



# **UNIVERSITY OF CALCUTTA**

## **Notification No. CSR/07/2026**


It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in the exercise of his powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 09.01.2026, approved the new revised complete Course Structure & Syllabus of 4-year Honours & Honours with Research & 3-year MDC of Zoology under CCF, 2022 including Question Patterns.

The above shall take effect from the Odd semester examinations, 2025 and onwards.

SENATE HOUSE

Kolkata-700073

21.01.2026

 21/01/2026  
Prof.(Dr.) Debasis Das

Registrar

## 4-YEAR Honours & Honours with Research Structure of NEP Curriculum for Zoology

### PART I; SEM I

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

### PART I; SEM II

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

### PART II; SEM III

SUBJECT CODE	COURSE	NAME OF PAPER	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	Cells & Tissue Structure	75	25
CC1	MZOO-MDC-Minor	Cell Biology	75	25
IDC-3	ZOOD	Animal Biology	50	25

### PART II; SEM IV

SUBJECT CODE	COURSE	NAME OF PAPER	THEORY	PRACTICAL
DSCC5	ZOOM	Non-chordates 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	Non-chordates structure & function	75	25
CC5	MZOO-MDC	Ecology	75	25
CC2	MZOO-MDC-Minor	Biochemistry	75	25

### PART III; SEM V

SUBJECT CODE	COURSE	NAME OF PAPER	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	Chordate structure & function	75	25
CC7	MZOO-MDC	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	NAME OF 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	Biodiversity & Conservation Biology	75	25
CC8	MZOO-MDC	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	NAME OF 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	NAME OF 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	<b>PROJECT</b>	75	25

### PARTIV;SEMVIII[WITHRESEARCH]

SUBJECT CODE	COURSE	NAME OF PAPER	THEORY	PRACTICAL
DSCC21	ZOOM	Research Methodology I	75	25[VIVA]
DSCC22	ZOOM	Research Methodology II	75	25[VIVA]
DSCC23	ZOOM	<b>Research Internship</b> [Dissertation Oriented Technique]	75	25
DSCC24	ZOOM	<b>Dissertation</b> Individual Based Projects	150	50

**OUTLINE STRUCTURE OF NEP CURRICULUM FOR  
3-YEAR MULTIDISCIPLINARY COURSE (MDC)  
ZOOLOGY (MAJOR/MINOR)**

PRAT I, SEM I					
	MDC ZOOLOGY MAJOR		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

## CORECOURSE- 1:CellBiology[DSCC-1Theory]

FullMarks75	3 Credits	46Hours
<b>Unit1:PlasmaMembrane</b>		<b>8</b>
<b>StructureofthePlasmaMembrane:</b> LipidBilayer(PhospholipidsandCholesterol),PeripheralandIntegralMembraneproteins,GlycolipidsandGlycoproteins( <i>basicconceptofGlycocalyx</i> ),FluidMosaic 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.		<b>CB</b>
<b>Unit2:CytoplasmicorganellesI</b>		<b>8</b>
<b>BasicconceptsonUltrastructureofER,GolgiandLysosome;OverviewofProteinsorting;</b> ERMorphology,TargetingproteinstoER,TheSignalthypothesis;InsertionofproteinsintoERmembrane, Protein folding and processing in ER, Export of proteins and lipids from ER ; <b>Golgi Apparatus;</b> Morphology,ProteinglycosylationwithinGolgi,ProteinsortingandexportfromGolgiapparatus; <b>Lysosome:</b> Polymorphism,Lysosomalacidhydrolases,Endocytosisandlysosomeformation.		<b>SS</b>
<b>Unit3:CytoplasmicorganellesII</b>		<b>4</b>
<b>Mitochondria:</b> Structure;MitochondrialRespiratoryChain,ChemiosmotichypothesisandOxidative Phosphorylation with reference to ATP Synthase and ATP synthesis <b>Centrosomeanditsorganization</b>		<b>AM</b>
<b>Unit4:Cytoskeleton</b>		<b>4</b>
StructureandTypes:Microtubules,Actinfilaments,andIntermediatefilaments;Compositionandfunction of ECM		<b>AM</b>
<b>Unit5:Nucleus</b>		<b>5</b>
Nuclear envelope, nuclear pore complex (transport not included), Kinetochore and centromeric DNA;Chromatin and levels of its packaging. Euchromatin& Heterochromatin.		<b>SD</b>
<b>Unit6:Nucleic Acids</b>		<b>3</b>
Structure and composition of DNA: Chargaff's Rule; Hypo and Hyperchromic shift; Watson and Crick ModeloftheThree-DimensionalStructureofDNA.DifferentformsofDNA-A,BandZDNA(comparative overview) RNA as the Genetic Material, Types and Function.		<b>PG</b>
<b>Unit7:DNAREplication</b>		<b>10</b>
Meselson–StahlExperiment,DNAREplicationinProkaryotes[Bidirectionalanddiscontinuous]; Enzymes/ProteinsassociatedwithReplication -Polymerase[I,II&III],Primase,Helicase,SSB,DNAligase; RNA priming; End replication Problem and Replication of telomeres in eukaryotes		<b>PG</b>
<b>Unit8:ToolsandTechniquesinCellBiology</b>		<b>4</b>
<ul style="list-style-type: none"> <li>• AnimalCellCulture:PrimarycellcultureandCellline.</li> <li>• SubcellularfractionationandUltracentrifugation.</li> <li>• FreezefractureReplicationandFreezeEtching</li> <li>• WorkingPrincipleofLightMicroscope:Brightfield,Phasecontrastmicroscope,FluorescenceMicroscope with reference to FRET; Working Principle of SEM &amp; TEM.</li> </ul>		<b>SD2</b>

### CellBiologyLab;DSCC-1-P

FullMarks25	1 Credit	20Hours
<b>Listof Practical</b>		
<ol style="list-style-type: none"> <li>1. CellviabilitystudybyTrypanBlueExclusionmethod. <b>SD +PG</b></li> <li>2. Standardization of Ocular and Stage Micrometer and Measurement of cell or microscopic specimen such as <i>Paramecium</i> sp. <b>AM+PG</b></li> <li>3. Preparationofsquamousepithelialcellwithstaining. <b>AM +PG</b></li> <li>4. IsolationofBoneMarrowCellsfromRat/MouseandGiemsaStaining. <b>CB+SS</b></li> <li>5. <b>LNB</b></li> </ol>		

# PART I : SEMESTER - I

## SEC-1: Applied Entomology Theory

Full Marks 75	3 Credits	43 Hours
<b>Unit 1 Basic of Entomology</b>		<b>11</b>
<p><b>Morphological adaptation of insects:</b> Head and antenna; Mouthparts of honey bee and cockroach; Thorax and thoracic appendages- legs and wings [General concept].</p> <p><b>Physiological adaptation in cockroach:</b> Digestive system: Alimentary canal and digestive glands, digestion; Respiratory organs and mechanism of gaseous exchange; Sense organs compound eyes, chemoreceptors.</p> <p><b>General Characteristics of Class Insecta and living orders with examples:</b> Orthoptera, Dictyoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera, Hymenoptera, Anoplura (Imms, A.D., 1938)</p>		<b>SD2</b>
<b>Unit 2 Medical Entomology</b>		<b>11</b>
<p><b>Concept of Vectors:</b> Carrier and biological vectors, modes of transmission with special reference to Malaria, Dengue, and Filariasis; Control measures of vectors</p> <p><b>Ticks as Causative agents and Vectors:</b> Rickettsiosis, Tick-borne encephalitis; General outline of Mites and their medical significance.</p> <p><b>Phlebotomus sp.:</b> Characteristics, Biology and mode of transmission of visceral leishmaniasis; control measures.</p>		<b>SS</b>
<b>Unit 3 Agricultural Entomology</b>		<b>11</b>
<p><b>Insect Pest:</b> Definition and types; Economic Injury Level (EIL), Economic Threshold Level (ETL), Dynamics of EIL;</p> <p><b>Pests of major crops (Life cycle, Nature of damage and control measures):</b> Pests of Paddy, <i>Scirpophaga incertulus</i>; Pests of Jute, <i>Anomisa bilifera</i>; Pests of brinjal, <i>Leucinodes orbonalis</i>; Stored grain pest: <i>Sitophilus oryzae</i>;</p> <p><b>Insect Pest control:</b> Chemical (classification and mode of action) and Biological control measures; Integrated Pest Management (IPM)</p>		<b>SD</b>
<b>Unit 4 Sericulture</b>		<b>5</b>
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.		<b>CB</b>
<b>Unit 5 Apiculture</b>		<b>5</b>
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.		<b>PG</b>

## Applied Entomology Lab: SEC-1-P

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
<p>1. Dissection and temporary mounting of: - Mouthparts of Cockroach and Mosquito <b>CB &amp; SD</b></p> <p>2. Methods of collection, preservation, and identification of economically important insects. <b>PG + AM</b></p> <p>3. Identification (Order and specimen characters only) with the economic importance of following insect pests: <i>Scirpophaga incertulus</i>; <i>Sitophilus oryzae</i>; <i>Callosobruchus chinensis</i>; <i>Leucinodes orbonalis</i>. <b>PG + SD2</b></p> <p>4. Life history stages of <i>Apis</i> sp. and <i>Bombyx mori</i>. <b>PG + SD2</b></p> <p>5. 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.. <b>PG + SD2</b></p> <p>6. Accomplish <b>any one</b> from the following related to applied entomological significance (submission of a report):</p> <ol style="list-style-type: none"> <li>Visit to Agricultural field related to damage caused by any pest and pest management. Make a report on it.</li> <li>Visit to any Sericulture farm to study silkworm rearing, silk reeling, silk processing and make a report on it.</li> <li>Visit to an Apiary and make a report on it. <b>FIELD REPORT BY SD2</b></li> <li>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.</li> </ol> <p>7. <b>LNB</b></p>		

# PART I : SEMESTER - II

## CORECOURSE-2: Biochemistry [DSCC-2 Theory]

Full Marks 75	3 Credits	45 Hours
<b>Unit1: Carbohydrates</b>		8
Structure, classification and properties of Monosaccharides (aldose and ketose), Disaccharides, Polysaccharides; Isomerism of monosaccharides (D and L, optical isomers, furanose and pyranose, $\alpha$ and $\beta$ anomers, epimers); Reducing and non – reducing sugars. Physiological importance of Monosaccharides, Disaccharides, Polysaccharides		CB
<b>Unit2: Proteins</b>		7
<b>Amino acids:</b> Structure, Classification, General and Electrochemical properties of $\alpha$ -amino acids; Essential and non-essential amino acids; <b>Structures of Protein:</b> Primary, secondary, tertiary and quaternary) of protein, Classification of proteins.		SS
<b>Unit3: Lipids</b>		4
<b>Classification of lipids;</b> Saturated and unsaturated fatty acids, essential and non – essential fatty acids. <b>Structure and formation of Triglyceride;</b> Iodine number and saponification number of fats.		SD
<b>Unit4: Enzymes</b>		8
<b>Nomenclature, classification and properties;</b> 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). <b>Enzyme kinetics:</b> 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 $K_m$		PG
<b>Unit5: Carbohydrates Metabolism</b>		6
Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis from lactate and glycerate, Glycogenesis and Glycogenolysis. (Pathways with name of enzymes and significance)		AM
<b>Unit6: Protein Metabolism</b>		4
Transamination, Deamination and its types (Pathways with name of enzymes and significance) Fate of C-skeleton of Glucogenic and Ketogenic amino acids.		SS
<b>Unit7: Lipid Metabolism</b>		4
$\beta$ -oxidation of fatty acids - a. Palmitic acid {saturated (C16:0)}, b. Linoleic acid {unsaturated (C18:2)}; Fatty acid biosynthesis		SD2
<b>Unit8: Nucleic acid Metabolism</b>		3
Degradation of purine; Purine Salvage pathway and significance.		SD
<b>Unit9: Free radicals and Antioxidants</b>		1
Concept of free radicals and antioxidants with examples.		SD2

### Biochemistry Lab; DSCC-2-P

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
<b>Group A</b>	<b>10 Hours</b>	<b>15 Marks</b>
<b>Qualitative tests for carbohydrates, proteins and lipids</b>		
1. For carbohydrate (Glucose, Fructose, Maltose, Sucrose, Starch) – Molisch test, Benedict test, Barfoed test, Seliwanoff test, Hydrolysis test for sucrose, Iodine test		PG + AM
2. For Protein (Albumin, Gelatine, Peptone) – Biuret test, Million's test, Xanthoproteic test, Ninhydrin test		SD + PG
3. For lipid – Grease spot test		
<b>Group B</b>	<b>10 Hours</b>	<b>10 Marks</b>
<b>Colorimetric estimation of the following</b>		
a) Protein by Lowry's method	CB + PG	
b) Activity of amylase	SD2 + PG	
<b>LNB</b>		

# PART I : SEMESTER - I I

## SEC-2 Aquaculture Theory

Full Marks 75	3 Credits	43 Hours
<b>Unit 1 Basic of Idea of Fish Biology</b>		3
Qualities of Cultivable fish, Indigenous and Exotic		SD
<b>Unit 2 Sustainable Aquaculture System</b>		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.		SD
<b>Unit 3 Recent Advancement of Aquaculture</b>		15
Aquarium Fisheries; Preparation and Management of Fish Aquarium; Biology of Common Ornamental Fish: Guppy, Swordtail, Angel, Bluemorph fish. Anemone fish, Butterfly fish, Molly. <b>Fish Nutritional Requirements:</b> Feed Formulations and Preparation of Compound Diets. <b>Capture Fishery:</b> Fishing Crafts and Gears, Post harvesting Technology. Fish Transport and Marketing. Fish Preservation and By-products. <b>Fish Biotechnology:</b> Transgenic Fish, Sex Reversal in Fish. Aquaponics, Application of GIS and Remote Sensing in Fisheries, Fishery Laws and Regulations.		SS
<b>Unit 4 Fin Fish pathology</b>		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		SD2
<b>Unit 5 Applied Aquaculture</b>		5
<b>Breeding Techniques in Shrimps and Prawns:</b> Eyestalk Ablation in Shrimp and Salinity shock in Prawns. Techniques of Artificial Pearl Culture.		SD2

## Aquaculture Lab: SEC-2-P

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
1. <b>Identification of different fish species using Meristic characters. (Systematic position, specimen characters)</b> Rohu, Catla, Cirrhinus, Puntius, Amblypharyngodon, Channa punctatus, Lates, Mystus, Notopterus, Cyprinus, Hypophthalmichthys, Ctenopharyngodon, Oreochromis niloticus, Oreochromis mossambicus, Anabas, Clarias, Heteropneustes, Mugil, Macrobrachium, Penaeus. SD + CB*		
2. <b>Visit to</b> nearby fish market and identification of economically important fishes, survey on market economy and preparation of report on it. SS+SD; FIELD REPORT BY SS		
3. <b>LNB</b>		

\*FIRST 10 SPECIMEN by SD; NEXT 10 BY CB

## SUGGESTED REFERENCES

### DISCIPLINESPECIFICCORECOURSE-1:CELLBIOLOGY

1. **TheCell(8<sup>th</sup>Edition)**G.M.CooperandR.E.Hausman
2. **Karp'sCellandMolecularBiology:ConceptsandExperiments8<sup>th</sup>edition**
3. **Lewin'sCELLS(3<sup>rd</sup>Edition)**DavidSharp, EricSikorski, GeorgePlopper
4. **MolecularBiologyoftheCellBruceAlberts6<sup>th</sup>Edition**
5. **Lehninger,PrinciplesofBiochemistry4<sup>th</sup>edition**
6. **TheWorldoftheCell:Becker,6<sup>th</sup>edition**
7. **CellandMolecularBiology8<sup>th</sup>EditionDeRobertis**
8. **ThriveinCellBiology,OxfordUniversityPress,2013**

### DISCIPLINESPECIFICCORECOURSE-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.DasBiochemistry**
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:APPLIEDENTOMOLOGY

1. **Chapman,R.F.(2012).TheInsects:Structureandfunction5<sup>th</sup>Edition,CambridgeUniversityPress.**
2. Triplehorn,C.A.andJohnson,N.F.(2005).BorrorandDeLong'sIntroductiontothestudyofInsects.7<sup>th</sup>Edition, Thompson Brooks/Cole, USA
3. **Atwal,A.S.(1986).AgriculturalPestsofIndiaandSouth-EastAsia.2<sup>nd</sup>Edition,KalyaniPublishers,NewDelhi.**
4. **Pedigo,L.P.andRice,M.E.(2009).EntomologyandPestManagement.6<sup>th</sup>Edition,PearsonPrenticeHall.**
5. **Hati,A.K.(2010).MedicalEntomology.AlliedBookAgency.**
6. Shukla,A.(2009)AhandbookonEconomicEntomology.DayaPublishingHouse,DelhiEntomology.3<sup>rd</sup>Edition, Academic Press, United Kingdom
7. Imms,A.D.(1938).AGeneralTextBookofEntomology.ChapmanandHall

### SEC-2:AQUACULTURE

1. Chaudhuri,S.(2017)EconomicZoology,NCBS.
2. Sarkar,S.,Kundu,G.Chaki,K.C.(2017)IntroductiontoEconomicZoology.NCBA
3. Khanna,S.S.andSingh,H.R.(2017)ATextBookofFishBiologyandFisheries.NarendraPublishingHouse.
4. Menon,A.G.K.(1999)theFreshwaterFishesofIndia,AHandbook.Z.S.I
5. Das, M.K.and Das, R.K.(1997) Fish and Prawn Diseases in India- Diagnosis and Control. Inland Fisheries Societyin India, Barrackpore, West Bengal.
6. Jhingran,V.G.(2007)HindustanPublishingCorporation.3<sup>rd</sup>Edition.
7. Pillai,T.V.R.andKutty.(2007)FishingNewsBook.2<sup>nd</sup>Edition.
8. Lutz.C.G.(.)PracticalGeneticsforAquaculture.FishingNewsBook.Oxford.
9. Govindan,T.K.(2008)FishProcessingTechnology.OxfordandIBHPublishingCo.Pvt.Ltd.Kolkata.
10. Dunham,R.A.(1985)AquacultureandFisheriesBiotechnology.GeneticApproaches.CABI.
11. Pierre Boundry, Andy Beaumont, Kathryn Hoare. (2010) Biotechnology and Genetics in Fisheries and Aquaculture. Wiley Blackwell.
12. Das,S.(2022)AquariumFishery.

### IDC-1:ANIMALBIOLOGY

1. Manna,S.,Bhowal,S.K.,Ghosh,R.,Ghosh,N.,Mukherjee,A.(2024)AConciseBookofAnimalBiology.(Ed.S. Manna), TechnoWorld, Kolkata. ISBN978-81-19777-08-2.

The University will offer Zoology related IDC 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
<b>Unit 1: Animal Diversity</b>		<b>10</b>
Phylum Characters and example: [Non-chordates - Porifera, Cnidaria, Ctenophora, Platyhelminthes, Nematelminthes, Annelida, Arthropoda, Mollusca and Echinodermata]; Chordata		<b>AM</b>
<b>Unit 2: Genetics</b>		<b>12</b>
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]		<b>CB</b>
<b>Unit 3: Biodiversity and Wildlife</b>		<b>10</b>
1. Biodiversity: Definition, types and value 2. Biodiversity: Indices [Shannon & Simpson] 3. Conservation: <i>insitu</i> and <i>exsitu</i> [outline idea] 4. Conservation Priority: Hotspot, Megadiversity, Sensitive Ecosystem 5. Indigenous Knowledge and PBR: Basic Concepts		<b>SD</b>
<b>Unit 4: Insect Vectors</b>		<b>8</b>
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 Sandfly [Life cycle and Control Measures]		<b>SS</b>
<b>Unit 5: Laboratory techniques and Instrumentation</b>		<b>5</b>
1. Basics of Light Microscopy 2. Principles and Application of Colorimetry 3. Principles and application of Ultracentrifugation		<b>SD2</b>

### Animal Biology Lab: IDC-1-P

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
1. Karyotype analysis of Klinefelter, Down, Turner, Edward & Patau Syndrome		<b>SD</b>
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> .		<b>CB + AM **</b>
3. Identification of different ecosystems through photographs: Marine ecosystem, Mangrove ecosystem, Lake ecosystem, Rainforest ecosystem, Desert ecosystem, Grassland ecosystem.		
4. <b>LNB</b>		<b>SD</b>

**\*\*FIRST 8 SPECIMEN CB; REST 8 SPECIMEN AM**

## SECG For MDC Applied Zoology-Theory

Full Marks 75	3 Credits	45 Hours
<b>Unit I: Agricultural Entomology</b>		<b>5</b>
Pest- definition and types (major and minor pests with example); Lifecycle, nature of damage and control of Pests: <i>Nilaparvatalugens</i> of paddy, <i>Anomissabulifera</i> of Jute, <i>Bandicoota</i> – storedhouse pest; Insect Pest control: Chemical, Mechanical, Cultural and Biological control measures; Integrated Pest Management (IPM).		SD
<b>Unit II: Sericulture</b>		<b>7</b>
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.		CB
<b>Unit III: Apiculture</b>		<b>6</b>
Various domesticated species of Honeybee; Social organization of Honeybee; Beekeeping: Langstroth Box for rearing of honeybee, Extraction and processing of honey; Composition of honey, apiculture by products and their uses; Pests and Diseases of bees and their control measures		PG
<b>Unit IV: Vermiculture</b>		<b>6</b>
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.		SS
<b>Unit V: Aquaculture</b>		<b>8</b>
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.		SD
<b>Unit VI: Live Stock Management</b>		<b>7</b>
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.		SD2
<b>Unit VII: Lac Culture</b>		<b>6</b>
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		AM

## Applied Zoology Lab

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>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 <b>CB</b></li> <li>Identification of the following fish and prawn specimens (Specimen character 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> <b>SD</b></li> <li>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>Nilaparvatalugens</i>, <i>Anomissabulifera</i> and <i>Leucinodes orbonalis</i> <b>CB</b></li> <li><b>LNB</b></li> </ol>		

# PART I : SEMESTER - III

## CORE COURSE-3: Genetics [DSCC-3 Theory]

Full Marks 75	3 Credits	46 Hours
<b>Unit 1: Chromosome</b>		<b>4</b>
Structural organization of Chromosomes; Polytene, Lampbrush and Satellite chromosomes; Human Karyotyping.		<b>CB</b>
<b>Unit 2: Allele concept</b>		<b>8</b>
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		<b>CB</b>
<b>Unit 3: Genetic Fine Structure</b>		<b>2</b>
Complementation test in Bacteriophage (Benzer's experiment on rII locus)		<b>PG</b>
<b>Unit 4: Linkage, Crossing over and linkage mapping</b>		<b>10</b>
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)		<b>PG</b>
<b>Unit 5: Mutations &amp; Chromosomal aberrations</b>		<b>8</b>
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>		<b>SD</b>
<b>Unit 6: Extra-chromosomal inheritance</b>		<b>2</b>
Kappa particle in <i>Paramecium</i> , Shell spiralling in snail		
<b>Unit 7: Transposable Genetic elements</b>		<b>4</b>
I element in bacteria; Ac-D elements in maize; P elements in <i>Drosophila</i> ; LINE, SINE, Alu elements in human		<b>SS</b>
<b>Unit 8: Sex Determination in mammals</b>		<b>4</b>
Sex determination in man and Dosage Compensation in mammals		
<b>Unit 9: Quantitative Genetics</b>		<b>4</b>
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)		<b>SD2</b>

### Genetics Lab; DSCC-3-P

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
1. <b>Chi-Square Test</b> - Test for Goodness of fit – Mendelian monohybrid and di-hybrid ratios, *Epistatic ratios; Contingency Chi-Square Test <b>PG</b>		
2. <b>Identification of Chromosomal aberration in <i>Drosophila</i></b> (Deletion, Duplication, Inversion and Translocation) and <b>Human</b> (Karyotype of Down Syndrome, Turner Syndrome, Patau Syndrome, Edward Syndrome and Klinefelter Syndrome) from photograph. <b>SD</b>		
3. <b>Pedigree Analysis</b> of some inherited traits in Human (Autosomal, X-linked and Y-linked). <b>CB</b>		
4. Temporary squash preparation of Grasshopper testis to study various stages of meiosis. <b>CB+PG+SS</b>		
5. <b>LNB</b>		
*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
<b>Unit 1: Stain, Dye and Histochemistry</b>		<b>8</b>
Difference between stain and dye. Components and classification of dye. Principle and chemistry of PAS and Feulgen reaction.		SS
<b>Unit 2: Epithelial Tissue</b>		<b>8</b>
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. <b>Clinical correlation:</b> Epithelial metaplasia.		CB
<b>Unit 3: Connective Tissue</b>		<b>14</b>
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 <b>Clinical correlation</b> with respect to bone tissue: Osteoarthritis and Osteoporosis		SD2
<b>Unit 4: Muscular Tissue</b>		<b>5</b>
Salient features. Types based on function and striations. Ultrastructure of skeletal muscle. Features of single unit and multi unit smooth muscle, cardiac muscle. Difference between white muscle fiber and red muscle fiber. <b>Clinical correlation:</b> Duchenne muscular dystrophy.		PG
<b>Unit 5: Nervous Tissue</b>		<b>5</b>
Salient features; Structure of neurons and types based on origin, myelin sheath and processes; Neuroglia and functions; <b>Clinical correlation:</b> Multiple sclerosis		SD
<b>Unit 6: Tissue repair</b>		<b>2</b>
<b>Steps of tissue (skin as an example) repair:</b> 1. Inflammation 2. Organization 3. Regeneration and/or Fibrosis. <b>Factors affecting it:</b> 1. Type of tissue 2. Type of injury 3. Adequacy of blood supply 4. State of health 5. Age.		PG

### Cells and Tissue Structure Lab; DSCC-4-P

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

## PART II : SEMESTER - III

### SEC-3: Poultry Farming and Animal Husbandry Theory

Full Marks 75	3 Credits	42 Hours
<b>Unit 1: Common Breeds of Fowl and their Characteristics</b>		<b>6</b>
American Class, Asiatic Class, Mediterranean Class, English Class, Indigenous breeds. Commercial strains of chickens: Broiler, Layer, Grower		SD
<b>Unit 2: Rearing methods in Poultry Housing and Equipment</b>		<b>6</b>
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).		SD
<b>Unit 3: Poultry nutrition:</b>		<b>4</b>
Nutrition, Feed formulation for chicks		SS
<b>Unit 4: Diseases of Poultry and their control measures:</b>		<b>3</b>
Viral disease, Parasitic disease, Fungal disease and their control		SS
<b>Unit 5: Poultry market in India:</b>		<b>2</b>
Size, growth and trends; poultry market opportunity and challenges		SS
<b>Unit 6: Animal Husbandry: Important cattle breed and their characteristics</b>		<b>5</b>
Cattle breeds in India, Cattle population, Milch breeds, Dual purpose breeds, Draught breed, Cross breed cattle strain		CB
<b>Unit 7: Livestock feeds:</b>		<b>4</b>
Cattle feed – Roughage and Concentrate		CB
<b>Unit 8: Breeding program:</b>		<b>4</b>
Artificial insemination and MOET in cattle.		SD2
<b>Unit 9: Dairying:</b>		<b>4</b>
Composition of Milk, Dairy products, National Dairy Development Board and Operation Flood Program.		SD2
<b>Unit 10: Dairy Pathology</b>		<b>4</b>
Viral disease, bacterial disease, and parasitic disease and control		SD2

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

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li><b>1. Identification of following poultry breeds</b> (only coloured photograph): Plymouth rock, Rhode Island red, New Hampshire, Cochin, Brahma, Leghorn, Cornish, Aseel, Kadaknath, Chittagong. <span style="float: right;">SD</span></li> <li><b>2. Identification of following cattle breeds</b> (only coloured photograph): Sahiwal, Red Sindhi, Gir, Malvi, Hariana, Tharparkar, Jersey. <span style="float: right;">CB</span></li> <li><b>3. Visit to a poultry farm or animal husbandry and make a report on that study.</b> <span style="float: right;">REPORT SD2</span></li> <li><b>4. LNB</b></li> </ol>		

# PART II : SEMESTER - IV

## CORECOURSE-5: Non-Chordate Structure and Function [DSCC-5 Theory]

Full Marks 75	3 Credits	45 Hours
<b>Unit 1: Kingdom Protista</b>		<b>4</b>
Subkingdom Protozoa: General characteristics and Classification up to phylum (Levine et. al., 1980); Locomotion in <i>Euglena</i> , <i>Paramecium</i> and <i>Amoeba</i> ; Asexual reproduction and Conjugation in <i>Paramecium</i>		CB
<b>Unit 2: Kingdom Animalia</b>		<b>4</b>
Basic structural organization of animals: Body symmetry; Body cavities with reference to pseudocoelom and coelom, Protostomes and Deuterostomes; Origin of Metazoa.		SD2
<b>Unit 3: Phylum Porifera</b>		<b>4</b>
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Canal system in sponge; Spicules in sponges.		CB
<b>Unit 4: Phylum Cnidaria</b>		<b>4</b>
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.		SD2
<b>Unit 5: Phylum Helminths</b>		<b>4</b>
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>		SD
<b>Unit 6: Phylum Annelida</b>		<b>4</b>
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Excretion in Annelida; Metamerism in Annelida.		SD
<b>Unit 7: Phylum Onychophora</b>		<b>2</b>
Affinities and Systematic position of Onychophorans		AM
<b>Unit 8: Phylum Arthropoda</b>		<b>6</b>
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Type study: <i>Macrobrachium</i> (respiration and excretion)		AM
<b>Unit 9: Phylum Mollusca</b>		<b>5</b>
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.		CB
<b>Unit 10: Phylum Echinodermata</b>		<b>5</b>
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Water vascular system in Starfish; Echinoderm larva and affinities with chordates.		PG
<b>Unit 11: Phylum Hemichordata</b>		<b>3</b>
General characteristics of Phylum Hemichordata; Affinities and systematic position of Hemichordates.		PG

### Non-Chordate Structure and Function Lab; DSCC-5-P

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
<p><b>1. Identification with reason &amp; 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>.</b> PG + CB + SD</p> <p><b>2. Anatomical study: <i>Periplaneta</i> sp.:</b> Salivary apparatus with hypothalamus, Mouth parts, Nervous system, Male and female Reproductive systems. PG + CB + SS + SD + AM + SD2***</p> <p><b>3. Laboratory culture and whole mount of <i>Paramecium</i>/<i>Euglena</i>/<i>Amoeba</i></b> CB AND PG</p> <p><b>4. LNB</b></p>		

\*\*\*salivary & mouth parts- AM + SS ; Nervous system : PG + SD ; Reproductive : CB + SD2

## PART I : SEMESTER-IV

### CORECOURSE-6:Parasitology[DSCC-6Theory]

FullMarks75	3Credits	42 Hours
<b>Unit1:IntroductiontoParasitology</b>		<b>4</b>
Parasitism:parasite,parasitoid,parasiticcastration;Vectorsandreservoirconcept; Zoonosis		SS
<b>Unit2:ParasiticProtists</b>		<b>7</b>
StudyofEpidemiology,Morphology,LifeCycle,Pathogenicity,DiagnosisandControl mechanisms of <i>Entamoeba histolytica</i> , <i>Leishmaniadonovani</i> , <i>Plasmodium vivax</i> , <i>Plasmodium falciparum</i>		CB
<b>Unit3:ParasiticPlatyhelminthes</b>		<b>8</b>
StudyofEpidemiology,Morphology,LifeCycle,Pathogenicity,DiagnosisandControl mechanisms of <i>Schistosoma haematobium</i> and <i>Echinococcusgranulosus</i>		SD
<b>Unit4:ParasiticNematodes</b>		<b>8</b>
1. StudyofEpidemiology,Morphology,LifeCycle,Pathogenicity,Diagnosisand Control mechanisms of <i>Ascarislumbricoides</i> and <i>Ancylostomaduodenale</i> 2. Studyofstructure,lifecycleandimportanceof <i>Meloidogyneincognita</i> (root-knot nematode)		SS
<b>Unit5:ParasiticArthropods</b>		<b>8</b>
Biology,importanceandcontrolofticks( <i>Ixodessp.</i> ),mites( <i>Sarcoptesp.</i> ),Lice ( <i>Pediculusp.</i> )		PG
<b>Unit6:ParasiticVertebrates</b>		<b>3</b>
BriefaccountofparasiticnatureofCookiecutterShark,HoodMockingbird,Vampire bat		SD2
<b>Unit7:ParasiticAdaptationandhostrelation</b>		<b>4</b>
1. Parasiticadaptationin Helminths 2. Hostparasiticinteractions		SD2

### ParasitologyLab;DSCC-6-P

FullMarks25	1Credit	20Hours
<b>Listof Practical</b>		
1. <b>Identification</b> of <i>Entamoeba histolytica</i> , <i>Leishmaniadonovani</i> , <i>Plasmodium vivax</i> through permanent slides/microphotographs <b>CB +AM</b>		
2. <b>Identification</b> of <i>Schistosoma haematobium</i> , <i>Echinococcus granulosus</i> through permanent slides/microphotographs <b>SD</b>		
3. <b>Identification</b> of <i>Ascarislumbricoides</i> , <i>Ancylostomaduodenale</i> , <i>Wuchereriabancrofti</i> throughpermanent slides/photographs <b>SD</b>		
4. <b>Isolation,Fixation,StainingandMounting</b> ofProtozoa( <i>Nyctotherussp/Balantidiumsp.</i> )andHelminth ( <i>Leidynemasp.</i> ) from gut of Cockroach ( <i>Periplanetaamericana</i> ) <b>SD + AM</b>		
5. <b>LNB</b>		

## PART I : SEMESTER-IV

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

Full Marks 75	3 Credits	48 Hours
<b>Unit 1: Transcription</b>		<b>6</b>
Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.		CB
<b>Unit 2: Post Transcriptional Modifications and Processing of Eukaryotic RNA</b>		<b>6</b>
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)		SD2
<b>Unit 3: Translation</b>		<b>6</b>
Genetic code; Characteristics of the Genetic Code; Aminoacylation of tRNA molecule; Mechanism of protein synthesis in prokaryotes.		SD
<b>Unit 4: Gene Regulation</b>		<b>8</b>
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).		PG
<b>Unit 6: Cell Cycle</b>		<b>9</b>
<b>Cell Cycle:</b> 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; <b>Cell Death:</b> Extrinsic (Death receptors) and Intrinsic Pathways (apoptosome); <b>Cancer:</b> Concept of Protooncogene [Ras] & Tumor suppressor genes [Rb and p53], Different ways of activation of a protooncogene to Oncogene.		
<b>Unit 7: Cell Signaling</b>		<b>5</b>
<b>Signalling system:</b> Modes of cell-cell signalling; Types of Signalling molecules <b>Signalling receptors:</b> Types and example with special reference to regulation of G protein, Adenyl cyclase-cAMP, Enzyme linked Receptors: RTK (ras-raf) and JAK/STAT		SS
<b>Unit 7: DNA Repair Mechanisms</b>		<b>4</b>
Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair		AM
<b>Unit 8: Molecular Techniques</b>		<b>4</b>
<ul style="list-style-type: none"> <li>• Principle and use of Agarose Gel Electrophoresis PG</li> <li>• Principle and use of SDS PAGE PG</li> <li>• Blot Technique: Southern, Northern and Western Blot SS</li> <li>• PCR: Basic Principle, Reverse Transcriptase-PCR SD2</li> </ul>		

### Molecular Biology Lab; DSCC-7-P

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

## PART I : SEMESTER -IV

### CORE COURSE-8: Ecology [DSCC-8 Theory]

Full Marks 75	3 Credits	44 Hours
<b>Unit 1: Introduction to Ecology</b>		<b>5</b>
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).		<b>SD2</b>
<b>Unit 2: Energy Flow in Ecosystem</b>		<b>8</b>
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).		<b>CB</b>
<b>Unit 3: Population Ecology.</b>		<b>7</b>
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.		<b>AM</b>
<b>Unit 4: Niche and Competition</b>		<b>8</b>
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.		<b>PG</b>
<b>Unit 5: Community Ecology</b>		<b>4</b>
Community; Definition and types; Stratification, species richness and Evenness; Dominance – Diversity Analysis, Interspecific interaction with inequilibrium communities (definition and examples).		<b>SS</b>
<b>Unit 6: Ecological Succession</b>		<b>4</b>
Definition of succession, Types of succession, Seral stages of succession with special reference to Hydrosere and Lithosere; Models of ecological succession; Resource-Ratio Hypothesis.		<b>SS</b>
<b>Unit 7: Pollution Biology</b>		<b>8</b>
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.		<b>SD</b>

### Ecology Lab; DSCC-8-P

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

## SUGGESTED REFERENCES

### CORE COURSE-3: GENETICS

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

### SEC-3: POULTRY FARMING AND ANIMAL HUSBANDRY

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

### CORE COURSE-5: NON-CHORDATE STRUCTURE AND FUNCTION

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

### CORE COURSE-6: PARASITOLOGY

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

## CORECOURSE-7:MOLECULARBIOLOGY

1. Genetics-**Strickberger**3<sup>rd</sup>edition
2. iGenetics-**Russell**3<sup>rd</sup>edition
3. Genetics-**BenjaminAPierce**4<sup>th</sup>Edition
4. ConceptsofGenetics-**KlugandCummings**12<sup>th</sup>Edition
5. MolecularBiologyoftheGene-**Watson**7<sup>th</sup>Edition
6. CellBruce-Alberts6<sup>th</sup>Edition
7. MolecularBiology-**Weaver**5<sup>th</sup>Edition
8. PrinciplesandtechniquesofBiochemistryandMolecularBiology-**WalkerandWilson**8<sup>th</sup>Edition

## CORECOURSE-8:ECOLOGY

1. AllenCainML,BowmanWDandHackerSD.2013.Ecology.3<sup>rd</sup>ed.Sinauerassociates.
2. BegonM,HarperJL.TownsendCR.2006.Ecology:Individuals,Populations&communities.4<sup>th</sup>Ed.
3. ChapmanRL,ReissMJ.2000.Ecology-Principles&Application.CambridgeUniversityPress.
4. ColinvauxP.1993.Ecology2.JohnWiley&Sons,Inc.NewYork.
5. FaurieC.,FerraC.,MedoriP.,DevauxJ.2001.Ecology-ScienceandPractice.Oxford&IBHPub.Company.
6. KormondyE.J.2002.ConceptsofEcology.4<sup>th</sup>IndianReprint,PearsonEducation.
7. Maiti,P.K.andMaiti,P.2023.Biodiversity,Perception,PerilandPreservation.PHI,LearningPvt,Ltd.
8. MollesJr.MC.2005.Ecology:ConceptsandApplications.3<sup>rd</sup>Ed.McGraw-Hill.
9. OdumE.P,BarretGW.2017.FundamentalsofEcology.15<sup>th</sup>Indianreprint.CengagelearningIndiaPtd.OdumE.P. 2008.FundamentalsofEcology.Brooks/Cole
10. Ricklefs.R.E.Miller,G.L.2000.Ecology.4<sup>th</sup>Ed.W.H.FreemanandCompany.
11. RusselP.J,WolfeLS,HertzPE,StarrC,McMillanB.2009.Ecology.CengageLearning,
12. SmithT.M,SmithRL.2006.ElementsofEcology.6<sup>th</sup>Ed.PearsonEducation.
13. StilingP.2009.Ecology-TheoriesandApplications.4<sup>th</sup>Ed.PrenticeHalofIndia.
14. Townsend,C.;J.L.Harper,M.Begon–Essentials ofEcology,BlackwellPublishing.

## FORLABORATORYCOURSE.

1. Ghosh,K.C.andManna,B.(2015):PracticalZoology,NewCentralBookAgency,Kolkata
2. Manna, B and Manna, S. (2019): Advanced Laboratory Manual of Parasitology and Immunoparasitology, New Central BookAgency,Kolkata
3. Poddar, T., Mukherjee, S., Das, S.K. (2003) Macmillan Publishers India Limited. An Advanced Laboratory Manual OfZoology.
4. Mazumder,Bhowal,Chatterjee,Saha(2020)ZoologyinLaboratory.SatraPublication.
5. D.K. Som, S. K. Bhowal, N.Ghosh, and A. Mukherjee (2024) A Concise Text Book on Practical Zoology. 1<sup>st</sup>Edition, RainbowPublishers,Kolkata700014,India.
6. S.S.Lal(2012)PracticalZoology.Volume1RastogiPublications,Meerut250002,India.
7. Ghosh,K.C.andManna,B.(2015):PracticalZoology,NewCentralBookAgency,Kolkata
8. Manna, B and Manna, S. (2019): Advanced Laboratory Manual of Parasitology and Immuno-parasitology, New Central Book Agency, Kolkata
9. SinhaJK,ChatterjeeAK.andChattopadhyayP.–AdvancedPracticalZoology.NewCentralBookAgency

## PART III : SEMESTER-V

### CORECOURSE-9:ChordateStructureandFunction[DSCC-9Theory]

FullMarks 75	3 Credits	45 Hours
<b>Unit1:IntroductiontoPhylumChordata</b>		<b>4</b>
Theories of Origin of chordates with reference to Dipleurula concept and the Echinoderm theory; General characteristics and outline classification (J.Z. Young, 1981).		SD2
<b>Unit2:Protochordata,AgnathaandPisces</b>		<b>8</b>
Protochordataand Agnatha:General characters andclassification 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 andclassification of Chondrichthyes and Osteichthyesuptoclass (J.Z.Young, 1981);Swimbladderinfishes;Structureof gillsincartilaginousandbonyfishes;Accessory respiratoryorgans;Olfactoryapparatusin <i>Tilapia</i> ;Electricorganin <i>Torpedo</i> .		SD
<b>Unit3:AmphibiaandReptilia</b>		<b>7</b>
OriginofTetrapods(Evolutionofterrestrialectotherms);Generalcharacteristicsandclassificationof Amphibia and Reptiliaup tolivingOrders(J.Z.Young,1981);Structure,function andderivativesof integument in amphibia; Paedomorphosis in Axolotl; Poisonous and Non-Poisonous snake; Poison apparatus and Biting mechanism in Snake.		CB
<b>Unit4:Avesand Mammalia</b>		<b>8</b>
GeneralcharacteristicsandclassificationofAvesandMammaliauptolivingSub-Classes(J.Z.Young, 1981);ExoskeletoninBirds;Air-sacsinPigeon,Aerodynamicsofflightinbirds;Exoskeleton derivativesofmammals;Dentitioninmammals;Ruminantstomach;EcholocationinMicro- chiropterans.		SS
<b>Unit5:Comparativeanatomyinchordates</b>		<b>10</b>
HeartandAorticarches;Brainwithreferencetocerebrum&cerebellum;kidneysandurino-genital ducts.		PG
<b>Unit6:Skeletalsystem</b>		<b>8</b>
Jawsuspensioninvertebrates;Abriefaccountofaxialskeletonandappendicularskeleton:typesof skullwithreferencetotemporalvacuities;vertebrae(structure,typesbasedoncentrumandregional specialization in mammals); structure of girdles (pectoral and pelvic girdles of Pigeon and Guinea pig)andlimbbones(Toad,PigeonandGuinea pig).		AM

### ChordateStructureandFunctionLab;DSCC-9-P

FullMarks 25	1 Credit	20 Hours
<b>ListofPractical</b>		
<ol style="list-style-type: none"> <li>1. Identification (upto order) with Reasons (Preserve specimen or Photograph) <b>Protochordata:</b> <i>Herdmania</i>, <i>Branchiostoma</i>, <b>Agnatha:</b> <i>Petromyzon</i>, <i>Myxine</i>; <b>Pisces:</b> <i>Scoliodon</i>, <i>Pristis</i>, <i>Hippocampus</i>, <i>Echeneis</i>, <i>Tetradon</i>, <i>Taractes</i>; <i>Tenualosa</i>, <i>Wallagu</i>, <i>Ompok</i>; <b>Amphibia:</b> <i>Necturus</i>, <i>Duttaphrynus</i>, <i>Rhacophorus</i>, <i>Hoplobatrachus</i>, <i>Ambystoma</i>, <i>Tylosotriton</i>, ; <b>Reptilia:</b> <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>; <b>Aves:</b> <i>Columba</i>, <i>Psittacula</i>, <i>Passer</i>, <i>Alcedo</i> <b>Mammalia:</b> <i>Sorex</i>, Bat (Insectivorous and Frugivorous), <i>Funambulus</i>, <i>Cavia</i>. <span style="color: red;">PG +CB+SD ***</span></li> <li>2. MountingofPlacoid,CycloidandCtenoidscales. <span style="color: red;">CB+AM</span></li> <li>3. Osteology:IdentificationofLimbbones,vertebraeandgirdlesof<i>Duttaphrynus</i>,<i>Columba</i>,<i>Cavia</i>;skullof <i>Duttaphrynus</i>,<i>Trionyx</i>,<i>Columba</i>,<i>Cavia</i>,<i>Canis</i>. <span style="color: red;">PG + SD2</span></li> <li>4. Comparativestudyofheartandbrain,withthehelpofmodel/pictures. <span style="color: red;">CB</span></li> <li>5. Anatomystudy:Brain,pituitary,olfactoryapparatus(exsitu),digestiveandurino-genitalsystemof<i>Tilapia</i> <span style="color: red;">CB+AM+SS</span></li> <li>6. PectenfromFowlhead. <span style="color: red;">PG</span></li> <li>7. <b>LNB</b></li> </ol>		

## PART III : SEMESTER V

### CORE COURSE - 10: Endocrinology and Reproductive Biology [DSCC - 10 Theory]

Full Marks 75	3 Credits	40 Hours
<b>Unit 1: Introduction to Endocrinology</b>		<b>2</b>
General idea of Endocrine system; Classification (with examples) & Transport of Hormones.		SD2
<b>Unit 2: Hypothalamo-Hypophyseal Axis</b>		<b>5</b>
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.		SD2
<b>Unit 3: Regulation of Hormone Action</b>		<b>5</b>
Receptors: Steroid hormone receptor, Isoreceptor, Orphan receptor Mechanism of action of steroidal, non-steroidal hormones with receptors (cAMP, IP3-DAG)		SD2
<b>Unit 4: Thyroid gland and parathyroid gland</b>		<b>5</b>
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.		PG
<b>Unit 5: Adrenal gland</b>		<b>5</b>
Histology of adrenal gland (LM study), Corticoid hormones with source, structure and function, Biosynthesis of adrenal and noradrenaline, Function of adrenaline; Generalised Adaptation Syndrome.		SS
<b>Unit 6: Pancreas</b>		<b>5</b>
Histology of pancreas (LM study) mentioning cell types with their hormone and function, Biosynthesis of insulin, Role of insulin and glucagon on carbohydrate homeostasis.		SD
<b>Unit 7: Pineal gland</b>		<b>3</b>
Histology of pineal gland (TEM study), Melatonin: Biosynthesis and its role in vitellogenesis in fish.		CB
<b>Unit 8: Reproductive endocrinology</b>		<b>5</b>
Histology of testis and ovary (LM study), Biosynthesis of oestrogen and testosterone, Effect of testosterone on prostate function, Effect of oestrogen on uterus. Lactation and its hormonal control Parturition and its hormonal control		SS
<b>Unit 9: Endocrine disorders</b>		<b>2</b>
Cause, Symptoms and Treatment: Graves' disease, Type I and Type II diabetes, Cushing Syndrome		AM
<b>Unit 10: Endocrine regulation of insect metamorphosis</b>		<b>3</b>
Endocrine glands; hormones and physiology of metamorphosis in insects		AM

### Endocrinology and Reproductive Biology Lab; DSCC - 10-P

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
1. Demonstration to localise thyroid, pancreas, adrenal, ovary and testis in rat.	SS	
2. Identification with reasons: Histological section of thyroid, pancreas, adrenal, ovary and testis of rat.		PG + AM
3. Analysis and interpretation of clinical condition from the provided blood sample data		
a) T <sub>3</sub> , T <sub>4</sub> , TSH and TPO		
b) Insulin, blood glucose and HbA1C	SS	
4. Haematoxylin-Eosin (HE) staining of histological section: Mammalian thyroid, adrenal, pancreas, testis and ovary.		AM + PG
5. LNB		

## PART III : SEMESTER V

### CORE COURSE- 11: Animal Physiology [DSCC-11 Theory]

Full Marks 75	3 Credits	45 Hours
<b>Unit 1: Physiology of Digestion</b>		<b>6</b>
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.		SD2
<b>Unit 2: Physiology of Respiration</b>		<b>6</b>
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.		AM
<b>Unit 3: Physiology of Circulation</b>		<b>8</b>
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 Stroke volume.		SS
<b>Unit 4: Renal Physiology</b>		<b>8</b>
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.		PG
<b>Unit 5: Neurophysiology</b>		<b>5</b>
Structure of neuron; Mechanism of impulse propagation across the myelinated and non-myelinated nerve fibres; Synapse: Chemical and Electrical; Mechanism of Synaptic transmission.		SD
<b>Unit 6: Muscular physiology</b>		<b>5</b>
Structure of muscle protein and their role along with calcium and ATP in muscle contraction (excitation-contraction-coupling); Muscle twitch, Muscular fatigue.		CB
<b>Unit 7: Thermoregulation</b>		<b>3</b>
Definition and example of aestivation and hibernation; Thermoregulation in camel, polar bear.		AM
<b>Unit 8: Reproductive physiology</b>		<b>4</b>
Menstrual cycle: stages with ovarian, uterine and hormonal changes. Estrous cycle: Stages with ovarian, vaginal and hormonal changes.		PG

### Animal Physiology Lab; DSCC-11-P

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
1. Determination of ABO Blood group and Rh factor. PG + SD2		
2. Identification of blood cells from human blood film (permanent slide). SS		
3. Staining, mounting and identification of haemocytes from cockroach haemolymph. SD + AM		
4. Preparation of haemincrystals from rat blood. PG + SD2		
5. Demonstration of blood pressure by digital meter. PG		
6. Qualitative tests for Ammonia, Urea and Uric acid in given sample. PG + SD2		
7. LNB		

## PART III : SEMESTER V

### CORE COURSE- 12: Biodiversity and Conservation Biology [DSCC- 12 Theory]

Full Marks 75	3 Credits	46 Hours
<b>Unit 1: Introduction to Biodiversity</b>		<b>10</b>
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).		AM
<b>Unit 2: Threats to biodiversity</b>		<b>7</b>
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 effect on Forest and Marine Ecosystems; Climate change effect on Indian Fauna.		CB
<b>Unit 3: Wildlife conservation. In situ Conservation.</b>		<b>15</b>
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.		SD
<b>Unit 4: Ex situ Conservation.</b>		<b>7</b>
Captive breeding of wild animals: Concept of captive breeding; Advantages and challenges of Captive Breeding; Re-introduction.		SD
<b>Unit 5: Wildlife Laws</b>		<b>7</b>
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).		SD

## Biodiversity and Conservation Biology Lab; DSCC-12-P

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
1. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community	AM	
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]	AM +SD +PG +SS	
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	SS	
4. Biodiversity study of in any one of the ecosystems of West Bengal (Study A is mandatory and any two studies from the rest)	FIELD REPORT SS+AM	two
A. Checklist 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. <b>LNB</b>		

## PART III : SEMESTER - VI

### CORECOURSE- 13: Developmental Biology [DSCC-13 Theory]

Full Marks 75	3 Credits	43 Hours
<b>Unit 1: Gametogenesis</b>		<b>5</b>
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).		<b>CB</b>
<b>Unit 2: Fertilization</b>		<b>4</b>
Internal and external fertilization; Phases of fertilization in sea urchin and mammal.		<b>SD</b>
<b>Unit 3: Post Fertilization events</b>		<b>10</b>
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; Fat map in chick embryo, fat mapping using vital dye technique. Extraembryonic membranes in chick and their functions.		<b>PG</b>
<b>Unit 4: Organogenesis</b>		<b>8</b>
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). <b>Induction in</b> : Neural Tube Formation and Development of Brain; Development of eye: retina, optic cup and lens. Development of Kidney: Different phases and reciprocal induction.		<b>SS</b>
<b>Unit 5: Implantation</b>		<b>4</b>
Implantation in humans: Types and hormonal control. Placenta: Structure, types based on histological association and distribution of villi; functions of placenta.		<b>AM</b>
<b>Unit 6: Infertility and ART</b>		<b>4</b>
Causes of infertility; Types of ART (ZIFT, GIFT, ICSI, IUI); Cryopreservation of gametes; IVF: method, advantages and disadvantages.		<b>SD2</b>
<b>Unit 7: Stem cells and its application</b>		<b>4</b>
Definition, Types with examples, concept of potency, applications of stem cell therapy in bone marrow transplantation and cartilage regeneration.		<b>SD2</b>
<b>Unit 8: Regeneration</b>		<b>4</b>
Regeneration: Morphallaxis and Epimorphosis in <i>Hydra</i> ; Epimorphic limb regeneration in Salamander.		<b>SD2</b>

### Developmental Biology Lab; DSCC-13-P

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
1. Study of whole mounts of developmental stages of chick embryo through permanent slides: 24, 48, 72 and 96 hours of incubation <b>SD</b>		
2. Study of the developmental stages and life cycle of <i>Drosophila</i> and frog using photographs <b>SD+PG</b>		
3. Study of different sections of placenta (photograph) <b>PG</b>		
4. 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> . <b>PG</b>		
5. Mounting of rat sperm and fish ova <b>PG+SD</b>		
6. <b>LNB</b>		

## PART III : SEMESTER VI

### CORE COURSE-14: Taxonomy, Evolution and Adaptation [DSCC-14 Theory]

Full Marks 75	3 Credits	45 Hours
<b>Unit 1: Taxonomy 1: Basics of Taxonomy and Systematics</b>		<b>5</b>
<p><b>Taxonomy and Systematics:</b> definition and importance; Binomial and Trinomial nomenclature; Law of priority; Homonymy and Synonymy: definition with example. <b>Taxonomic types:</b> Holotype, Paratype, Allotype, Lectotype, Neotype and Syntype: definition with example; <b>Linnean Hierarchy;</b> Biological Species concept and its limitations.</p>		AM
<b>Unit 2: Taxonomy 2: Character and Character states</b>		<b>3</b>
<p><b>Types of characters with examples:</b> Primitive, Advance, convergence, parallelisms, reversal of characters; Outgroup and ingroup; Homology versus Analogy; Monophyly, Polyphyly and Paraphyly: definition with examples.</p>		SD2
<b>Unit 3: Taxonomy 3: Approaches in Classification</b>		<b>6</b>
<p><b>Classification:</b> Definition; <b>Phenetics:</b> Definition, OTU, Single linkage clustering and construction of phenogram; <b>Cladistics:</b> Definition, brief concept on parsimony; DNA Barcoding and application.</p>		SD2
<b>Unit 4: Evolution 1: Gene frequency in a Population and Factors influencing gene frequency</b>		<b>8</b>
<p>Hardy-Weinberg Principle: Assumption, proof of equilibrium, calculation of gene frequency and genotype frequency (for autosomal gene only), testing for equilibrium; Equilibrium destabilizing forces: concept and mathematical expression of Selection (against deleterious recessive allele only); Mutation (changes from dominant to recessive allele only) and Migration.</p>		PG
<b>Unit 5: Evolution 2: Concept of Organic Evolution</b>		<b>7</b>
<p><b>Biochemical Origin of life:</b> concept of Protenoids, Microspheres and Protobionts; RNA-world Hypothesis; Darwinism and its limitations; <b>Modern Synthetic Theory of Evolution:</b> Sources of variation; Natural selection (types with example); Genetic drift and population bottle neck; Isolation (types with examples); <b>Speciation:</b> types and examples.</p>		CB
<b>Unit 6: Evolution 3: Evidences</b>		<b>7</b>
<p><b>Biogeographical realms:</b> definition, names of six realms; geographical limit, climate and important vertebrate fauna of Oriental, Palaeartic and Australian realms; <b>Geological timescale</b> (only outline idea; detail description not needed); <b>Fossil:</b> types and age determination by Carbon dating; <b>Evolution of horse; Evolution of Man.</b></p>		SD
<b>Unit 7: Adaptation 1: Basics of adaptation</b>		<b>4</b>
<p>Adaptation: definition; adaptive convergence, adaptive divergence: definition with examples; Adaptive radiation in marsupial mammals and Darwin's finches.</p>		SD
<b>Unit 8: Adaptation 2: Form of adaptation</b>		<b>5</b>
<p>Cursorial adaptation; Fossorial adaptation; Desert adaptation; Primary and secondary aquatic adaptation, Colouration and Mimicry.</p>		SS

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

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
<p>1. Study of fossils from models/pictures: <i>Dickinsonia</i>, <i>Paradoxides</i> (Trilobite), <i>Asteroceras</i> (Ammonoid), <i>Pentremites</i> (Blastoid Echinoderm), Ichthyosaur, <i>Archaeopteryx</i>, Cynodont. <b>CB</b></p> <p>2. Study (from preserved specimen or photographs) of features and their adaptive significance : <i>Labeorohita</i>, <i>Exocoetusp.</i> (Flying fish), <i>Cynoglossusp.</i> (Flat fish, Bengal tongue-sole), <i>Torpedo</i> sp. (Electric ray), <i>Himanturasp.</i> (Sting-ray of Bay of Bengal), <i>Sphyrna</i> sp. (hammer-headed shark), <i>Ichthyophisp.</i>, Axolotl larva of <i>Ambystomasp.</i>, <i>Hylasp.</i>, <i>Phrynosomasp.</i>, <i>Crocodylusp.</i>, <i>Najasp.</i>, <i>Pipistrellusp.</i> (Indian common Microchiroptera), <i>Bandicotasp.</i>, <i>Platinistasp.</i> (Gangetic dolphin), <i>Semnopithecusp.</i> (Hanuman Langur). <b>CB</b></p> <p>3. *Phylogenetic trees, Construction &amp; interpretation of Phylogenetic tree using parsimony, Construction of dendrogram following principles of phenetics &amp; cladistics from a data table. <b>SD2</b></p> <p>4. *Calculation of change in gene frequency in population due to Selection (against deleterious recessive trait only), Mutation (changes from dominant to recessive trait only), Migration. <b>PG + SD2</b></p> <p>5. <b>LNB.</b></p> <p>*Only for major course students</p>		

## PART III : SEMESTER VI

### CORECOURSE-15:AnimalBehaviour[DSCC-15Theory]

FullMarks75	3Credits	44Hours
<b>Unit1:IntroductiontoAnimalBehaviour</b>		<b>5</b>
Contribution of Konrad Lorenz, Karl Von Frisch and Niko Tinbergen; Three foundations of behaviour study: Natural selection, individual learning and cultural transmission; Approaches in behaviour study: Conceptual, theoretical and empirical.		SD2
<b>Unit2:PatternsofBehaviour</b>		<b>6</b>
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.		SD2
<b>Unit3:SocialBehaviour</b>		<b>7</b>
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.		PG
<b>Unit4:SexualBehaviour</b>		<b>7</b>
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.		SD
<b>Unit5:EvolutionaryStrategies</b>		<b>8</b>
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.		SS
<b>Unit6:BiologicalRhythm</b>		<b>5</b>
Types and characteristics of biological rhythms; Photoc and non-photoc 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).		AM
<b>Unit7:Communication</b>		<b>6</b>
Adaptive value of Communication: Example of yelling Raven and related hypothesis. Cost-benefit 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 kairomones, Synomones, info-chemicals, semio-chemicals; Bruce effect, Lee boot effect and Whitten effect of pheromones. Tactile Communication: Beedance language.		CB

## Animal Behaviour Lab; DSCC-15-P

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>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).</li> <li>2. Study of geotaxis behavior in earthworm and phototaxis behavior in insect larvae.</li> <li>3. Identification of common behavior (by photographs/video) of Fixed Action pattern in Stickleback &amp; 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.</li> <li>4. To study circadian functions in humans (daily eating, sleep and temperature patterns). <span style="float: right; color: red;">AM+SS</span></li> <li>5. <b>LNB</b></li> </ol>		

## 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 KV. 2005. Comparative Anatomy of Vertebrates, Function and Evolution; McGraw-Hill
4. Norman, J.R. A history of Fishes, Hill and Wang Publishers
5. Parker TJ, Haswell W. 1972. Text Book of Zoology, Volume I: Marshall and William Eds. Macmillan Pr.
6. Pough H, Christine MJ, Haiser B. 2002. Vertebrate Life, VIII Edition, Pearson Internatl.
7. Romer AS, Parsons TS. 1986. The vertebrate body. 6th Ed. Saunders College Publishing
8. Som, D.K., Bhowal, S.K., Ghosh, N. and Mukherjee, A. (2024) A concise Text Book on Practical Zoology,
9. Rainbow Publisher, Kolkata
10. Ghosh, K.C. and Manna, B. (2009) Practical Zoology, New Central Book Agency (P) Ltd. Kolkata
11. Young JZ. 1981. The Life of Vertebrates. III Edition. Oxford University Press

### CORE COURSE-10: ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY

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

### CORE COURSE-11: ANIMAL PHYSIOLOGY

1. Ganong's Review of Medical Physiology; McGraw Hill
2. Hall JE. 2015. Guyton and Hall Textbook of Medical Physiology. Saunders publication.
3. Hill RW, Wyse GA, Anderson M. 2012. Animal Physiology. 3rd Edn. Sinauer Assn
4. Randall ID, Burggren W. 2001. Eckert Animal Physiology by. 4th edition. W.H. Freeman.
5. Sembulingam K, Sembulingam P. 2012. Essentials of Medical Physiology. Jaypee Pub, New Delhi
6. Sherwood L. 2013. Human Physiology from cells to systems. 8th Edn. Brooks & Cole
7. Tortora, G.J. and Derrickson, B.H.; 2009. Principles of Anatomy and Physiology, XI 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
7. New T.R. – Invertebrate Surveys for Conservation – Oxford Univ. Pr
8. Saha G.K. & S. Majumdar – Threatened Mammals of India – Daya Publication House
9. Saha GK, Mazumdar S. 2017. Wildlife Biology: an Indian Perspective, PHI Learning,
10. Saharia VB. 1998. Wildlife in India. Natraj Publishers.
11. Sutherland WJ. 1997. Ecological Census Techniques, A Handbook. Cambridge University Press.
12. Sutherland WJ. 2000. The Conservation Handbook: Research, Management & Policy. Blackwell Sc
13. Van Dyke F. 2008. Conservation Biology: Foundations, Concepts, Application. 2nd Ed. Springer Science Wild life (Protection) Act 1972 – Wildlife Society of India (Nataraj Publication)
14. Wilson, E. O. – Biodiversity – National Academic Press Woodroffe R., Thirgood S, Rabinowitz A. 2005. People and Wildlife, Conflict or Co-existence? Cambridge Univ. P2111

### **CORECOURSE-13:DEVELOPMENTALBIOLOGY**

1. CarlsonBM.2014.HumanEmbryologyandDevelopmentalBiology.5thEdn.Elsevier.
2. GilbertS.F.2010.DevelopmentalBiology,IXEdition,SinauerAssociates,Inc.,Publishers,
3. SlackJMW.2012.EssentialDevelopmentalBiology.Wiley-Blackwell.
4. WolpertL.2002.PrinciplesofDevelopment.2ndEdn.OxfordUniv.Press.

### **CORECOURSE-14:TAXONOMY,EVOLUTIONANDADAPTATION**

1. Mayr,E.andAshlock,P.D.(1992)PrinciplesofSystematicZoology(2<sup>ND</sup>Edn.).McGrawHill,NewYork
2. Quicke,D.L.J.(1997)PrinciplesandTechniquesofContemporaryTaxonomy.(1<sup>st</sup>Edn)BlackieAcademic& Professional,animprintofChapman&Hall,London
3. Blackwelder,R.E.(1967)Taxonomy,aTextandReferencebook.JohnWileyandSons,NewYork
4. I.C.Z.N. (1985) International Code of Zoological Nomenclature (3<sup>rd</sup>Edn) University of California Press, Berkley and Los Angeles.
5. Rosenbaum,P.A.(2011)Volpe'sUnderstandingEvolution.McGrawHill,NewYork.
6. Som,D.K.,Bhowal,S.K.,Ghosh,N.andMukherjee,A.(2024)AconciseTextBookonPracticalZoology.(1<sup>st</sup>Edn). Rainbow Publishers, Kolkata, India
7. Hall,B.K.(2008)Strickberger'sevolution(4<sup>th</sup>Edn.)JonesandBarlettPublishers,USA
8. Futuyma,D.J.(2024)Evolution(5<sup>TH</sup>Edn.)OxfordUniversityPress.

### **CORECOURSE-12:ANIMALBEHAVIOR**

1. AlcockJ.2013.AnimalBehaviour,SinauerAssociatInc.,USA.
2. DrickamerLC,VesseySH.2001.AnimalBehaviour.McGraw-Hill
3. DugatkinLA.2014.PrinciplesofAnimalBehaviour.3rdEdn.W.W.NortonandCo.

# 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 16<sup>th</sup> May to 30<sup>th</sup> 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 project 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

## CORECOURSE-16: BIOTECHNOLOGY & ITS APPLICATION [DSCC-16 Theory]

Full Marks 75	3 Credits	46 Hours
<b>Unit 1: Introduction and Molecular Techniques in Gene Manipulation</b>		<b>8</b>
<p>Organization of <i>E. coli</i>; Recombinant DNA Technology, Restriction endonucleases.</p> <p><b>Cloning Vectors &amp; their features:</b> Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, and HAC. Shuttle and Expression Vectors. Construction of Genomic libraries and cDNA libraries.</p> <p><b>Transformation techniques:</b> Cloning in bacteria and detection technique of clone. Polymerase chain reaction: DNA Fingerprinting</p>		
<b>Unit 2: Genetically Modified Organisms</b>		<b>5</b>
<p><b>Production of cloned and transgenic animals:</b> Nuclear Transplantation, Retroviral Method, DNA microinjection.</p>		
<b>Unit 3: Culture Techniques and Applications</b>		<b>5</b>
<p>Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle Cell Anaemia). Dolly &amp; Polly cloning. Gene Therapy</p>		
<b>Unit 4: Introduction to Bioinformatics</b>		<b>9</b>
<p><b>Overview of Bioinformatics:</b> Definition, scope, and significance in modern biology and biotechnology; Types of molecular biological data: Genomic sequences; Protein sequences and structures; Gene expression data</p> <p><b>Biological Databases and Data Sources</b></p> <ul style="list-style-type: none"> <li>• <b>Nucleotide Sequence Databases:</b> NCBI GenBank; NCBI RefSeq (Ref. Sequence Database)</li> <li>• <b>Protein Structure and Sequence Databases:</b> RCSB PDB (Protein Data Bank)</li> <li>• <b>Functional Gene Databases:</b> GeneCards® – The Human Gene Database</li> <li>• <b>Expression Data Repositories:</b> NCBI GEO (Gene Expression Omnibus)</li> </ul>		
<b>Unit 5: Tools of Bioinformatics</b>		<b>9</b>
<p><b>Sequence Alignment and Comparative Genomics:</b> Importance and applications in functional and evolutionary biology; <b>Key Concepts:</b> Similarity vs Homology; Homology, Paralogy, Orthology, Analogy, Xenology</p> <p><b>Sequence Alignment Techniques</b></p> <ul style="list-style-type: none"> <li>• <b>Pairwise Alignment:</b> Local and global alignment; Dot matrix method</li> <li>• <b>Multiple Sequence Alignment (MSA):</b> Purpose and significance; Tools: Clustal W</li> </ul> <p><b>Sequence Search</b></p> <ul style="list-style-type: none"> <li>• <b>BLAST (Basic Local Alignment Search Tool):</b> Working principle and types of BLAST</li> <li>• <b>FASTA Format:</b> Representation and structure for nucleotide and amino acid sequences</li> </ul> <p><b>Phylogenetic Analysis</b></p> <ul style="list-style-type: none"> <li>• Using sequence data to infer evolutionary relationships</li> <li>• <b>Distance-Based Methods:</b> <ul style="list-style-type: none"> <li>○ UPGMA (Unweighted Pair Group Method with Arithmetic Mean)</li> <li>○ Neighbour Joining (NJ)</li> </ul> </li> </ul>		
<b>Unit 6: Microbial Biotechnology</b>		<b>5</b>
<p>Food Production - Dairy products &amp; probiotics, Pharmaceuticals - production of antibiotics and antifungals and Biofuel production</p>		
<b>Unit 7: Biosafety</b>		<b>5</b>
<p>Biosafety Principle: Primary and Secondary Barriers; Types of Risk (occupational, environmental, ethical) &amp; 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)</p>		

## BIOTECHNOLOGY&ITSAPPLICATIONLAB;DSCC-16-P

FullMarks25	1 Credit	20Hours
<b>List of Practical</b>		
<p>7. Plasmid DNA isolation (pUC18/19) from <i>E.coli</i></p> <p>8. <b>BLAST Analysis</b></p> <ul style="list-style-type: none"><li>• Performing <b>BLASTn</b> for nucleotide sequence similarity search.</li><li>• Performing <b>BLASTp</b> for protein sequence similarity search.</li><li>• Understanding and interpreting <b>BLAST results</b>: E-value, identity, and alignment score</li></ul> <p>9. <b>Melting Temperature (T<sub>m</sub>) Calculation of PCR Primers</b>: Designing short oligonucleotide primers for PCR.; Calculating <b>melting temperature (T<sub>m</sub>)</b> using standard formulas or online tools.</p> <p>10. <b>Phylogenetic Tree Construction</b>: Application of <b>distance matrix methods-UPGMA (Unweighted Pair Group Method with Arithmetic Mean); Neighbour Joining (NJ)</b> method</p> <p>11. <b>LNB</b></p> <p><b>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.</b></p>		

## PART IV: SEMESTER VII

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

Full Marks 75	3 Credits	45 Hours
<b>Unit 1: Structures of Nervous System</b>		<b>9</b>
Types of Invertebrates nervous system: Nervous system in Cnidarians (Nerve net of Hydra, medusa nerve net and pacemaker nerve in Aurelia), Ladder Annelida (Earthworm), and Insects (Cockroach), Mollusca (Octopus), Echinodermata (Asterias). General plan and organization of central, peripheral and autonomic nervous system in Vertebrate. Different nuclei/lobes/areas and function of thalamus, hypothalamus, cerebellum, cerebral cortex and brain stem in Human.		
<b>Unit 2: Nerve and Nerve-Muscle Physiology</b>		<b>5</b>
Structure of neuromuscular junction and mechanism of neuromuscular transmission. Modulation of Synaptic transmission.		
<b>Unit 3: Sensory Nervous System</b>		<b>8</b>
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.		
<b>Unit 4: Neurodevelopment and Higher Brain Functions</b>		<b>8</b>
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.		
<b>Unit 5: Neurochemistry and Neuroendocrine System</b>		<b>5</b>
Cellular and Molecular foundation of Neuro-biochemistry (Human): Neurotransmitters and Neuromodulators [Acetylcholine, Dopamine, GABA, Serotonin, Nor-epinephrine and Glutamine and receptors for Acetylcholine, Blood brain barrier		
<b>Unit 6: Tools in Neuroscience</b>		<b>5</b>
Techniques and tools applicable in neuroscience: CT, MRI, PET, Optogenetics, Patch Clamp, EEG, Neural stimulation, Brain-computer interface.		
<b>Unit 7: Neuropathology</b>		<b>5</b>
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
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Identification of CNS and PNS structures in animal models (Mouse/Chick/Zebrafish/Drosophila).</li> <li>2. Gross anatomy of Human brain and its different parts (with models).</li> <li>3. Studying early, mid and late developmental stages of CNS in animal models (Chick, Zebrafish).</li> <li>4. Identification of different brain areas in CT and MRI images.</li> <li>5. <b>LNB</b></li> </ol>		

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

Full Marks 75	3 Credits	47 Hours
<b>Unit 1: Introduction to Toxicology</b>		<b>10</b>
<p>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 &amp; Cadmium] Pesticides [Organochlorine and organophosphates], Microplastics. Acute toxicity, chronic toxicity, systemic toxicity, local toxicity (concept only); Scope of Toxicology</p>		
<b>Unit 2: Toxicants: Routes, Dose Toxicity test and influencing factors</b>		<b>10</b>
<p><b>Exposure to Toxicants.</b> Routes and Sites of Exposure (Inhalation, Injection, Intestinal)  <b>Factors influencing toxicity.</b> Species, Strains, Age, Sex, Nutritional Status, Environmental Stressors.  <b>Dose of toxicants:</b> 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</p>		
<b>Unit 3: Xenobiotic Classification and Metabolism</b>		<b>7</b>
<p>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]</p>		
<b>Unit 4: Action of Toxicants</b>		<b>10</b>
<p>Receptors, Mechanism of action of Lead, DDT            Bioremediation in soil and aquatic system. Therapeutic Index, Potency and Efficacy.</p>		
<b>Unit 5: Environmental Contaminants</b>		<b>6</b>
<p>Food additives [Metanillyellow, 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.</p>		
<b>Unit 6: Endocrine Disruptors</b>		<b>4</b>
<p>Source, Types, Effects, Mechanism of action on behavior and neuroendocrine system:            Phthalate; BPA; PCB; DDT; DES; and PAH</p>		

**TOXICOLOGY LAB; DSCC-18-P**

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>Study of Acute, Subacute and Chronic toxicity of Formaldehyde on <i>Drosophila</i> larva.</li> <li>Study of LC50 for 24, 48, 72, 96 hours of Temephoson on mosquito larva.</li> <li>Micronucleus study from Buccal Smear.</li> <li>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.</li> <li><b>LNB</b></li> </ol>		

**PART IV: SEMESTER VII**  
**CORE COURSE-19: IMMUNOLOGY [DSCC-19 Theory]**

Full Marks 75	3 Credits	47 Hours
<b>Unit 1: Introduction</b>		<b>5</b>
Cells and Organs [Primary, Secondary and Tertiary] of the Immune system		
<b>Unit 2: Innate and Adaptive Immunity</b>		<b>7</b>
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).		
<b>Unit 3: Antigens</b>		<b>4</b>
Antigenicity and Immunogenicity, Immunogens, Adjuvants and Haptens, Factors influencing immunogenicity, B and T-Cell epitopes		
<b>Unit 4: Immunoglobulins</b>		<b>7</b>
Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA, RIA and Immunoprecipitation), Monoclonal antibody production		
<b>Unit 5: Major Histocompatibility Complex</b>		<b>6</b>
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		
<b>Unit 6: Cytokines</b>		<b>3</b>
Types, properties and functions of cytokines.		
<b>Unit 7: Complement System</b>		<b>4</b>
Components and pathways of complement activation.		
<b>Unit 8: Hypersensitivity</b>		<b>6</b>
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.		
<b>Unit 9: Vaccines &amp; Immunotherapy</b>		<b>5</b>
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
<b>List of Practical</b>		
1. Widal test.		
2. Demonstration of Lymphoid Organs (by picture).		
3. Histological study of Bursa of Fabricius, Spleen, Thymus and Lymph nodes through photographs		slides/
4. Demonstration of ELISA, Immunoprecipitation and Ouchterlony method through photographs		
5. <b>LNB</b>		

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

Full Marks 75	3 Credits	48 Hours
<b>Unit 1: Concept of Animal Model and their Application in Research</b>		<b>6</b>
Different Animal Models and their Advantage and Limitations Cnidaria; <i>C. elegans</i> ; <i>Drosophila</i> ; Starfish and Sea urchin; Zebrafish; Mouse, Rat and Monkey		
<b>Unit 2: Cnidaria</b>		<b>6</b>
<ul style="list-style-type: none"> <li>• Classic Hydra Regeneration Experiments <i>Spemann, H. (1938). Embryonic Development and Induction. Yale University Press.</i> <i>Lenhoff, H.M., &amp; Lenhoff, S.G. (1986). Hydra and the Birth of Experimental Biology: 1744. Boxwood Press.</i></li> <li>• 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></li> </ul>		
<b>Unit 3: <i>C. elegans</i></b>		<b>6</b>
<ul style="list-style-type: none"> <li>• Genetic Regulation of Organ Development &amp; 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 protease similar to mammalian interleukin-1<math>\beta</math>-converting enzyme." <i>Cell</i>, 75(4), 641–652.</i></li> <li>• 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., &amp; Mello, C.C. (1998). Potent and specific genetic interference by double-stranded RNA in <i>Caenorhabditis elegans</i>. <i>Nature</i>, 391(6669), 806–811.</i></li> </ul>		
<b>Unit 4: <i>Drosophila</i></b>		<b>10</b>
<ul style="list-style-type: none"> <li>• Sex determination and Dosage compensation</li> <li>• Cytological Demonstration of Crossing over [Sterns Experiment];</li> <li>• Muller sex experiment for Balanced-lethal system; Concept of Balancer;</li> <li>• Position effect variegation.</li> <li>• Concept of axis formation and homeotic gene in <i>Drosophila</i></li> <li>• 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>. <i>Nature</i>, 277(5688), 565–570.</i></li> </ul>		
<b>Unit 5: Starfish and Sea-urchin</b>		<b>6</b>
<p><b>Starfish:</b></p> <ul style="list-style-type: none"> <li>• 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></li> </ul> <p><b>Sea Urchin:</b></p> <ul style="list-style-type: none"> <li>• Tim Hunt – Discovery of Cyclins: Nobel Prize in Physiology or Medicine, 2001 (with Leland Hartwell &amp; Paul Nurse) <i>Evans, T., Rosenthal, E.T., Youngblom, J., Distel, D., &amp; Hunt, T. (1983). Cyclin: A protein specified by maternal mRNA in sea urchin eggs that is destroyed at each cleavage division. <i>Cell</i>, 33(2), 389–396.</i></li> <li>• Understanding of acetyl-CoA as the universal intermediate in metabolism; cornerstone of the Krebs cycle. <i>Hans Adolf Krebs &amp; Fritz Lipmann – Discovery of Coenzyme A. Nobel Prize in Physiology or Medicine, 1953. Lipmann, F. (1945). <i>J. Biol. Chem.</i>, 160, 173–190.</i></li> </ul>		
<b>Unit 6: Zebra fish</b>		<b>6</b>
<ul style="list-style-type: none"> <li>• Establishing the zebrafish developmental staging series.</li> </ul>		

<p>Kimmel, C.B., Ballard, W.W., Kimmel, S.R., Ullmann, B., &amp; Schilling, T.F. (1995). Stages of embryonic development of the zebrafish. <i>Developmental Dynamics</i>, 203(3), 253–310. <a href="https://doi.org/10.1002/aja.1002030302">https://doi.org/10.1002/aja.1002030302</a>.</p> <ul style="list-style-type: none"> <li>• Large-scale mutagenesis screens led by Christiane Nüsslein-Volhard and Wolfgang Driever, which became a landmark in zebrafish genetics.</li> </ul> <p>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., &amp; 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.</p>	
<p><b>Unit 7: Mouse/Rat and Monkey/Horse</b></p>	<b>8</b>
<ul style="list-style-type: none"> <li>• Concept of gene knockout, knockdown and knockin.</li> <li>• <b>Mice:</b> 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></li> <li>• <b>Monkey:</b> Primate visual cortex physiology (Hubel &amp; 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></li> <li>• <b>Horse:</b> Immunization of horses (to raise anti-venom antibodies)]</li> </ul>	

### ANIMAL MODELS IN RESEARCH LAB; DSCC-20-P

Full Marks 25	1 Credit	20 Hours
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Identification of X-linked and autosomal dominant and recessive mutation in <i>Drosophila</i></li> <li>2. Use of mutation in inheritance study through genetic crosses.</li> <li>3. Demonstration of different imaginal discs and expression of genes through photographs.</li> <li>4. Demonstration of developmental stages of Zebrafish through photographs.</li> </ol>		
<b>5. LNB</b>		

## PART IV: SEMESTER-VIII

### CORECOURSE-21: RESEARCH METHODOLOGY-1 [DSCC-21 Theory]

Full Marks 75	3 Credits	45 Hours
<b>Unit 1: Plan and Design of Research Framework:</b>		<b>7</b>
<p>(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.</p>		
<b>Unit 2: Data:</b>		<b>7</b>
<p>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.</p>		
<b>Unit 3: Estimate of the Central Tendency:</b>		<b>5</b>
<p>Concept and calculation of mean, median and mode (only for normal distribution). Estimation of variance and standard distribution of normally distributed data.</p>		
<b>Unit 4: Hypothesis Testing:</b>		<b>10</b>
<p>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).</p>		
<b>Unit 5: Correlation and Regression:</b>		<b>6</b>
<p>Correlation coefficient, Positive and negative correlation, co-variance, Linear regression and regression line, concept of outlier.</p>		
<b>Unit 6: Research Ethics:</b>		<b>5</b>
<p>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, CCSEA guideline in India.</p>		
<b>Unit 7: Biological Research and Society:</b>		<b>5</b>
<p>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.</p>		

## PART IV: SEMESTER VII I

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

Full Marks 75	3 Credits	46 Hours
<b>Unit 1: Writing Of A Scientific Paper:</b>		<b>8</b>
<p>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.</p>		
<b>Unit 2: Literature Review:</b>		<b>8</b>
<p>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.</p>		
<b>Unit 3: Bibliography:</b>		<b>4</b>
<p>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.</p>		
<b>Unit 4: Presentation Of Research:</b>		<b>10</b>
<p>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.</p>		
<b>Unit 5: Writing A Research Proposal For Grant And Preparing Its Report:</b>		<b>7</b>
<p>Component of grant proposal: Abstract/Summary, Introduction and Background, Aims &amp; 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.</p>		
<b>Unit 6: Intellectual Property Right (IPR)</b>		<b>4</b>
<p>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.</p>		
<b>Unit 7: Copyright And Patent:</b>		<b>5</b>
<p>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,</p>		

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

<b>Full Marks 75</b>	<b>3 Credits</b>	<b>40 Hours</b>
<b>Unit 1: Elements of Biophysics</b>		<b>6 Hours</b>
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-Boltzmann equation.		
<b>Unit 2 : Chromatography</b>		<b>6 Hours</b>
Principles and Applications: Paper Chromatography, Thin-layer Chromatography, Adsorption chromatography, Affinity Chromatography, Ion-exchange Chromatography, Molecular sieve Chromatography, High performance liquid Chromatography, Gas Chromatography		
<b>Unit 3 : Spectroscopy</b>		<b>10 Hours</b>
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		
<b>Unit 4 : Flow Cytometry</b>		<b>5 Hours</b>
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		
<b>Unit 5: Basic Laboratory Instruments</b>		<b>4 Hours</b>
Applications of Water distillation plant, Dry bath and Water bath, BOD incubator, pH meter, Vortex, Magnetic stirrer, Weighing balance (manual and digital), Autoclave		
<b>Unit 6: Polymerase Chain Reaction (PCR)</b>		<b>5 Hours</b>
Basic concept; Stages in PCR; PCR primer designing; Types of PCR (Allele specific PCR, RT-PCR, qRT-PCR, RAPD PCR), Applications of PCR		
<b>Unit 7: Medical Diagnostic Tools</b>		<b>4 Hours</b>
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**

<b>Full Marks 25</b>	<b>1 Credit</b>	<b>20 Hours</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Analysis of: -a) Apoptosis and b) Cell Cycle from flow cytometry data sheets. [PI &amp; Annexin V]</li> <li>2. Packing and Sterilization of glass and plastic wares using Autoclave.</li> <li>3. Paper Chromatography – Demonstration and Rf value calculation. [amino acids]</li> <li>4. Estimation of Random blood sugar using a Glucometer.</li> <li>5. Estimation of blood oxygen saturation using Pulse oximeter.</li> <li>6. Analysis of Electrocardiogram data sheets.</li> <li>7. <b>LNB.</b></li> </ol>		

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

Full Marks 75	3 Credits	46 Hours
<b>Unit 1: Introduction</b>		<b>7</b>
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.		
<b>Unit 2: Zoonosis</b>		<b>7</b>
Definition, List of Zoonotic Diseases, Concept of Zoonosis with respect to Taeniasis, Chikungunya, Typhus, Dengue.		
<b>Unit 3: Communicable diseases</b>		<b>4</b>
Causes, Symptoms, Epidemiology, Prevention, Diagnostic Techniques of AIDS, Hepatitis B, Tuberculosis, and its Types, SARS, MARS, Ebola, Zika		
<b>Unit 4: Non-Communicable diseases</b>		<b>10</b>
Causes, Types, Symptoms, Epidemiology, Prevention, Risk Factors of Obesity and Hypertension.		
<b>Unit 5: Occupational disease</b>		<b>6</b>
Definition and detail of Silicosis, Anthracosis, Byssinosis, Asbestosis, Farmer's Lung, Lead poisoning and Occupational dermatitis.		
<b>Unit 6: Mental health</b>		<b>3</b>
Types according to ICD 10, their causes and prevention.		
<b>Unit 7: Nutrition and health</b>		<b>5</b>
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.		
<b>Unit 8: Health planning and management</b>		<b>4</b>
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
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Calculation of BMI from data sheet and assessment of health status.</li> <li>2. Identification and clinical significance (with picture) of <i>Mycobacterium tuberculosis</i>, HIV, <i>Xenopsyllacheopsis</i>, Hepatitis B, Hexacanth/Oncosphere, Ebola, Zika</li> <li>3. CBC, Lipid profile and LFT report analyses.</li> <li>4. LNB</li> </ol>		

## SUGGESTED REFERENCES

### BIOTECHNOLOGY

1. Brown, T. A. (2016). *Gene cloning and DNA analysis: An introduction* (7th ed.). Wiley-Blackwell. ISBN: 9781119072560
2. Clark, D. P., & Pazdernik, N. J. (2016). *Biotechnology* (2nd ed.). Academic Press. ISBN: 9780123850638
3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2017). *Molecular biotechnology: Principles and applications of recombinant DNA* (5th ed.). ASM Press. ISBN: 9781555819333
4. Nicholl, D. S. T. (2008). *An introduction to genetic engineering* (3rd ed.). Cambridge University Press. ISBN: 9780521615211
5. Old, R. W., & Primrose, S. B. (2013). *Principles of gene manipulation and genomics* (7th ed.). Wiley-Blackwell. ISBN: 9781405135443
6. Russell, P. J. (2016). *iGenetics: A molecular approach* (3rd ed.). Pearson Education. ISBN: 9780321772896
7. Thieman, W. J., & Palladino, M. A. (2018). *Introduction to biotechnology* (4th ed.). Pearson. ISBN: 9780134604718
8. Weaver, R. F. (2011). *Molecular biology* (5th ed.). McGraw-Hill Education. ISBN: 9780073525327

### BIOINFORMATICS

1. Baxevanis, A. D., & Ouellette, B. F. F. (2005). *Bioinformatics: A practical guide to the analysis of genes and proteins* (3rd ed.). Wiley-Interscience. ISBN: 9780471478782
2. Gautham, N. (2006). *Bioinformatics: Databases and algorithms*. Narosa Publishing House. ISBN: 9788173197091
3. Higgs, P. G., & Attwood, T. K. (2005). *Bioinformatics and molecular evolution*. Blackwell Publishing. ISBN: 9781405131704
4. Hodgman, C., French, A., & Westhead, D. R. (2009). *BIOS instant notes: Bioinformatics* (2nd ed.). Taylor & Francis Group. ISBN: 9780415382072
5. Lesk, A. M. (2019). *Introduction to bioinformatics* (5th ed.). Oxford University Press. ISBN: 9780198794141
6. Mount, D. W. (2004). *Bioinformatics: Sequence and genome analysis* (2nd ed.). Cold Spring Harbor Laboratory Press. ISBN: 9780879697129
7. Rashidi, H., & Buehler, L. K. (2004). *Bioinformatics basics: Applications in biological science and medicine* (2nd ed.). CRC Press. ISBN: 9780849323750

### NEUROBIOLOGY

1. Principles of Neural Science, Eric R. Kandel;
2. Neuroscience, Dale Purves;
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. Tortora, 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;
17. William's Textbook of Endocrinology, Kroenberg, Meaund;
18. Basic and Clinical Pharmacology, Katzung

## IMMUNOLOGY

1. Abbas, K.A., & Lichtman, A.H. (2003). *Cellular and molecular immunology* (5th ed.). Saunders Publication.
2. Abbas, K. A., & Lichtman, A. H. (2011). *Basic immunology: Functions and disorders of the immune system* (4th ed.). Saunders Elsevier.
3. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2006). *Roitt's essential immunology* (11th ed.). Blackwell Publishing.
4. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). *Kuby immunology* (6th ed.). W.H. Freeman and Company.
5. Mohanty, S.K., & Leela, K.S. (2014). *Textbook of immunology* (2nd ed.). Jaypee Brothers Medical Publishers.
6. Parija, S.C. (2012). *Textbook of microbiology and immunology* (2nd ed.). Elsevier.
7. Playfair, J.H.L., & Chain, B.M. (2001). *Immunology at a glance* (7th ed.). Blackwell Publishing.
8. Reed, J.C., & Green, D.R. (2011). *Apoptosis: Physiology and pathology*. Cambridge University Press.
9. Shetty, N. (2005). *Immunology: Introductory textbook*. New Age International Publishers.
10. Virella, G. (2007). *Medical immunology* (5th ed.). Informa Healthcare.

## TOXICOLOGY

1. Derelanko Michael J. (2018) *The Toxicologist's pocket Handbook*, CRC Press, Taylor & Francis Group ISBN 10: 0849300096
2. Hodgson Ernest: *A Textbook of Modern Toxicology* (2010) Wiley; 4<sup>th</sup> edition, ISBN-10: 0470
3. Lee Byung-Mu, Sam Kacew, Hyung Sik Kim: *Lu's Basic Toxicology (Fundamentals, Target Risk Assessment)*, Seventh Edition, (2017), CRC Press, Taylor & Francis Group,
4. Pani Balram: *Textbook of Toxicology*, Drrmtech Press (2019), ISBN-10
5. Pandey, K., Shukla, J.P., and Trivedi, S.P. *Fundamentals of Toxicology*. Central Book Agency.

## BIOPHYSICS AND LABORATORY TECHNIQUES

1. *Fundamentals and Techniques of Biophysics and Molecular Biology* (2018- 2<sup>nd</sup> Edition): Pranav Kumar. *Pathfinder Publication*.
2. *Principles and Techniques of Biochemistry and Molecular Biology* (2008- 6<sup>th</sup> Edition): Keith Wilson and John Walker. *Cambridge University Press*.
3. *Biophysics and Biophysical Chemistry* (2022- 6<sup>th</sup> Edition): Debajyoti Das. *Academic Publishers*.
4. *Fundamentals of Bioanalytical Techniques and Instrumentation* (2010) - Sabari Ghoshal, A.K. Srivastava. *Prentice-Hall of India Pvt. Ltd.*
5. *Biological Instrumentation and methodology* (2010) - P.K. Bajpai. *S. Chand & Company*.
6. *A Textbook of Practical Physiology* (2012) - C.L. Ghai. *Jaypee Brothers Medical Publishers Pvt. Limited*.
7. *Textbook of Medical Physiology* (2006- 11<sup>th</sup> Edition) - Guyton and Hall. *Elsevier Saunders*.
8. *Handbook of Biomedical Instrumentation* (2022 - 3<sup>rd</sup> Edition) - R.S. Khandpur. *McGraw Hill Education (India) Private Limited*.

## DISEASE BIOLOGY AND PUBLIC HEALTH

1. Boldaun, Charles Frederick, Nils William Boldaun 1949, *Public health and Hygiene* (4<sup>th</sup> edn) Philadelphia Saaunders
2. Dass, K 2021. *Public health and Hygiene*. Notion press.
3. Goel, Arvind Kumar 2005. *A college Textbook of Health and Hygiene*, ABD publishers.
4. Park, K. 2007. *Preventive and Social medicine*. B.B. Publishers.
5. Shanmugavel, G, Binu George. 2021. *Textbook of public health and hygiene*. Darshan publishers.
6. Wagh, Sudhir R., Vinod B. kakade, Jiwanp. sarwade. *Public health and Hygiene*. Success Publication.
7. Kumaresan, V., R. somaraj. *Public Health and Hygiene*. Saras Publication., New Delhi

**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	<ul style="list-style-type: none"> <li>Total 15 questions will be given by question setters</li> <li>Students will attempt 10 question</li> <li>Questions will be set from all the units</li> <li>Each question will carry 2 marks (10X2)=20</li> </ul>	<ul style="list-style-type: none"> <li>Total 5 short notes to be given by question setters.</li> <li>Students will attempt 3 short notes</li> <li>Short notes can be given from any of the units. No two short notes can be from the same unit</li> <li>Each short notes will carry 5 marks (3X5)=15</li> </ul>	<ul style="list-style-type: none"> <li>Total 7 questions to be given by question setters.</li> <li>Students will attempt 4 questions.</li> <li>Each carrying 10 marks. Questions can be given from any of the units.</li> <li>Each question should have part questions.</li> <li>Each question will carry 10 marks (10X4)=40</li> </ul>	<p>Total marks 20+15+40=75</p> <p>Examination would be taken at away center. Question paper will be arranged by the University.</p> <p>QS, MOD, HE and Examiners will be recommended by UGBOS.</p>
Zoology Major Core Practical	<ul style="list-style-type: none"> <li>Experiments</li> <li>Identifications</li> </ul> <p>22 Marks</p>	<p>Lab note book/Field report/Dissertation</p> <p>3 marks</p>	No marks allotted for Viva voce	<p>Total Marks 25</p> <p>Examination should be taken at away center with two internal and one external examiners recommended by UGBOS. Questions will be set by UGBOS</p>

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	<ul style="list-style-type: none"> <li>Total 15 questions will be given by question setters</li> <li>Students will attempt 10 question</li> <li>Questions will be set from all the units</li> <li>Each question will carry 2 marks (10X2)=20</li> </ul>	<ul style="list-style-type: none"> <li>Total 5 short notes to be given by question setters.</li> <li>Students will attempt 3 short notes</li> <li>Short notes can be given from any of the units. No two short notes can be from the same unit</li> <li>Each short notes will carry 5 marks (3X5)=15</li> </ul>	<ul style="list-style-type: none"> <li>Total 7 questions to be given by question setters.</li> <li>Students will attempt 4 questions.</li> <li>Each carrying 10 marks. Questions can be given from any of the units.</li> <li>Each question should have part questions.</li> <li>Each question will carry 10 marks (10X4)=40</li> </ul>	<p>Total marks 20+15+40=75</p> <p>Examination would be taken at away center.</p> <p>QS, MOD, HE and Examiners will be recommended by UGBOS.</p>
Zoology minor Core Practical	<ul style="list-style-type: none"> <li>Experiments</li> <li>Identifications</li> </ul> <p>20 Marks</p>	<p>Lab note book/Field report/Dissertation</p> <p>5 marks</p>	<p>No marks allotted for Viva voce</p>	<p>Total Marks 25</p> <p>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</p>

Zoology Multi-disciplinary Papers

Examination/Paper type	Section A	Section B	Section B	Comment
Zoology MDC Core Major/ Minor Theory	<ul style="list-style-type: none"> <li>• Total 15 questions will be given by question setters</li> <li>• Students will attempt 10 question</li> <li>• Questions will be set from all the units</li> <li>• Each question will carry 2 marks (10X2)=20</li> </ul>	<ul style="list-style-type: none"> <li>• Total 5 short notes to be given by question setters.</li> <li>• Students will attempt 3 short notes</li> <li>• Short notes can be given from any of the units. No two short notes can be from the same unit</li> <li>• Each short notes will carry 5 marks (3X5)=15</li> </ul>	<ul style="list-style-type: none"> <li>• Total 7 questions to be given by question setters.</li> <li>• Students will attempt 4 questions.</li> <li>• Questions can be given from any of the units.</li> <li>• Each question should have part questions.</li> <li>• Each question will carry 10 marks</li> <li>• (10X4)=40</li> </ul>	<p>Total marks 20+15+40=75</p> <p>Examination would be taken at awaycenter.</p> <p>QS, MOD, HE and Examiners will be recommended by UGBOS.</p>
Zoology MDC Core Practical	<ul style="list-style-type: none"> <li>•Experiments</li> <li>•Identifications</li> </ul> <p>20 Marks</p>	<p>Lab note book/Field report/Dissertation</p> <p>5 marks</p>	<p>No marks allotted for Viva voce</p>	<p>Total Marks 25</p> <p>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</p>

	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	<p>Total 30 questions will be set by question setter.</p> <p>Students will attempt 25 questions. Each carrying 1 marks.</p> <p>Questions should be MCQ with four alternative options with no negative alternative.</p> <p>Questions will cover all the units.</p> <p>25X1=25</p>	<p>Total 30 questions will be set by question setter.</p> <p>Students will attempt 25 questions.</p> <p>Each question will carry 1 marks.</p> <p>Questions will cover all the units.</p> <p>Questions should be MCQ with four alternative options with no negative alternative.</p> <p>Questions will cover all the units.</p> <p>25X1=50</p>	Total marks 50	<p>Questions would be set by internal teachers.</p> <p>Students will write only the correct alternative against the question number.</p> <p>Examination should be taken at home center.</p> <p>Questions will be arranged by college teachers.</p>
Zoology IDC Practical	<ul style="list-style-type: none"> <li>•Experiments</li> <li>•Identifications</li> </ul> <p>20 Marks</p>	<p>Lab note book/Field report/Dissertation</p> <p>5 marks</p>	No marks allotted for Viva voce	<p>Total Marks 25</p> <p>Examination should be taken at homecenter with two internal examiners as recommended by HOD of respective college.</p> <p>Question format will be given by UGBOS.</p>



**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:

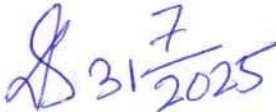
- 1) Amendments in the Course Structure (clause no. 9) for semester-5,6,7 & 8: Detail Course Structure is laid down in the accompanying pamphlets.
- 2) Students shall study two papers from a single Minor subject (both either from m1 or from m2) in semester-V and shall study two papers from another Minor 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 31<sup>st</sup> 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
<b>Semester</b>	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
<b>Credits</b>	<b>15x4= 60</b>	<b>8x4=32</b>	<b>3x3=9</b>	<b>4x2=8</b>	<b>3x4=12</b>	<b>4x2=8</b>	<b>1x3=3</b>	<b>132</b>
<b>Marks</b>	<b>15x100=1500</b>	<b>8x100=800</b>	<b>3x75=225</b>	<b>4x50=200</b>	<b>3x100=300</b>	<b>4x50=200</b>	<b>1x75=75</b>	<b>Total Marks =3300</b>

Marks=25markspercredit.

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.

**RevisedCourseStructure(semester-7&8)underCCF,2022**

**4-YEARB.A./B.Sc.HONOURSCOURSESOFSTUDIES**

**SEMESTER-7**

<b>SEMESTER</b>	<b>DSCC/COREfromMajorsubject 4 CREDITS (3 TH+1 P/ TU) each</b>	<b>Totalcredits</b>
* 7	5papersx 4credits =20credits	20

**SEMESTER-8**

<b>SEMESTER</b>	<b>1<sup>st</sup>paper&amp;2<sup>nd</sup>paper From Major subject (4 Credits each) 2papersx4 credits =8 credits</b>	<b>3<sup>rd</sup>paper&amp;4<sup>th</sup>paper From Major subject (4 Credits each) 2papersx4 credits =8 credits</b>	<b>5<sup>th</sup>paper FromMajorsubject (4Credits) 1paperx4credits =4 credits</b>	<b>Totalcredits</b>
#8	2 papers of ResearchMethodology (RM-1&RM-2) (3TH+1viva)  Or 2 Core papers (3TH+1P/ TU)	2Corepapers (3TH+1P/ TU)	1paperofProject/Review (3 TH+1 viva)  Or 1 Core paper (3TH+1P/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 <sup>st</sup> paper & 2 <sup>nd</sup> paper From Major subject (4 Credits each) 2 papers x 4 credits = 8 credits	3 <sup>rd</sup> paper From Major subject (4 Credits) 1 paper x 4 credits = 4 credits	4 <sup>th</sup> 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 7<sup>th</sup> 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 8<sup>th</sup> 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.

**Totalcredits&Marks(semester-1to8)for4-YEARB.A./B.Sc.HonoursCoursesofStudies**

	DSCC/Core/ ResearchMethodology /Project/Review (Major)	Minor (m1&m2)	IDC	AEC	SEC	CVAC	Summer Internship	TotalCredits
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

**Totalcredits&Marks(semester-1to8)for4-YEARB.A./B.Sc.HonourswithResearchCoursesofStudies**

	DSCC/Core/ ResearchMethodology (Major)	Minor (m1&m2)	IDC	AEC	SEC	CVAC	Summer Internship	Research Internship (Major)	Dissertation/ Project (Major)	TotalCredits
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-7:5papers--(20credits):fromtheMajorsubject**

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

**5 core papers** (4 credit each: 3Th+1P/TU: 5x4 credits=20 credits)

**Semester-8:(20credits)**

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

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

**OR**

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

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

c) **5<sup>th</sup> 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 subjects 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 subjects shall be included.

## **Semester-8:(20credits)**

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

- **1<sup>st</sup>&2<sup>nd</sup>paper:2papersofResearchMethodology-(RM-1&RM-2):**  
(4creditseach)—2x4credits=8credits
- **3<sup>rd</sup>paper:1paperonResearchInternship:1x4credits=4credits**
- **4<sup>th</sup>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)

- **ResearchMethodology(RM-1&RM-2)-(4creditseach):**

(4creditseach:3Th+1viva)---(2x4credits:8credits)

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 the 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 examinations 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:(4credits):**

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

(Guidelines shall be formulated by the respective UGBOS)

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

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).