiency diseases of vitamins and minerals; Balanced diet and dietary goals.		
Unit 8: Health planning and management		4
Objective, targets and goals, planning cycle and health sector planning.		

DISEASE BIOLOGY AND PUBLIC HEALTH LAB; DSCC-24-P

Full Marks 25	1 Credit	20 Hours
List of Practical		
1. Calculation of BMI from data sheet and assessment of health status. 2. Identification and clinical significance (with picture) of <i>Mycobacterium tuberculosis</i>, HIV, <i>Xenopsylla cheopis</i>, Hepatitis B, Hexacanth/Oncosphere, Ebola, Zika 3. CBC, Lipid profile and LFT report analyses. 4. LNB		

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3. The Human Nervous System, Mai Paxinos;
4. Instant Notes in Neuroscience, Alan Longstaff;
5. Netter's Atlas of Human Neuroscience, David L. Felten and Ralph F. Jozefowicz;
6. Text Book of Medical Physiology, Guyton and Hall;
7. Ganong's Reviews of Medical Physiology, Barrett, Barman;
8. Principles of Anatomy and Physiology, G. J. Tortotora, B. Derrickson;
9. Principle of Cognitive Neuroscience, Dale Purves;
10. Cognitive Neuroscience, Marie T. Banich, Rebecca J. Compton;
11. Developmental Biology, Scott F. Gilbert;
12. Development of the Nervous System, Dan Sanes, Thomas Reh, William Harris;
13. Developmental Neurobiology, Greg Lemke
14. Neuromuscular Disorders, Amato & Russell;
15. Clinical Neurology, Simon, Greenberg, Aminoff;
16. Handbook of Neuroendocrinology, George Fink;
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BIOPHYSICS AND LABORATORY TECHNIQUES

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NOTE:

For Semester-1 to Semester-6 the Question Pattern given from page 43 to page 48 is to be followed
 For Semester-7 & Semester-8 refer the format as mentioned in CSR/52/2025 dated 31.07.2025

Sl. No. 01

Question pattern for Zoology

Under CCF, 2022

All semestersZoology Major Core Papers:

Full marks: 75(Section A + Section B + Section C) = 20+15+40

Time: 3 hours

Examination/Paper type	Section A	Section B	Section B	Comment
Zoology Major Core Theory	- Total 15 questions will be given by question setters - Students will attempt 10 question - Questions will be set from all the units - Each question will carry 2 marks (10X2)=20	- Total 5 short notes to be given by question setters. - Students will attempt 3 short notes - Short notes can be given from any of the units. No two short notes can be from the same unit - Each short notes will carry 5 marks (3X5)=15	- Total 7 questions to be given by question setters. - Students will attempt 4 questions. - Each carrying 10 marks. Questions can be given from any of the units. - Each question should have part questions. - Each question will carry 10 marks (10X4)=40	Total marks 20+15+40=75 Examination would be taken at away center. Question paper will be arranged by the University. QS, MOD, HE and Examiners will be recommended by UGBOS.
Zoology Major Core Practical	- Experiments - Identifications 22 Marks	Lab note book/Field report/Dissertation 3 marks	No marks allotted for Viva voce	Total Marks 25 Examination should be taken at away center with two internal and one external examiners recommended by UGBOS. Questions will be set by UGBOS

Zoology Major Skill Enhancement Course (SEC) Papers:

Time 2 hours

Multiple Choice Questions

	Section A	Section B		
Zoology Major SEC Theory	Total 30 questions will be set by question setter. Students will attempt 25 questions. Each carrying 1 marks. Questions should be MCQ with four alternative options with no negative alternative. Questions will cover all the units. 25X1=25	Total 35 questions will be set by question setter. Students will attempt 25 questions. Each question will carry 2 marks. Questions will cover all the units. Questions should be MCQ with four alternative options with no negative alternative. Questions will cover all the units. 25X2=50	Total marks 75	Answer would be given in OMR sheet. Examination should be taken at away center. QS, MOD, HE and Examiners will be recommended by UGBOS.
Zoology Major SEC Practical	•Experiments •Identifications 22 Marks	Lab note book/Field report/Dissertation 3 marks	No marks allotted for Viva voce	Total Marks 25 Examination should be taken at away center with two internal and one external examiners recommended by UGBOS. Questions will be set by UGBOS

Zoology Minor Core Papers

Full marks: 75 (Section A + Section B + Section C) = 20+15+40

Time: 3 hours

Examination/Paper type	Section A	Section B	Section B	Comment
Zoology Minor Core Theory	• Total 15 questions will be given by question setters • Students will attempt 10 question • Questions will be set from all the units • Each question will carry 2 marks (10X2)=20	• Total 5 short notes to be given by question setters. • Students will attempt 3 short notes • Short notes can be given from any of the units. No two short notes can be from the same unit • Each short notes will carry 5 marks (3X5)=15	• Total 7 questions to be given by question setters. • Students will attempt 4 questions. • Each carrying 10 marks. Questions can be given from any of the units. • Each question should have part questions. • Each question will carry 10 marks • (10X4)=40	Total marks 20+15+40=75 Examination would be taken at away center. QS, MOD, HE and Examiners will be recommended by UGBOS.
Zoology minor Core Practical	•Experiments •Identifications 20 Marks	Lab note book/Field report/Dissertation 5 marks	No marks allotted for Viva voce	Total Marks 25 Examination should be taken at homecenter with one internal and one external examiners. External examiner will be arranged by the college. Questions will be arranged by UGBOS

Zoology Multi-disciplinary Papers

Examination/Paper type	Section A	Section B	Section B	Comment
Zoology MDC Core Major/ Minor Theory	• Total 15 questions will be given by question setters • Students will attempt 10 question • Questions will be set from all the units • Each question will carry 2 marks (10X2)=20	• Total 5 short notes to be given by question setters. • Students will attempt 3 short notes • Short notes can be given from any of the units. No two short notes can be from the same unit • Each short notes will carry 5 marks (3X5)=15	• Total 7 questions to be given by question setters. • Students will attempt 4 questions. • Questions can be given from any of the units. • Each question should have part questions. • Each question will carry 10 marks • (10X4)=40	Total marks 20+15+40=75 Examination would be taken at awaycenter. QS, MOD, HE and Examiners will be recommended by UGBOS.
Zoology MDC Core Practical	•Experiments •Identifications 20 Marks	Lab note book/Field report/Dissertation 5 marks	No marks allotted for Viva voce	Total Marks 25 Examination should be taken at homecenter with one internal and one external examiners. External Examiner will be arranged by the college. Question format will be provided by UGBOS

	Section A	Section B		
Zoology MDC SEC Theory	Total 30 questions will be set by question setter. Students will attempt 25 questions. Each carrying 1 marks. Questions should be MCQ with four alternative options with no negative alternative. Questions will cover all the units. 25X1=25	Total 35 questions will be set by question setter. Students will attempt 25 questions. Each question will carry 2 marks. Questions will cover all the units. Questions should be MCQ with four alternative options with no negative alternative. Questions will cover all the units. 25X2=50	Total marks 75	Questions would be set by internal teachers Students will write only the correct alternative against the question number. Examination should be taken at homecenter. Questions will be arranged by college teachers.
Zoology MDC SEC Practical	•Experiments •Identifications 20 Marks	Lab note book/Field report/Dissertation 5 marks	No marks allotted for Viva voce	Total Marks 25 Examination should be taken at homecenter with 2 internal examiners. Question format will be given by UGBOS

	Section A	Section B		
Zoology IDC Theory	Total 30 questions will be set by question setter. Students will attempt 25 questions. Each carrying 1 marks. Questions should be MCQ with four alternative options with no negative alternative. Questions will cover all the units. 25X1=25	Total 30 questions will be set by question setter. Students will attempt 25 questions. Each question will carry 1 marks. Questions will cover all the units. Questions should be MCQ with four alternative options with no negative alternative. Questions will cover all the units. 25X1=50	Total marks 50	Questions would be set by internal teachers. Students will write only the correct alternative against the question number. Examination should be taken at home center. Questions will be arranged by college teachers.
Zoology IDC Practical	•Experiments •Identifications 20 Marks	Lab note book/Field report/Dissertation 5 marks	No marks allotted for Viva voce	Total Marks 25 Examination should be taken at homecenter with two internal examiners as recommended by HOD of respective college. Question format will be given by UGBOS.



UNIVERSITY OF CALCUTTA

Notification No. CSR/52/2025

It is hereby notified for information of all concerned that the Syndicate at its meeting held on 22.07.2025 (Item No. 05 & 06) approved the following amendments pertaining to the Admission Regulations (CSR/05/2023, dt. 23.06.2023) for Four-year B.A./ B.Sc. Honours & Honours with Research courses of studies under CCF, 2022, under this University:

- 1) Amendments in the Course Structure (clause no. 9) for semester-5,6,7 & 8: Detail Course Structure is laid down in the accompanying pamphlets.
- 2) Students shall study two papers from a single Minor subject (both either from m1 or from m2) in semester-V and shall study two papers from another Minor subject (both either from m1 or from m2) in semester-VI and shall appear in the semester-5 & 6 examinations accordingly.

Note: The Minor subject to be studied in semester-6 shall be different from the Minor subject studied in semester-5.

- 3) Guidelines including examination modalities for the papers of semester-7 & 8 are laid down in the accompanying pamphlets.

The above shall take effect for the Four-year B.A./ B.Sc. Honours & Honours with Research courses of studies under CCF, 2022, which was introduced from the academic session 2023-2024.

SENATE HOUSE
KOLKATA-700073
The 31st July, 2025

Prof. (Dr.) Debasis Das
Registrar

Amendments in Course structure, as mentioned in Admission Regulations for 4-Year B.A./ B.Sc.--Honours & Honours with Research (clause no. 9 of CSR/05/2023, dt. 23.07.2023)

Revised Course Structure for 4-Year Honours & Honours with Research (semester-1 to 6)-CCF, 2022

	DSCC/ Core (Major)	Minor (m1 & m2)	IDC	AEC	SEC	CVAC	Summer Internship	Total Credit
Semester	15x4= 60	8x4= 32	3x3= 9	4x2= 8	3x4= 12	4x2= 8	1x3= 3	172
1	1x4= 4 3TH+1P/TU	1x4= 4 (m1) 3TH+1P/TU	1x3= 3 2TH +1P/TU	1x2= 2 2TH +0P/TU	1x4= 4	2x2= 4		21
2	1x4= 4 3TH+1P/TU	1x4= 4 (m1) 3TH+1P/TU	1x3= 3 2TH +1P/TU	1x2= 2 2TH +0P/TU	1x4= 4	2x2= 4		21
3	2x4= 8 2x(3TH+1P/TU)	1x4= 4 (m2) 3TH+1P/TU	1x3= 3 2TH +1P/TU	1x2= 2 2TH +0P/TU	1x4= 4			21
4	4x4= 16 4x(3TH+1P/TU)	1x4= 4 (m2) 3TH+1P/TU		1x2= 2 2TH +0P/TU				22
5	4x4= 16 4x(3TH+1P/TU)	m1/m2 2x4= 8 2x(3TH+1P/TU)						24
6	3x4= 12 3x(3TH+1P/TU)	m1/ m2 2x4= 8 2x(3TH+1P/TU)						23
Credits	15x4= 60	8x4= 32	3x3= 9	4x2= 8	3x4= 12	4x2= 8	1x3=3	132
Marks	15x100=1500	8x100=800	3x75=225	4x50=200	3x100=300	4x50=200	1x75=75	Total Marks =3300

Marks= 25 marks per credit.

Summer Internship has to be undertaken in semester-2/4/6.

Minor Courses will come from two subjects of same broad discipline as Major (m1 & m2)

Students shall study two papers from a single Minor subject (both either from m1 or from m2) in semester-V and shall study two papers from another Minor subject (both either from m1 or from m2) in semester-VI

The Minor subject to be studied in semester-6 shall be different from the Minor subject studied in semester-5.

Revised Course Structure (semester-7 & 8) under CCF, 2022

4-YEAR B.A./ B.Sc. HONOURS COURSES OF STUDIES

SEMESTER-7

SEMESTER	DSCC/ CORE from Major subject 4 CREDITS (3 TH+1 P/ TU) each	Total credits
* 7	5 papers x 4 credits = 20 credits	20

SEMESTER-8

SEMESTER	1st paper & 2nd paper From Major subject (4 Credits each) 2 papers x 4 credits = 8 credits	3rd paper & 4th paper From Major subject (4 Credits each) 2 papers x 4 credits = 8 credits	5th paper From Major subject (4 Credits) 1 paper x 4 credits = 4 credits	Total credits
# 8	2 papers of Research Methodology (RM-1 & RM-2) (3 TH+1 viva) Or 2 Core papers (3 TH+1 P/ TU)	2 Core papers (3 TH+1 P/ TU)	1 paper of Project/ Review (3 TH+1 viva) Or 1 Core paper (3 TH+1 P/ TU)	20

Revised Course Structure (semester-7 & 8) under CCF, 2022

4-YEAR B.A./ B.Sc. HONOURS WITH RESEARCH COURSES OF STUDIES

SEMESTER-7

SEMESTER	DSCC/ CORE from Major subject 4 CREDITS (3 TH+1 P/ TU) each	Total credits
*7	5 papers x 4 credits = 20 credits	20

SEMESTER-8

SEMESTER	1 st paper & 2 nd paper From Major subject (4 Credits each) 2 papers x 4 credits = 8 credits	3 rd paper From Major subject (4 Credits) 1 paper x 4 credits = 4 credits	4 th paper From Major subject (8 Credits) 1 paper x 8 credits = 8 credits	Total credits
#8	2 papers of Research Methodology (RM-1 & RM-2) (3 TH+1 viva)	Research Internship (3 TH+1 viva)	Dissertation / Project (6 TH+2 viva)	20

Note:-

*** In semester-7:**

The 5 DSCC/ Core papers to be studied in the 7th semester of the Honours Programme shall be identical with core papers to be studied by the students pursuing Honours with Research programme.

In semester-8:

The 2 papers of Research Methodology (RM-1 & RM-2) to be studied in the 8th semester of the Honours with Research Programme, shall be identical with 2 papers of Research Methodology (RM-1 & RM-2) to be studied by the students pursuing Honours programme.

Total credits & Marks (semester-1 to 8) for 4-YEAR B.A./ B.Sc. Honours Courses of Studies

	DSCC/ Core/ Research Methodology / Project / Review (Major)	Minor (m1 & m2)	IDC	AEC	SEC	CVAC	Summer Internship	Total Credits
Credits	25x4= 100	8x4= 32	3x3= 9	4x2= 8	3x4= 12	4x2= 8	1x3=3	172
Marks	25x100=2500	8x100=800	3x75=225	4x50=200	3x100=300	4x50=200	1x75=75	Total Marks =4300

Total credits & Marks (semester-1 to 8) for 4-YEAR B.A./ B.Sc. Honours with Research Courses of Studies

	DSCC/ Core/ Research Methodology (Major)	Minor (m1 & m2)	IDC	AEC	SEC	CVAC	Summer Internship	Research Internship (Major)	Dissertation/ Project (Major)	Total Credits
Credits	22x4= 88	8x4= 32	3x3= 9	4x2= 8	3x4= 12	4x2= 8	1x3=3	1x4=4	1x8=8	172
Marks	22x100=2200	8x100=800	3x75=225	4x50=200	3x100=300	4x50=200	1x75=75	1x100=100	1x200=200	Total Marks =4300

**Guidelines including Examination Modalities
for the papers, taught at semester-7 & 8**

Semester-7: 5 papers-- (20 credits): from the Major subject

The students pursuing **Honours** or **Honours with Research** Courses of Studies at U.G. Level, shall study:-

5 core papers (4 credits each: 3Th+1P/TU: 5 x 4 credits= 20 credits)

Semester-8: (20 credits)

❖ **The students pursuing Honours Courses of Studies at U.G. Level, shall study 5 papers from the Major subject:**

a) **1st and 2nd papers:** (4 credits each: 3Th+1 viva): 2 papers of Research Methodology (RM-1 & RM-2) -- (2x4 credits= 8 credits)

OR

2 Core papers: (4 credits each: 3Th+1P/TU) --- (2x4 credits= 8 credits) in lieu of 2 Research Methodology papers.

b) **3rd & 4th papers:** 2 core papers (4 credits each: 3Th+1P/TU): (2x4 credits: 8 credits)

c) **5th paper: 1 Project/ Review** (4 Credits: 3Th+1 viva): 1x4 credits: 4 credits.

OR

1 Core paper: 4 credits: (3Th+1P/TU): 1x4 credits: 4 credits in lieu of Project/ Review

Note:-

For sl. No. (a) : Respective **U.G.B.O.S. shall decide** whether 2 papers of Research Methodology or 2 core papers of Major subject shall be included.

For sl. No. (c) : Respective **U.G.B.O.S. shall decide** whether 1 paper of Project/Review or 1 core of Major subject shall be included.

Semester-8: (20 credits)

❖ **The students pursuing Honours with Research Courses of Studies at U.G. Level, shall study 4 papers from the Major subject:**

- **1st & 2nd paper: 2 papers of Research Methodology - (RM-1 & RM-2):**
(4 credits each)—2 x 4 credits=8 credits
- **3rd paper: 1 paper on Research Internship:** 1 x 4 credits= 4 credits
- **4th paper: 1 paper on Research oriented Dissertation/ Project:**
1 x 8 credits= 8 credits.

Broad guidelines and examination modalities and evaluation procedure shall be as follows:

(Two Research Methodology papers (RM-1 & RM-2) shall be identical for both Honours & Honours with Research Courses of Studies)

- **Research Methodology (RM-1 & RM-2)- (4 credits each):**

(4 credits each: 3Th+1 viva)--- (2x 4 credits: 8 credits)

RM-1 & RM-2 are to be formulated according to the following generic format:

- Fundamentals of Research: Research Process and Design**
- Research Ethics and Social Impact**
- Literature Review**
- Methods, Techniques and Tools**
- Citation & Bibliography**

The detailed formulation of the content with regard to the above items will be done by the respective U.G.B.O.S.

The format of questions in Research Methodology shall be **either essay type** (non MCQ) or **MCQ** and that shall be decided by the concerned UGBOS.

For MCQ/ non MCQ question patterns-(100 marks): There shall be theory component of 3 credits-75 marks and viva-voce of 1 credit- 25 marks.

Question pattern for Theory component of MCQ type (75 marks):

15 questions x 3 marks = 45 marks

15 questions x 2 marks = 30 marks

Evaluation: The Theory examination shall be held in away centre and viva-voce shall be held in home centre in presence of External examiners (external examiners shall be recommended by the colleges).

- **Research Internship:(4 credits):**

Credit distribution: 3Th (75 marks) +1 viva-voce (25 marks)

(Guidelines shall be formulated by the respective UGBOS)

- **Dissertation/ Project (8 credits):**

Credit distribution: Report Writing (6credits, i.e. 150 marks) + Viva-voce (2 credit, i.e. 50 marks)

Contents of this paper may differ for different subjects and shall be evaluated by the internal examiners (faculty members of the concerned college) in presence of External examiners (External examiners shall be recommended by the colleges).