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.

21/01/2026

SENATE HOUSE

Kolkata-700073

21.01.2026

Prof.(Dr.) Debasis Das

Registrar

4-YEAR Honours & Honours with Research

Structure of NEP Curriculum for Zoology

PARTI;SEMI

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

PARTI;SEMII

SUBJECT CODE	COURSE	NAMEOFPAPER	THEORY	PRACTICAL
DSCC2	ZOOM	Biochemistry	75	25
SEC-2	ZOOM	Aquaculture	75	25
MN2	MZOO	Biochemistry	75	25
CC2	MZOO-MDC	Biochemistry	75	25
SEC-G	MZOO-MDC	AppliedZoology	75	25
IDC2	ZOOD	AnimalBiology	50	25

PARTII;SEMIII

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

PARTII;SEMIV

SUBJECT CODE	COURSE	NAMEOFPAPER	THEORY	PRACTICAL
DSCC5	ZOOM	Non-chordates tructure & 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 tructure & function	75	25
CC5	MZOO-MDC	Ecology	75	25
CC2	MZOO-MDC-Minor	Biochemistry	75	25

PARTIII;SEMV

SUBJECT CODE	COURSE	NAMEOFPAPER	THEORY	PRACTICAL
DSCC9	ZOOM	Chordate structur e& 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 &f unction	75	25
CC6	MZOO-MDC	Chordate structure &f unction	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	NAMEOFPAPER	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	NAMEOFPAPER	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	NAMEOFPAPER	THEORY	PRACTICAL
DSCC21	ZOOM	Research Methodology I	75	25[VIVA]
DSCC22	ZOOM	Research Methodology II	75	25[VIVA]
DSCC23	ZOOM	Biophysics & LabTechniques	75	25
DSCC24	ZOOM	Disease Biology & PublicHealth	75	25
DSCC25	ZOOM	PROJECT	75	25

PARTIV;SEMVIII[WITHRESEARCH]

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

OUTLINE STRUCTURE OF NEP CURRICULUM FOR
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
Unit1:PlasmaMembrane		**8**
StructureofthePlasmaMembrane: LipidBilayer(PhospholipidsandCholesterol),Peripheraland IntegralMembraneproteins,GlycolipidsandGlycoproteins(*basicconceptofGlycocalyx*),FluidMosaic Model with special reference to Lipid rafts, Mobility of membrane lipids (FRAP assay) and Mobility ofMembraneProteins (Frye-Edidin Experiment); Cell-cell junctions; Transport through plasma membrane.		
Unit2:CytoplasmicorganellesI		**8**
BasicconceptsonUltrastructureofER,GolgiandLysosome;OverviewofProteinsorting; ERMorphology,TargetingproteinstoER,TheSignalhypothesis;InsertionofproteinsintoERmembrane, Protein folding and processing in ER, Export of proteins and lipids from ER ; **Golgi Apparatus;** Morphology,ProteinglycosylationwithinGolgi,ProteinsortingandexportfromGolgiapparatus; **Lysosome:**Polymorphism**,**Lysosomalacidhydrolases,Endocytosisandlysosomeformation.		
Unit3:CytoplasmicorganellesII		**4**
Mitochondria: Structure;MitochondrialRespiratoryChain,ChemiosmotichypothesisandOxidative Phosphorylation with reference to ATP Synthase and ATP synthesis **Centrosomeanditsorganization**		
Unit4:Cytoskeleton		**4**
StructureandTypes:Microtubules,Actinfilaments,andIntermediatefilaments;Compositionandfunction of ECM		
Unit5:Nucleus		**5**
Nuclear envelope, nuclear pore complex (transport not included), Kinetochore and centromeric DNA;Chromatin and levels of its packaging. Euchromatin& Heterochromatin.		
Unit6:Nucleic Acids		**3**
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.		
Unit7:DNAReplication		**10**
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		
Unit8:ToolsandTechniquesinCellBiology		**4**
• AnimalCellCulture:PrimarycellcultureandCellline. • SubcellularfractionationandUltracentrifugation. • FreezefractureReplicationandFreezeEtching • WorkingPrincipleofLightMicroscope:Brightfield,Phasecontrastmicroscope,FluorescenceMicroscope with reference to FRET; Working Principle of SEM & TEM.		

CellBiologyLab;DSCC-1-P

FullMarks25	1 Credit	20Hours
Listof Practical		
1. CellviabilitystudybyTrypanBlueExclusionmethod. **2.** Standardization of Ocular and Stage Micrometer and Measurement of cell or microscopic specimen such as *Paramoecium*sp. **3.** Preparationofsquamousepithelialcellwithstaining. **4.** IsolationofBoneMarrowCellsfromRat/MouseandGiemsaStaining. **5. LNB**		

PART I: SEMESTER - I

SEC-1: Applied Entomology Theory

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

Applied Entomology Lab: SEC-1-P

Full Marks 25	1 Credit	20 Hours
List of Practical		

1. Dissection and temporary mounting of:- Mouthparts of Cockroach and Mosquito
2. Methods of collection, preservation, and identification of economically important insects.
3. Identification (Order and specimen charactersonly) with economic importance of following insect pests: *Scirpophaga incertulus; Sitophilus oryzae*; *Callosobruchus chinensis; Leucinodesorbonalis*.
4. Life history stages of *Apis* sp and *Bombyx mori*.
5. Identification and medical significance of following insects (adults) through permanent slides: *Aedes aegypti, Aedes albopictus*, *Culex* sp., *Anopheles* sp. [for mosquito, larvae and both sexes of adults], *Musca* sp., *Phlebotomus* sp..
6. Accomplish **anyone** from the following sreated to applied entomological significance (submission of a report):
   a. Visit to Agricultural field related to damage caused by any pest and pest management. Make a report on it.
   b. Visit to any Sericulture farm to study silkworm rearing, silk reeling, silk processing and make a report on it.
   c. Visit an Apiary and to make a report on it.
   d. Visit to any rural or urban health centre to study various aspects of vector surveillance and vector borne diseases of that locality. Make a report on it.
7. **LNB**

PART I: SEMESTER - II

CORE COURSE-2: Biochemistry [DSCC-2 Theory]

Full Marks 75	3 Credits	45 Hours
Unit1: Carbohydrates		**8**
Structure, classification and properties of Monosaccharides (aldose and ketose), Disaccharides, Polysaccharides; Isomerism of monosaccharides (D and L, optical isomers, furanose and pyranose, α and β anomers, epimers); Reducing and non – reducing sugars. PhysiologicalimportanceofMonosaccharides,Disaccharides,Polysaccharides		
Unit2: Proteins		**7**
Aminoacids: Structure,Classification,GeneralandElectrochemicalpropertiesofα-aminoacids; Essential and non-essential amino acids; **Structures of Protein:** Primary, secondary, tertiary and quaternary)ofprotein,Classificationofproteins.		
Unit3: Lipids		**4**
Classification of lipids; Saturated and unsaturated fatty acids, essential and non – essential fatty acids.**StructureandformationofTriglyceride**.;Iodinenumberandsaponificationnumberoffats.		
Unit4: Enzymes		**8**
Nomenclature,classificationandproperties;Cofactorsandcoenzymes,EffectofTemperature,pH, substrate concentration, enzyme concentration on enzyme action, Isozymes and Proenzyme, Mechanism of enzyme action (Lock and key model, Induced fit model). **Enzymekinetics**:DerivationofMichaelis-Mentenequationwithitssignificance,Lineweaver-Burkplot and its significance. Enzyme inhibition – competitive, non- competitive, allosteric / feedback and its effect on Vmax and Km		
Unit5:CarbohydratesMetabolism		**6**
Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis from lactate and glycerate,GlycogenesisandGlycogenolysis.(Pathwayswithnameofenzymesandsignificance)		
Unit6:ProteinMetabolism		**4**
Transamination,Deaminationanditstypes(Pathwayswithnameofenzymesandsignificance)Fate of C-skeleton of Glucogenic and Ketogenic amino acids.		
Unit7:LipidMetabolism		**4**
β-oxidationoffattyacids-a.Palmiticacid{saturated(C16:0)},b.Linoleicacid{unsaturated(C18:2)}; Fatty acid biosynthesis		
Unit8:NucleicacidMetabolism		**3**
Degradationofpurine;PurineSalvagepathwayandsignificance.		
Unit9:FreeradicalsandAntioxidants		**1**
Conceptoffreeradicalsandantioxidantswithexamples.		

BiochemistryLab;DSCC-2-P

Full Marks 25		1 Credit	20 Hours
ListofPractical			
GroupA	**10 Hours**	**15 Marks**	
Qualitativetestsforcarbohydrates,proteinsandlipids 1. Forcarbohydrate(Glucose,Fructose,Maltose,Sucrose,Starch) –Molischtest,Benedicttest,Barfoedtest, Seliwanoff test, Hydrolysis test for sucrose, Iodine test 2. ForProtein(Albumin,Gelatine,Peptone)–Biurettest,Million'stest,Xanthoproteictest,Ninhydrintest 3. Forlipid–Greasespottest			
GroupB	**10 Hours**	**10 Marks**	
Colorimetricestimationofthefollowing a) ProteinbyLowry'smethod b) Activityof amylase **LNB**			

PART I: SEMESTER - I I

SEC-2 Aquaculture Theory

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

Aquaculture Lab: SEC-2-P

Full Marks 25	1 Credit	20 Hours
List of Practical		

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

SUGGESTEDREFERENCES

DISCIPLINESPECIFICCORECOURSE-1:CELLBIOLOGY

1. **TheCell(8thEdition)G.M.Cooper**andR.E.Hausman
2. **Karp'sCellandMolecularBiology:**ConceptsandExperiments**8thedition**
3. **Lewin'sCELLS(3rdEdition)**DavidSharp,EricSikorski,GeorgePlopper
4. **MolecularBiologyoftheCellBruceAlberts**6thEdition
5. **Lehninger,PrinciplesofBiochemistry**4thedition
6. **TheWorldoftheCell:Becker**,6thedition
7. **CellandMolecularBiology**8thEdition**DeRobertis**
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.andStryer,L.(2007).**Biochemistry.VI**Edition,W.H.FreemanandCo.,NewYork.
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:Structureandfunction5thEdition,CambridgeUniversityPress.
2. Triplehorn,C.A.andJohnson,N.F.(2005).BorrorandDelong'sIntroductiontothestudyofInsects.7thEdition, Thompson Brooks/Cole,USA
3. **Atwal,A.S.**(1986).AgriculturalPestsofIndiaandSouth-EastAsia.2ndEdition,KalyaniPublishers,NewDelhi.
4. **Pedigo,L.P.andRice,M.E**.(2009).EntomologyandPestManagement.6thEdition,PearsonPrenticeHall.
5. **Hati,A.K**.(2010).**MedicalEntomology**.AlliedBookAgency.
6. Shukla,A.(2009)AhandbookonEconomicEntomology.DayaPublishingHouse,DelhiEntomology.3rdEdition, 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.3rdEdition.
7. Pillai,T.V.R.andKutty.(2007)FishingNewsBook.2ndEdition.
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.

TheUniversitywillofferZoologyrelatedIDCasthePaperofAnimalSciencewhichwillbe selected by Students pursuing Major and Minor Courses other than Zoology

PARTI:SEMESTER-I/II/III

IDC-1:AnimalBiology
IDC-1-TH

FullMarks50	2Credits	45Hours
Unit1:AnimalDiversity		**10**
PhylumCharactersandexample:[Non-chordates-Porifera,Cnidaria,Ctenophora,Platyhelminthes,Nemathelminthes,Annelida,Arthropoda,MolluscaandEchinodermata]; Chordata		
Unit2: Genetics		**12**
1. MendelianPrinciplesandLawsofinheritance 2. LinkageandRecombinationbasicConcepts 3. SexDeterminationwithreferenceto*Drosophila* [onlygenicbalancetheory] 4. ChromosomalAberration[StructuralandNumerical]		
Unit3:BiodiversityandWildlife		**10**
1. Biodiversity:Definition,typesand value 2. Biodiversity:Indices[Shannon&Simpson] 3. Conservation:*insitu*and*exsitu*[outlineidea] 4. ConservationPriority:Hotspot,Megadiversity,SensitiveEcosystem 5. IndigenousKnowledgeandPBR:Basic Concepts		
Unit4:Insect Vectors		**8**
1. ConceptofVector:BiologicalandMechanicalVectorswith examples 2. Diseasecycle&Reservoir Concept 3. MajorVectors:Mosquito(*Anopheles*sp.&*Aedes*sp.)andSandfly[Lifecycleand Control Measures]		
Unit5:LaboratorytechniquesandInstrumentation		**5**
1. BasicsofLight Microscopy 2. PrinciplesandApplicationofColorimetry 3. PrinciplesandapplicationofUltracentrifugation		

AnimalBiologyLab:IDC-1-P

FullMarks25	1Credit	20Hours
Listof Practical		
1. KaryotypeanalysisofKlinefelter,Down,Turner,Edward&PatauSyndrome **2.** Identification (Phylum and specimen characters): *Amoeba, Paramoecium, Sycon, Neptune's Cup, Taenia,Ascaris,Nereis,Pheretima,Pila,Lamellidens,Penaeus,Macrobrachium,Musca,Anopheles, Culex, Asterias*. **3.** Identification of different ecosystems through photographs: Marine ecosystem, Mangrove ecosystem,Lakeecosystem,Rainforestecosystem,Desertecosystem,Grasslandecosystem. **4. LNB**		

SECGForMDC
AppliedZoology-Theory

FullMarks 75	3 Credits	45 Hours
UnitI:AgriculturalEntomology		**5**
Pest- definition and types (major and minor pests with example); Lifecycle, nature of damage and controlof Pests: *Nilaparvatalugens*of paddy, *Anomissabulifera*of Jute, *Bandicoota*– storedhouse pest;InsectPestcontrol:Chemical,Mechanical,CulturalandBiologicalcontrolmeasures;Integrated PestManagement(IPM).		
UnitII: Sericulture		**7**
TypesofSilkwormswithspecialreferencetotheirscientificname,geographicaldistributionand host plants; *Bombyxmori*: Silk gland, Composition of silk, Uses of silk; Lifecycle; Rearing, Extraction and Reeling of mulberry silk; Silkworm diseases, pests and their control.		
UnitIII: Apiculture		**6**
VariousdomesticatedspeciesofHoneybee;SocialorganizationofHoneybee;Beekeeping: LangstrothBoxforrearingofhoneybee,Extractionandprocessingofhoney;Compositionofhoney, apiculturebyproductsandtheiruses;PestsandDiseasesofbeesandtheircontrolmeasures		
UnitIV:Vermiculture		**6**
Scope of Vermiculture; Habit categories of earthworms; methodology of vermicomposting: containers for culturing, raw materials required, preparation of bed, environmental pre-requisites, feeding,harvestingandstorageofvermicompost;Advantagesofvermicomposting;Diseasesand pestsofearthworms.		
UnitV: Aquaculture		**8**
Principles, definition and scope; Prawn culture: Penaeid and Palaemonid features with examples; Semi-intensive method of prawn culture; Application of prawn culture; Difference between major andminorcarpswithexamples;Compositefishfarming:Generalconcepts,advantagesand disadvantages;Inducedbreeding:methodandadvantages;Integratedfishfarming.		
UnitVI:LiveStockManagement		**7**
Dairy: Introduction to common dairy animals: Types ofCattle breeds and theirdistribution in India; Exoticcattlebreeds;Principlesandmethodsof 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:Typesofbreeds(fowl)withfeaturesand examples;Rearing method:Deeplitter system; feed formulationforchicks;poultrybyproductswitheconomicimportance;Diseasesofpoultryandtheir control measures.		
UnitVII:LacCulture		**6**
Life cycle, host plants and strains of Lac insect; Lac cultivation: Local practice, improved practice,propagationofLacinsect,inoculationperiod,harvestingofLac;Laccomposition,processing, productsanduses;Naturalenemiesoflacinsectandtheirmanagement		

AppliedZoologyLab

FullMarks25	1Credit	20Hours
Listof Practical		

1. Identification of various castes of Honey bee, life stages of *Bombyxmori*, various life stages of *Kerrialacca,* various earthworm species used in vermiculture and ectoparasites of Poultry birds
2. Identificationofthefollowingfishandprawnspecimens(Specimencharactersonly):*Labeorohita,Catlacatla, Cirrhinusmrigala, Cyprinuscarpio, L. bata, Penaeus monodon, Macrobrachiumrosenbergii*
3. Collection of any two pests and submission of specimen it along with a small report on its identifying features, life cycle, nature of damage and control: *Sitophilus oryzae, Triboliumcastaneum, Nilaparvatalugens, Anomissabulifera*and *Leucinodesorbonalis*
4. **LNB**

PARTII:SEMESTER-III

CORECOURSE-3:Genetics[DSCC-3Theory]

FullMarks75	3Credits	46Hours
Unit1: Chromosome		**4**
Structural organization of Chromosomes; Polytene, Lampbrush and Satellite chromosomes; Human Karyotyping.		
Unit2:Alleleconcept		**8**
Epistasis, Multiple alleles (ABO blood group in human), Isoallele (White eye mutations in *Drosophila*), Pseudoallele (Lozenge Locus in *Drosophila*) & Cis-trans test for allelism, Lethal alleles, Pleiotropy, Penetrance & Expressivity		
Unit3:GeneticFine Structure		**2**
ComplementationtestinBacteriophage(Benzer'sexperimentonrIIlocus)		
Unit4:Linkage,Crossingoverandlinkagemapping		**10**
LinkageandCrossingover;CompleteandIncompleteLinkage;Hollidaymodelof recombination; Linkage map construction using three point crosses; Sexlinkagein*Drosophila*(Whiteeyelocus)&Human(Haemophilia)		
Unit5:Mutations&Chromosomalaberrations		**8**
Types of gene mutations (Substitution and Frameshift);Types of chromosomal aberrations (StructuralandNumerical);Non-disjunctionofXchromosomein*Drosophila*,Non-disjunction of human chromosome 21; Molecular basis of mutations induced by UV light and chemical mutagens; mutation detection in *Drosophila* by attached X and CLB method; Biochemical mutation detection in *Neurospora*		
Unit6:Extra-chromosomalinheritance		**2**
Kappaparticlein*Paramoecium*,Shellspirallinginsnail		
Unit7:TransposableGeneticelements		**4**
ISelementinbacteria;Ac-Dselementsinmaize;Pelementsin*Drosophila*;LINE,SINE,Alu elements in human		
Unit8:SexDeterminationinmammals		**4**
SexdeterminationinmanandDosageCompensationinmammals		
Unit9:QuantitativeGenetics		**4**
Conceptofquantitativetraits(Examples–Kernelcolourinwheat,EarlengthinCorn); Polygenic inheritance; Heritability – Concept and types (Broad sense heritability and Narrow sense heritability)		

GeneticsLab;DSCC-3-P

FullMarks25	1Credit	20Hours
Listof Practical		

1. **Chi-Square Test** - Test for Goodness of fit – Mendelian monohybrid and di-hybrid ratios, *Epistatic ratios; Contingency Chi-Square Test
2. **Identification of Chromosomal aberration in *Drosophila*** (Deletion, Duplication, Inversion and Translocation)and**Human**(KaryotypeofDownSyndrome,TurnerSyndrome,PatauSyndrome,Edward Syndrome and Klinefelter Syndrome) from photograph.
3. **PedigreeAnalysis**ofsomeinheritedtraitsinHuman(Autosomal,X-linkedandY-linked).
4. TemporarysquashpreparationofGrasshoppertestistostudyvariousstagesofmeiosis.
5. **LNB**

*Onlyformajorcoursestudents

PARTII:SEMESTER-III

CORECOURSE-4:CellsandTissueStructure[DSCC-4Theory]

FullMarks75	3Credits	42Hours
Unit1:Stain,DyeandHistochemistry		**8**
Difference between stain and dye. Componentsandclassificationofdye. PrincipleandchemistryofPASandFeulgenreaction.		
Unit2:EpithelialTissue		**8**
Salient features; Classification with location and diagram (based on structure and functions) Glandular epithelium in details. Cell polarity and modifications; Apical domain, Basal domain & Lateral domain. **Clinical correlation:** Epithelial metaplasia.		
Unit3:ConnectiveTissue		**14**
Salient features with respect to cell types and fibers and Extracellular Matrix in context to Connective tissue; Classification. StructureandfunctionwithdiagramofAdiposetissue–brownfatandwhitefat 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) Briefideaonepithelialmembrane:cutaneousmembrane,mucousmembrane **Clinicalcorrelation**withrespecttobonetissue:OsteoarthritisandOsteoporosis		
Unit4:Muscletissue		**5**
Salientfeatures.Typesbasedonfunctionandstriations. Ultrastructure of skeletal muscle. Featuresofsingleunitandmultiunitsmoothmuscle,cardiacmuscle. Difference between white muscle fiber and red muscle fiber. **Clinicalcorrelation:**Duchenemusculardystrophy.		
Unit5:Nervous Tissue		**5**
Salientfeatures;Structureofneuronsandtypesbasedonorigin,myelinsheathandprocesses; Neuroglia and functions; **Clinical correlation:** Multiple sclerosis		
Unit6:Tissue repair		**2**
Stepsoftissue(skinasanexample)repair: 1.Inflammation2.Organization3.Regenerationand/orFibrosis. **Factorsaffectingit:** 1.Typeoftissue2.Typeofinjury.3.Adequacyofbloodsupply.4.Stateofhealth.5.Age.		

CellsandTissueStructureLab;DSCC-4-P

FullMarks25	1Credit	20Hours
Listof Practical		
1. Preparation,stainingandmountingofthefollowing a. Epithelialtissuefromvaginalsmearofratusingmethyleneblue. b. ConnectivetissuefrombloodfilmofratusingGiemsa. c. Muscletissuefromthighmuscleofcockroachusingmethyleneblue. **2. Identification**withreasonsthefollowingmammalianhistologicalsections–lung,liver,stomach,kidney. **3. Tissuepreparation**,blockmakingandsectioningofanyorganofrat/mice. **4. LNB**		

PARTII:SEMESTER-III

SEC-3:PoultryFarmingandAnimalHusbandryTheory

FullMarks75	3Credits	42Hours
Unit1:CommonBreedsofFowlandtheirCharacteristics		**6**
AmericanClass,AsiaticClass,MediterraneanClass,EnglishClass,Indigenousbreeds.Commercial strains of chickens: Broiler, Layer, Grower		
Unit2:RearingmethodsinPoultryHousingandEquipment		**6**
Essentialofgoodhousing;housingrequirements;Poultryequipment(eggcollector,incubator, chick cage); Housing systems: Free range system, Semi intensive system, Folding unit system, Deep litter system, Cage system (battery).		
Unit3:Poultry nutrition:		**4**
Nutrition,Feedformulationforchicks		
Unit4:DiseasesofPoultryandtheircontrolmeasures:		**3**
Viraldisease,Parasiticdisease,Fungaldiseaseandtheircontrol		
Unit5:PoultrymarketinIndia:		**2**
Size,growthandtrends;poultrymarketopportunityandchallenges		
Unit6:AnimalHusbandry:Importantcattlebreedandtheircharacteristics		**5**
Cattle breeds in India, Cattle population, Milch breeds, Dual purpose breeds, Draught breed, Cross breed cattle strain		
Unit7:Livestockfeeds:		**4**
Cattlefeed–RoughageandConcentrate		
Unit8:Breedingprogram:		**4**
ArtificialinseminationandMOETincattle.		
Unit9: Dairying:		**4**
Composition of Milk, Dairy products, National Dairy Development Board and Operation Flood Program.		
Unit10:Dairy Pathology		**4**
Viraldisease,bacterialdisease,andparasiticdiseaseandcontrol		

PoultryFarmingandAnimalHusbandryLab;SEC-3-P

FullMarks25	1Credit	20Hours
Listof Practical		
1. **Identificationoffollowingpoultrybreeds** (onlycolouredphotograph):Plymouthrock,RhodeIsland red, New Hampshire, Cochin, Brahma, Leghorn, Cornish, Aseel, Kadaknath, Chittagong. 2. **Identificationoffollowingcattlebreeds** (onlycolouredphotograph):Sahiwal,RedSindhi,Gir,Malvi, Hariana, Tharparkar, Jersey. 3. Visittoapoultryfarmoranimalhusbandryandmakeareportonthatstudy. 4. **LNB**		

PARTII:SEMESTER-IV

CORECOURSE-5:Non-ChordateStructureandFunction[DSCC-5Theory]

FullMarks75	3 Credits	45Hours
Unit1:KingdomProtista		**4**
Subkingdom Protozoa: General characteristics and Classification up to phylum (Levine et. al., 1980); Locomotion in *Euglena, Paramoeciumand Amoeba*; Asexual reproduction and Conjugation in *Paramoecium*		
Unit2:KingdomAnimalia		**4**
Basic structural organization of animals: Body symmetry; Body cavities with reference to pseudocoelom and coelom, Protostomes and Deuterostomes; Origin of Metazoa.		
Unit3:PhylumPorifera		**4**
GeneralcharacteristicsandClassificationuptoclasses(RuppertandBarnes,1994,6thEd.);Canalsystem in sponge; Spicules in sponges.		
Unit4:PhylumCnidaria		**4**
GeneralcharacteristicsandClassificationuptoclasses(RuppertandBarnes,1994,6thEd.), Metagenesisin*Obelia*;PolymorphisminSiphonophora;Coralreef:types,formation,threatsandConservation.		
Unit5:PhylumHelminths		**4**
GeneralcharacteristicsandClassificationuptoclassesofPhylaPlatyhelminthesandNematoda(Ruppert andBarnes,1994,6thEd.);Typestudy(descriptionofdigestive,excretoryandreproductive):*Fasciola hepatica,Ascarislumbricoides*		
Unit6:PhylumAnnelida		**4**
GeneralcharacteristicsandClassificationuptoclasses(RuppertandBarnes,1994);ExcretioninAnnelida; Metamerism in Annelida.		
Unit7:PhylumOnychophora		**2**
AffinitiesandSystematicpositionofOnychophorans		
Unit8:PhylumArthropoda		**6**
GeneralcharacteristicsandClassificationuptoclasses(RuppertandBarnes,1994);Typestudy: *Macrobrachium*(respirationandexcretion)		
Unit9:PhylumMollusca		**5**
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Type study *Pila* sp. (Nervous system and respiratory) and *Octopus* sp. (Nervous system); Torsion in Gastropoda.		
Unit10:PhylumEchinodermata		**5**
GeneralcharacteristicsandClassificationuptoclasses(RuppertandBarnes,1994);Watervascularsystem in Starfish; Echinoderm larva and affinities with chordates.		
Unit11:PhylumHemichordata		**3**
GeneralcharacteristicsofPhylumHemichordata;AffinitiesandsystematicpositionofHemichordates.		

Non-ChordateStructureandFunctionLab;DSCC-5-P

FullMarks 25	1 Credit	20 Hours
ListofPractical		

1. **Identification with reason & Systematic position of** *Entamoeba, Trypanosoma, Sycon, Obelia, Aurelia, Metridium,Madrepora,Fasciola,Taenia,Ascaris,Nereis,Chaetopterus,Hirudinaria,Peripatus,Limulus,Buthus, Macrobrachium,Balanus,Eupagurus,Julus,Scolopendra,Patella,Chiton,Pila,Sepia,Octopus,Asterias,Ophiura, Echinus, Cucumaria, Antedon*and *Balanoglossus*.
2. **Anatomical study**:***Periplaneta*sp.:** Salivary apparatus with hypothalamus, Mouth parts, Nervous system, Male and female Reproductive systems.
3. **Laboratorycultureandwholemountof***Paramoecium/Euglena/Amoeba*
4. **LNB**

PARTII:SEMESTER-IV

CORECOURSE-6:Parasitology[DSCC-6Theory]

FullMarks75	3Credits	42 Hours
Unit1:IntroductiontoParasitology		**4**
Parasitism:parasite,parasitoid,parasiticcastration;Vectorsandreservoirconcept; Zoonosis		
Unit2:ParasiticProtists		**7**
StudyofEpidemiology,Morphology,LifeCycle,Pathogenicity,DiagnosisandControl mechanisms of *Entamoeba histolytica, Leishmaniadonovani, Plasmodium vivax, Plasmodium falciparum*		
Unit3:ParasiticPlatyhelminthes		**8**
StudyofEpidemiology,Morphology,LifeCycle,Pathogenicity,DiagnosisandControl mechanisms of*Schistosoma haematobium*and *Echinococcusgranulosus*		
Unit4:ParasiticNematodes		**8**
1. StudyofEpidemiology,Morphology,LifeCycle,Pathogenicity,Diagnosisand Control mechanisms of *Ascarislumbricoides andAncylostomaduodenale* 2. Studyofstructure,lifecycleandimportanceof*Meloidogyneincognita*(root-knot nematode)		
Unit5:ParasiticArthropods		**8**
Biology,importanceandcontrolofticks(*Ixodes*sp.),mites(*Sarcoptes*sp.),Lice (*Pediculus*sp.)		
Unit6:ParasiticVertebrates		**3**
BriefaccountofparasiticnatureofCookiecutterShark,HoodMockingbird,Vampire bat		
Unit7:ParasiticAdaptationandhostrelation		**4**
1. Parasiticadaptationin Helminths 2. Hostparasiticinteractions		

ParasitologyLab;DSCC-6-P

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

PARTII:SEMESTER-IV

CORECOURSE-7:MolecularBiology[DSCC-7Theory]

FullMarks75	3Credits	48Hours
Unit1: Transcription		**6**
Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.		
Unit2:PostTranscriptionalModificationsandProcessingofEukaryotic RNA		**6**
Capping and Poly A tail formation in mRNA; Concept of introns and exons and Split genes; Splicing mechanism [Intron Removal by Spliceosome]; RNA editing (gRNA mediated and cytidine deaminase mediated)		
Unit3: Translation		**6**
Geneticcode;CharacteristicsoftheGeneticCode;AminoacylationofatRNAmolecule; Mechanism of protein synthesis in prokaryotes.		
Unit4:Gene Regulation		**8**
Regulation of Transcription in prokaryotes: *lac* operon and *trp*operon (Attenuation control); Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing. EpigeneticRegulation:DNAMethylation(byDNMT),HistoneMethylation(byHMT)& Acetylation (by HAT and HDAC).		
Unit6:CellCycle		**9**
Cell Cycle: Phases of the eukaryotic cell cycle, Protein Kinases and Cell cycle regulation, MPF, Growth factors and regulation of G1-Cdks, S phase and regulation of DNA replication; **Cell Death:** Extrinsic (Death receptors) and Intrinsic Pathways (apoptosome); **Cancer:** Concept of Protooncogene [Ras] & Tumor suppressor genes [Rb and p53], Different ways of activation of a protooncogene to Oncogene.		
Unit7:CellSignaling		**5**
Signallingsystem: Modesofcell-cellsignalling;TypesofSignallingmolecules**Signallingreceptors**: Types and example with special reference to regulation of G protein, Adenyl cyclase-cAMP, Enzymelinked Receptors: RTK (ras-raf) and JAK/STAT		
Unit7:DNARepair Mechanisms		**4**
TypesofDNArepairmechanisms,RecBCDmodelinprokaryotes,nucleotideandbaseexcision repair, SOS repair		
Unit8:MolecularTechniques		**4**
• PrincipleanduseofAgaroseGelElectrophoresis • PrincipleanduseofSDS PAGE • BlotTechnique:Southern,NorthernandWesternBlot • PCR:BasicPrinciple,ReverseTranscriptase-PCR		

MolecularBiologyLab;DSCC-7-P

FullMarks25	1Credit	20Hours
Listof Practical		
1. IsolationofgenomicDNAfromGoatLiverbyphenol-chloroformmethod. **2. QuantificationofDNA**bydiphenylamine(DPA)method. **3. AgaroseGelElectrophoresis**. **4. Conceptofbufferpreparation**andrelatedcalculationanddilution. **5. Instruments and accessories** used to be shown by photographs for the following techniques: PCR, SDS PAGE, Western Blot, Southern Blot. **6. LNB**		

PARTII:SEMESTER-IV

CORECOURSE-8:Ecology[DSCC-8Theory]

FullMarks 75	3 Credits	44 Hours
Unit1:IntroductiontoEcology		**5**
Autecology/Synecology. Laws of Limiting factor. Temperature as limiting factor (effect on plant andanimalmetabolism,Bergman'srule,Jordan's,rule,Allen'srule,Rensch'srule).Lightaslimiting factor (photo periodism in plants and animals).		
Unit2:EnergyFlowinEcosystem		**8**
FunctionalcomponentsofEcosystem:Energyflow(UniversalmodelandYshapedmodel,Ten percentlawofenergyflow);Productivity(Primaryandsecondary)andecologicalefficiencies.Types of Ecological Pyramids with examples; Food chain (Detritus Food Chain and Grazing Food Chain); Food web and types; Bio geochemical cycles (Nitrogen cycle).		
Unit3:PopulationEcology.		**7**
Definitionandproperties(Natality,mortality,Density,Bioticpotential,Agestructure,survivorship curves,Growthcurveswithequations);Populationregulation(densitydependentand independent); r- and k – strategies.		
Unit4:Nicheand Competition		**8**
Definition of Habitat and Niche, Typesof Niche, N-dimensionalniche concept; Nicheoverlap and resourcepartitioning,Competitionandexclusionprinciple,Gause'sandConnell'sFieldexperiment, nichesegregationandcharacterdisplacement,LotkaVolterraequationforcompetition.Habitat Ecology–MetabolismandEcosystemservicesofTropicalRainforestandWetlands.		
Unit5:CommunityEcology		**4**
Community;Definitionandtypes;Stratification,speciesrichnessandEvenness;Dominance–DiversityAnalysis,Interspecificinteractionwithinequilibriacommunities(definitionandexamples).		
Unit6:EcologicalSuccession		**4**
Definition of succession, Types of succession, Seral stages of succession with special reference to Hydrosere and Lithosere; Models of ecological succession; Resource-Ratio Hypothesis.		
Unit7:PollutionBiology		**8**
Definition, Types of Pollutants (primary and secondary with examples); Causes and effects of acid rain, photochemical smog, ozone layer depletion and eutrophication; Cause and effects of heavy metalpollutioninwater(Pb,As,Hg);GroundwaterPollution;ConceptofBioconcentrationand Biomagnification.		

EcologyLab;DSCC-8-P

FullMarks25	1Credit	20Hours
Listof Practical		
1. **Quantitative Estimation** of Dissolved O_2(Winkler's method), Free CO_2, Alkalinity from the provided water sample and comment on the observation. 2. **Estimation**ofpHvalueoftheprovidedwatersample. 3. **Identification**withreasonsofthefollowingzooplanktons:*Daphnia,Cyclops,Cypris* 4. **Identification**withreasonsofthefollowingsoilarthropods:Collembola,termiteworker,ant 5. **Studyoflifetableandsurvivorshipcurve**fromahypotheticaldatasetandcommentontheresults. 6. **LNB**		

SUGGESTEDREFERENCES

CORECOURSE-3:GENETICS

1. Genetics-**Strickberger**3rdedition
2. iGenetics-**Russell**3rdedition
3. Genetics-**BenjaminAPierce**7thEdition
4. ConceptsofGenetics-**KlugandCummings**12thEdition
5. PrinciplesofGenetics,7thEdition,**SnustadandSimmons**.
6. AnIntroductiontoGeneticAnalysis,12thEdition,**Griffithetal.**
7. Schaum'sOutlinesofGenetics,5thEdition,**Stansfield**.
8. ProblemsonGenetics,MolecularGeneticsandEvolutionaryGenetics,2ndRevisededition**,P.K.Banerjee**

CORECOURSE-4:CELLSANDTISSUESTRUCTURE

1. JunqueriaLC,CarneiroJ.2005.Basichistologytextandatlas
2. RossMH,PawlinaW.2010.Histology:ATextandAtlas.LippincottWilliamsandWilkins
3. DonW.FawcettandWilliamBloom1998:atextbookonhistology
4. JohnD.Bancroft2019:Theoryandpracticeofhistology
5. KiernanJ.A.2001:Histologyandhistochemicalmethods3rdedition

SEC-3:POULTRYFARMINGANDANIMALHUSBANDRY

1. J.Prasad(2015)PoultryProductionandManagement,KalyaniPublisher
2. N.Ghosh(2015)PoultryScienceandPractice,CBSPublishersandDistributors
3. I.B.Singh(2000)Poultry,Fisheries,BeeKeepingandSericultureinIndia,PushalPublicationsandDistributors, 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, 8thEdn., Oxford and IBH Publishing Company Pvt. Ltd., New Delhi
6. D.N.Pandey(1995-1996)AnimalHusbandryandVeterinaryScience,15thEdn.,PublishedbyJaiPrakashNathand Company,Meerut.
7. P.R.Gupta(2007)DairyIndiaYearbook

CORECOURSE-5:NON-CHORDATESTRUCTUREANDFUNCTION

1. E.E.RuppertandR.D.Barnes(1994)InvertebrateZoology,6thEdition.HarcourtAsiaPTELtd.Singapore.
2. R.C.BruscaandG.J.Brusca(2003)Invertebrates,2ndEdition,SinauerAssociates,Inc.,Publishers,USA
3. Chapman,R.F.(2012).TheInsects:Structureandfunction5thEdition,CambridgeUniversityPress.UK
4. L.L.JordanandP.S.Verma(2002)InvertebrateZoology.S.ChandandCompanyLtd.,NewDelhi
5. K.K.Chaki,G.KunduandS.Sarkar(2005)IntroductiontoGeneralZoology.NewCentralbookAgency(P)Ltd. Kolkata.
6. R.L.Kotpal(2012)ModernTextBookofZoologyInvertebrates(AnimalDiversityI)RastogiPublications,Meerut 250002, India.

CORECOURSE-6:PARASITOLOGY

1. AhmedN,DawsonM,SmithC,WoodEd.2007.BiologyofDisease.TaylorandFrancisGroup.
2. AroraDR,AroraB.2001.MedicalParasitology.IIEdition.CBSPublicationsandDistributors
3. Bogitsch,BJ,CarterCE,OeltmannTN.(2013):HumanParasitology.4thEdn.Elsevier.
4. BoseM(2017).Parasitosesandzoonoses.NewCentralBookAgency.1:3-808
5. Chakraborty,P.(2016):TextbookofMedicalparasitology,3rdedition.NewCentralBookAgency.
6. ChatterjeeKD.2009.Parasitology:ProtozoologyandHelminthology.XIIIEdition,CBSPublishers
7. Cheng,T.C.,(1986):GeneralParasitology.AcademicPress.
8. DaileyMD.1996.Meyer,Olsen&Schmidt'sEssentialsofParasitology.W.C.BrownPublishers
9. GunnA,PittSJ.2012.Parasitology:anIntegratedApproach.WileyBlackwell.
10. HatiAK.1979.MedicalEntomology.AlliedBookAgency
11. JohnDT,PetriWA.2006.MarkellandVoge'sMedicalParasitology.Elsevier.
12. Roberts,L.SandJanovy,J.(2009).Smith&Robert'sFoundationofParasitology.8th.Edn.McGrawHill
13. SmythJD(2012):Introductiontoanimalparasitology.CambridgeLowPricedEdition.

CORECOURSE-7:MOLECULARBIOLOGY

1. Genetics-**Strickberger**3rdedition
2. iGenetics-**Russell**3rdedition
3. Genetics-**BenjaminAPierce**4thEdition
4. ConceptsofGenetics-**KlugandCummings**12thEdition
5. MolecularBiologyoftheGene-**Watson**7thEdition
6. CellBruce-Alberts6thEdition
7. MolecularBiology-**Weaver**5thEdition
8. PrinciplesandtechniquesofBiochemistryandMolecularBiology-**WalkerandWilson**8thEdition

CORECOURSE-8:ECOLOGY

1. AllenCainML,BowmanWDandHackerSD.2013.Ecology.3rded.Sinauerassociates.
2. BegonM,HarperJL.TownsendCR.2006.Ecology:Individuals,Populations&communities.4thEd.
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.4thIndianReprint,PearsonEducation.
7. Maiti,P.K.andMaiti,P.2023.Biodiversity,Perception,PerilandPreservation.PHI,LearningPvt,Ltd.
8. MollesJr.MC.2005.Ecology:ConceptsandApplications.3rdEd.McGraw-Hill.
9. OdumE.P,BarretGW.2017.FundamentalsofEcology.15thIndianreprint.CengagelearningIndiaPtd.OdumE.P. 2008.FundamentalsofEcology.Brooks/Cole
10. Ricklefs.R.E.Miller,G.L.2000.Ecology.4thEd.W.H.FreemanandCompany.
11. RusselP.J,WolfeLS,HertzPE,StarrC,McMillanB.2009.Ecology.CengageLearning,
12. SmithT.M,SmithRL.2006.ElementsofEcology.6thEd.PearsonEducation.
13. StilingP.2009.Ecology-TheoriesandApplications.4thEd.PrenticeHallofIndia.
14. Townsend,C.;J.L.Harper,M.Begon–EssentialsofEcology,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. 1stEdition, 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

PARTIII:SEMESTER-V

CORECOURSE-9:ChordateStructureandFunction[DSCC-9Theory]

FullMarks 75	3 Credits	45 Hours
Unit1:IntroductiontoPhylumChordata		**4**
Theories of Origin of chordates with reference to Dipleurula concept and the Echinoderm theory; General characteristics and outline classification (J.Z. Young, 1981).		
Unit2:Protochordata,AgnathaandPisces		**8**
Protochordataand Agnatha:General characters andclassification up to class (J.Z. Young,1981); Structure of pharynx and feeding in *Branchiostoma*; Retrogressive metamorphosis in *Ascidia*;Pisces: General characters andclassification of Chondrichthyes and Osteichthyesuptoclass (J.Z.Young,1981);Swimbladderinfishes;Structureof gillsincartilaginousandbonyfishes;Accessory respiratoryorgans;Olfactoryapparatusin*Tilapia*;Electricorganin*Torpedo*.		
Unit3:AmphibiaandReptilia		**7**
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.		
Unit4:Avesand Mammalia		**8**
GeneralcharacteristicsandclassificationofAvesandMammaliauptolivingSub-Classes(J.Z.Young, 1981);ExoskeletoninBirds;Air-sacsinPigeon,Aerodynamicsofflightinbirds;Exoskeleton derivativesofmammals;Dentitioninmammals;Ruminantstomach;EcholocationinMicro- chiropterans.		
Unit5:Comparativeanatomyinchordates		**10**
HeartandAorticarches;Brainwithreferencetocerebrum&cerebellum;kidneysandurino-genital ducts.		
Unit6:Skeletalsystem		**8**
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).		

ChordateStructureandFunctionLab;DSCC-9-P

FullMarks 25	1 Credit	20 Hours
ListofPractical		

1. Identification (upto order) with Reasons (Preserve specimen or Photograph) **Protochordata**: *Herdmania, Branchiostoma*, **Agnatha:** *Petromyzon, Myxine*; **Pisces**: *Scoliodon, Pristis, Hippocampus, Echeneis, Tetradon, Taractes*; *Tenualosa, Wallagu, Ompok*; **Amphibia**: *Necturus, Duttaphrynus, Rhacophorus, Hoplobatrachus, Ambystoma,Tylototriton*, ; **Reptilia**: *Chelone, Hemidactylus, Varanus, Calotes, Chamaeleon, Draco, Vipera, Hydrophis, Bungarus;* **Aves**: *Columba, Psittacula, Passer, Alcedo***Mammalia**: *Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus, Cavia*.
2. MountingofPlacoid,CycloidandCtenoidscales.
3. Osteology:IdentificationofLimbbones,vertebraeandgirdlesof*Duttaphrynus,Columba,Cavia*;skullof *Duttaphrynus,Trionyx,Columba,Cavia,Canis*.
4. Comparativestudyofheartandbrain,withthehelpofmodel/pictures.
5. Anatomystudy:Brain,pituitary,olfactoryapparatus(exsitu),digestiveandurino-genitalsystemof*Tilapia*
6. PectenfromFowlhead.
7. **LNB**

PARTIII:SEMESTERV

CORECOURSE-10:EndocrinologyandReproductiveBiology[DSCC-10Theory]

FullMarks 75	3 Credits	40 Hours
Unit1:IntroductiontoEndocrinology		**2**
GeneralideaofEndocrinesystem;Classification(withexamples)&TransportofHormones.		
Unit2:Hypothalamo-HypophysealAxis		**5**
Hypothalamicnuclei:Name,SecretionandFunction;FeedbackmechanismwithHypothalamo-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.		
Unit3:RegulationofHormoneAction		**5**
Receptors:Steroidhormonereceptor,Isoreceptor,Orphanreceptor Mechanismofactionofsteroidal,non-steroidalhormoneswithreceptors(cAMP,IP3-DAG)		
Unit4:Thyroidglandandparathyroidgland		**5**
Histologyofthyroidgland(LMandTEMstudy);Biosynthesisofthyroxine;Roleofthyroxinin calorigenesis and metabolism (carbohydrate, protein and fat). Roleofthyrocalcitoninandparathormoneincalciumhomeostasiswithspecialemphasisonvitamin D3.		
Unit5:Adrenalgland		**5**
Histologyofadrenalgland(LMstudy),Corticoidhormoneswithsource,structureandfunction, Biosynthesisofadrenalineandnoradrenaline,Functionofadrenaline;GeneralisedAdaptation Syndrome.		
Unit6: Pancreas		**5**
Histologyofpancreas(LMstudy)mentioningcelltypeswiththeirhormoneandfunction, Biosynthesis of insulin, Role of insulin and glucagon on carbohydrate homeostasis.		
Unit7:Pinealgland		**3**
Histologyofpinealgland(TEMstudy),Melatonin:Biosynthesisanditsroleinvitellogenesisinfish**.**		
Unit8:Reproductiveendocrinology		**5**
Histologyoftestisandovary(LMstudy),Biosynthesisofestrogenandtestosterone,Effectof testosterone on prostate function, Effect of estrogen on uterus. Lactation and its hormonal control Parturitionanditshormonalcontrol		
Unit9:Endocrinedisorders		**2**
Cause,SymptomsandTreatment:Graves'disease,TypeIandtypeIIdiabetes,CushingSyndrome		
Unit10:Endocrineregulationofinsectmetamorphosis		**3**
Endocrineglands;hormonesandphysiologyofmetamorphosisininsects		

EndocrinologyandReproductiveBiologyLab;DSCC-10-P

FullMarks 25	1Credit	20Hours
ListofPractical		

1. Demonstrationtolocalizethyroid,pancreas,adrenal,ovaryandtestisin rat.
2. Identificationwithreasons:Histologicalsectionofthyroid,pancreas,adrenal,ovaryandtestisofrat.
3. Analysisandinterpretationofclinicalconditionfromtheprovidedbloodsampledata
   a) T_3,T_4,TSHandTPO
   b) Insulin,bloodglucoseand HbA1C
4. Haematoxylin-Eosin (HE) staining of histological section: Mammalian thyroid, adrenal, pancreas, testis and ovary.
5. **LNB**

PARTIII:SEMESTERV

CORECOURSE-11:AnimalPhysiology[DSCC-11Theory]

FullMarks 75	3Credits	45Hours
Unit1:PhysiologyofDigestion		**6**
Anatomy of alimentary system in human; Mechanical digestion and chemical digestion of Carbohydrates, Lipids and Proteins in Human; Absorption of simple sugars, amino acids and fat; Role of GI hormones in digestion: source and function of Gastrin, Secretin, CCK – PZ, Motilin.		
Unit2:PhysiologyofRespiration		**6**
Anatomy of respiratory system in human; Mechanism of breathing; Pulmonary volumes and capacities; Transport of Oxygen and Carbon dioxide in blood; Oxygen Dissociation curve and the factors influencing it (Bohr effect and Haldane effect); Carbon monoxide poisoning.		
Unit3:PhysiologyofCirculation		**8**
Structure of hemoglobin, R and T form of hemoglobin; Hemostasis and Mechanism of blood clotting [pathways and clotting factors (I -XIII)]; Hematopoiesis: Basic steps; Bloodgroups:ABOandRhfactor;Erythroblastosisfoetalis,Bombayphenotype; Structureofhumanheartandconductingsystemofhumanheart;CardiacCycleanditsevents: Cardiac output and Strokes volume.		
Unit4:RenalPhysiology		**8**
AnatomyofKidneyandhistologyofnephronwithreferencetoJGA; Ammonotelic,ureotelicandUricotelicanimalswithexamples;Stepsofureacycle; Mechanismofurineformation:Glomerularfiltration,obligatoryandfacultativewater reabsorption and sodium dependent reabsorption, Counter-current mechanism; RoleofADHandRAASinurineformation;Osmoregulationinmarine(elasmobranchand teleost) and freshwater (teleost) fishes; Case study: Osmoregulation in Eel and Salmon.		
Unit5: Neurophysiology		**5**
Structure of neuron; Mechanism of impulse propagation across the myelinated and non-myelinated nerve fibres; Synapse: Chemical and Electrical; Mechanism of Synaptic transmission.		
Unit6:Muscularphysiology		**5**
Structure of muscle protein and their role along with calcium and ATP in muscle contraction (excitation-contraction-coupling); Muscle twitch, Muscular fatigue.		
Unit7: Thermoregulation		**3**
DefinitionandexampleofAestivationandhibernation;Thermoregulationincamel,polarbear.		
Unit8:Reproductivephysiology		**4**
Menstrualcycle:stageswithovarian,uterineandhormonalchanges. Estrous cycle: Stages with ovarian, vaginal and hormonal changes.		

AnimalPhysiologyLab;DSCC-11-P

FullMarks25	1Credit	20Hours
ListofPractical		

1. DeterminationofABOBloodgroupandRh factor.
2. Identificationofbloodcellsfromhumanbloodfilm(permanentslide).
3. Staining,mountingandidentificationofhaemocytesfromcockroachhaemolymph.
4. Preparationofhaemincrystalsfromratblood.
5. Demonstrationofbloodpressurebydigitalmeter.
6. QualitativetestsforAmmonia, UreaandUricacidingivensample.
7. **LNB**

PARTIII:SEMESTERV

CORECOURSE-12:BiodiversityandConservationBiology[DSCC-12Theory]

FullMarks75	3 Credits	46 Hours
Unit1:IntroductiontoBiodiversity		**10**
Definition,BiodiversityValues: DirectandIndirectvalues,TypesofBiodiversity, DepictingSpeciesDiversityatalphadiversity,betadiversityandgammadiversity; Biodiversityindices:Shannondiversityindex,Simpson'sdiversityindices; Genetic Diversity: significanceinBiodiversitypersistence,Consequencesofloss ofGenetic diversity;Ecosystemdiversity:BasicconceptofStructuralandFunctionalDiversitywith significance; Mega-diversity countries; Concept of endemism and Biodiversity Hot spot; Indicator Species,Flagship species,Keystonespecies,Umbrella species(definitionwithexamples).		
Unit 2:Threats tobiodiversity		**7**
Habitat loss, Habitat Degradation,Habitat Fragmentation and Edge effects in Ecotonal communities; Overexploitation of Natural Resource; ConceptofExoticorInvasive Species; Climatechange:CauseandeffectsonForestandMarineEcosystems; Climate change effect on Indian Fauna.		
Unit3:Wildlifeconservation.InsituConservation.		**15**
Definition of Conservation; Red data book (Extinct, Threatened, Endangered, Rare,and Vulnerable); Indian Wild life Protection Act, 1972 and Schedules I -V (mammalian examples any 2); Concept of Population Viability Analysis; WildlifeConservation methods:In Situ Conservation; ConceptandDesignofProtected Areas, NationalPark,WildlifeSanctuary, Biosphererereserves (with examples); TigerProject;ElephantProject;(History,Objective,Implementation,TigerCrisis); Concept of Corridors; AdvantagesanddisadvantagesofWildlifecorridors; CausesandconsequencesofHuman-wildlifeconflicts;Mitigationofconflict–an overview; JointForestManagement;People'sBiodiversityRegister.		
Unit4:Exsitu Conservation.		**7**
Captivebreedingofwildanimals:Conceptofcaptivebreeding;Advantagesand challenges of Captive Breeding; Re-introduction.		
Unit5:WildlifeLaws		**7**
Convention on Biodiversity; Biodiversity Act, 2002 and Rules 2004 (Basic Concept); Wildlifetradeandimpacts:TheConventiononInternationalTradeinEndangered SpeciesofWildFaunaandFlora(CITIES)andWildlifeTradeMonitoringNetwork(TRAFFIC); IUCN, WWF (Basic concept).		

BiodiversityandConservationBiologyLab;DSCC-12-P

FullMarks25	1 Credit	20 Hours
Listof Practical		

1. Determinationofpopulationdensityinanatural/hypotheticalcommunityby quadratemethodandcalculationofShannon-Weinerdiversityindexforthesamecommunity
2. Demonstration of basic equipmentneeded in wildlife studies use, care and maintenance: Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various DSLR Camera.[Photographs may be used]
3. Familiarizationandstudyofanimalsecondaryevidences(throughphotographs);Identificationof animals through
   pug marks of tiger and leopard, hoof marks of deer and elephant, scats of tiger and elephant, antler and horn
4. Biodiversitystudyofinanyoneoftheecosystemsof WestBengal(StudyAismandatoryandany two studies from the rest)
   A. Checklistoffaunashouldbepreparedalongwithcalculationofanydiversityindex.
   B. BirdCountusinglinetransect.
   C. Treeheightmeasurement,
   D. Measurementofcanopycover.
   E. ButterflySampling.
   F. Pitfallsampling
   G. QuadratSampling
5. **LNB**

PARTIII:SEMESTER-VI

CORECOURSE-13:DevelopmentalBiology[DSCC-13Theory]

FullMarks75	3Credits	43Hours
Unit1:Gametogenesis		**5**
Origin and fate of Primordial Germ Cells; Structure of mammalian sperm and ovum; Spermatogenesis in mammals, Stages of Spermiogenesis, Spermiation;Oogenesis in mammal; Compositionofyolkandpolarityandtypesofegg(basedonamountofyolkanditsdistribution).		
Unit2:Fertilization		**4**
Internalandexternalfertilization;Phasesoffertilizationinseaurchinandmammal.		
Unit3:PostFertilizationevents		**10**
Cleavage:Typesbasedonplaneandpattern,Roleofyolkincleavage. Blastula formation in chick. Gastrulation: Definition, Morphogenetic movement (epiboly, emboly, invagination, ingression, involution,delamination)withspecialreferencetoNieuwkoopcentreandKoller'ssickle;Process ofgastrulationinchick;ProcessofGastrulationinfrog;Fatemapinchickembryo,fatemapping using vital dye technique. Extraembryonicmembranesinchickandtheirfunctions.		
Unit4: Organogenesis		**8**
Induction anditstypes;Organizerconcept, Competence,Spemann andMangoldexperimentas Origin of organizer concept; Concept of molecular nature of organizer molecules (signaling/molecular mechanism excluded). **Induction in** : Neural Tube Formation and Development of Brain; Development of eye: retina, optic cup and lens. DevelopmentofKidney:Differentphasesandreciprocalinduction.		
Unit5: Implantation		**4**
Implantationinhumans:Typesandhormonalcontrol. Placenta: Structure, types based on histological association and distribution of villi; functions of placenta.		
Unit6:InfertilityandART		**4**
Causesofinfertility;TypesofART(ZIFT,GIFT,ICSI,IUI);Cryopreservationofgametes; IVF: method, advantages and disadvantages.		
Unit7:Stemcellsandits application		**4**
Definition, Types with examples, concept of potency, applications of stem cell therapy in bone marrow transplantation and cartilage regeneration.		
Unit8: Regeneration		**4**
Regeneration: MorphallaxisandEpimorphosisin*Hydra*;Epimorphiclimbregenerationsin Salamander.		

DevelopmentalBiologyLab;DSCC-13-P

FullMarks 25	1 Credit	20 Hours
Listof Practical		
1. Studyofwholemountsofdevelopmentalstagesofchickembryothroughpermanentslides:24,48,72 and 96 hours of incubation **2.** Studyofthedevelopmentalstagesandlifecycleof*Drosophila*andfrogusingphotographs **3.** Studyofdifferentsectionsofplacenta(photograph) **4.** Identificationoflarvathroughslides–*Nauplius*,Zoea,Veliger,Glochidium,Megalopa,Mysis, Trochophore. **5.** Mountingofratspermandfishova **6. LNB**		

PARTIII:SEMESTERVI

CORECOURSE-14:Taxonomy,EvolutionandAdaptation[DSCC-14Theory]

FullMarks75	3Credits	45 Hours
Unit1:Taxonomy1:BasicsofTaxonomyandSystematics		**5**
Taxonomy and Systematics: definition and importance; Binomial and Trinomial nomenclature; Law of priority; Homonymy and Synonymy**:** definition with example. **Taxonomic types:** Holotype, Paratype, Allotype, Lectotype, Neotype and Syntype: definition with example; **Linnean Hierarchy**; Biological Species concept and its limitations.		
Unit2:Taxonomy2:CharacterandCharacterstates		**3**
Types of characters with examples: Primitive, Advance, convergence, parallelisms, reversalofcharacters; Outgroupandingroup;HomologyversusAnalogy;Monophyly, PolyphylyandParaphyly:definitionwith examples.		
Unit3:Taxonomy3:Approachesin Classification		**6**
Classification: Definition; **Phenetics:** Definition, OTU, Single linkage clustering and construction of phenogram; **Cladistics:** Definition**,** brief concept on parsimony; DNA Barcoding and application**.**		
Unit4:Evolution1:GenefrequencyinaPopulationandFactorsinfluencing gene frequency		**8**
Hardy-Weinberg Principle: Assumption, proof of equilibrium, calculation of gene frequencyandgenotypefrequency(forautosomalgeneonly),testingforequilibrium; Equilibrium destabilizing forces: concept and mathematical expression of Selection (againstdeleteriousrecessivealleleonly);Mutation(changesfromdominantto recessivealleleonly)andMigration.		
Unit5:Evolution2:ConceptofOrganic Evolution		**7**
Biochemical Origin of life: concept of Protenoids, Microspheres and Protobionts; RNA-world Hypothesis; Darwinism and its limitations; **Modern Synthetic Theory of Evolution**: Sources of variation; Natural selection (types with example); Genetic drift and population bottle neck; Isolation (types with examples); **Speciation**: types and examples.		
Unit6:Evolution3:Evidences		**7**
Biogeographical realms: definition, names of six realms; geographical limit, climate and important vertebrate fauna of Oriental, Palaearctic and Australian realms; **Geologicaltimescale**(onlyoutlineidea;detaildescriptionnotneeded);**Fossil**: types andagedeterminationbyCarbondating; **Evolution ofhorse**;**Evolution ofMan.**		
Unit7:Adaptation1:Basicsofadaptation		**4**
Adaptation:definition;adaptiveconvergence,adaptivedivergence:definitionwith examples;AdaptiveradiationinmarsupialmammalsandDarwin's finches.		
Unit8:Adaptation2:Formof adaptation		**5**
Cursorial adaptation; Fossorial adaptation; Desert adaptation; Primary and secondary aquatic adaptation, Colouration and Mimicry.		

Taxonomy,EvolutionandAdaptationLab;DSCC-14-P

FullMarks25	1Credit	20Hours
ListofPractical		

1. Studyoffossilsfrommodels/pictures:*Dickinsonia*,*Paradoxides*(Trilobita),*Asteroceras*(Ammonoid), *Pentremites*(BlastoidEchinoderm),Ichthyosaur,*Archaeopteryx*,Cynodont.
2. Study (from preserved specimen or photographs) of features and their adaptive significance : *Labeorohita*, *Exocoetus*sp.(Flying fish), *Cynoglossus*sp. (Flat fish, Bengal tongue-sole), *Torpedo* sp. (Electric ray), *Himantura*sp. (Sting-ray of Bay of Bengal), *Sphyrna* sp. (hammer-headed shark), *Ichthyophis*sp., Axolotl larva of *Ambystoma*sp.,*Hyla*sp., *Phrynosoma*sp., *Crocodylus*sp., *Naja*sp., *Pipistrellus*sp. (Indiancommon Microchiroptera), *Bandicota*sp.,*Platinista*sp. (Gangetic dolphin), *Semnopithecus*sp. (Hanuman Langur).
3. *****Phylogenetictrees,Construction&interpretationofPhylogenetictreeusingparsimony,Construction of dendrogram following principles of phenetics& cladistics from a data table.
4. *****CalculationofchangeingenefrequencyinpopulationduetoSelection(againstdeleteriousrecessive trait only), Mutation (changes from dominant to recessive trait only), Migration.
5. **LNB**.

*Onlyformajorcoursestudents

PARTIII:SEMESTERVI

CORECOURSE-15:AnimalBehaviour[DSCC-15Theory]

FullMarks75	3Credits	44Hours
Unit1:IntroductiontoAnimalBehaviour		**5**
Contribution of Konrad Lorenz, Karl Von Frisch and Niko Tinbergen; Three foundations of behaviourstudy:Naturalselection,individualslearningandculturaltransmission;Approaches in behaviour study: Conceptual, theoretical and empirical.		
Unit2:PatternsofBehaviour		**6**
Stereotyped Behaviours (Orientation and Reflex):Primary and secondary orientation; Kinesis-orthokinesis, klinokinesis; Taxis: tropotaxis and klinotaxis, menotaxis (light compass orientation). Sign stimulus and Fixed Action pattern in Stickleback; Individual Behavioural patterns; Instinct vs. Learned Behaviour; Associative learning, classical and operant conditioning; bituation and Sensitisation; Imprinting: Filial and sexual imprinting.		
Unit3:SocialBehaviour		**7**
Advantageofgroupliving;Eusociality,SocialorganisationintermitesandLionpride. Kinship theory: Relatedness & inclusive fitness. Altruism,Selfishness,Hamilton'srule,Reciprocalaltruism. Cooperationandco-operativebehaviours:SocialgroominginSpidermonkey,Group Hunting in Hyenas; Aggregations: schooling in fishes, flocking in birds.		
Unit4:SexualBehaviour		**7**
Sexualdimorphism;CourtshipbehaviourandMatechoice;Goodgenesmodelinsexual selection; Runaway Sexual Selection Hypothesis. Intra-sexualselection(malerivalryinRedDeer);Inter-sexualselection(femalechoicein peacock); Definitionwithexample:Monogamy,polygamyandPolyandry.		
Unit5:EvolutionaryStrategies		**8**
ConceptofParentalcareandparentalinvestment:Parentalcareinfishes:oviparity,viviparity and ovoviviparity, nest building behavior of fish and amphibia; Cost and benefit of parental care by male fish; Parent-offspringconflict,Infanticide;sexualconflictinparentalcare; Territorial behaviour in monkey. EvolutionaryStablestrategies(ESS):Hawk–DoveModel.		
Unit6:BiologicalRhythm		**5**
Typesandcharacteristicsofbiologicalrhythms;Photicandnon-photiczeitgebers;Conceptof synchronizationandmasking;Biologicaloscillation:theconceptofAverage,amplitude,phase and period; Adaptive significance of biological clocks. Circaannualrhythm:CaseStudy-Birdmigration; Humanbiologicalclock(SCNandmelatonin);Sleep-wakecycleanditshormonalregulation; Concept of biological cycle disorders in human (brief idea).		
Unit7:Communication		**6**
AdaptivevalueofCommunication:ExampleofyellingRavenandrelatedhypothesis. Cost-benefitsofSignalproducer:Singerbirds'advantage,copingwithillegitimatereceiver byfrog. Chemical Communication: Pheromones in social insects: (trail, alarm, sexual, home range making and queen pheromones); Pheromones in Big-cat; Definition and examples of kiromones,Synomones,info-chemicals,semio-chemicals;Bruceeffect,Leebooteffectand Whitten effect of pheromones. TactileCommunication:Beedancelanguage.		

AnimalBehaviourLab;DSCC-15-P

FullMarks25	1Credit	20Hours
ListofPractical		
1. Demonstrationofnestsandnestingbehaviorofthebirdthroughphotographs(Pigeon,Crow,Tailor bird, Weaver Bird) and social insects throughphotographs (Termite, Ant andHoney bee). 2. Studyofgeotaxisbehaviorinearthwormandphototaxisbehaviorininsectlarvae. 3. Identification of common behavior (by photographs/video) of Fixed Action pattern in Stickleback &Greylaggoose,socialgroominginspidermonkey,grouphuntinginHyenas,schoolinginfishes,flocking in birds, male rivalry in Red Deer, parental care in Hippocampus, parental care in tree frog, territorial marking in tiger, following response in chicks. 4. Tostudycircadianfunctionsinhumans(dailyeating,sleepandtemperaturepatterns). 5. **LNB**		

SUGGESTEDREFERENCES

CORECOURSE-9:CHORDATESTRUCTUREANDFUNCTION

1. GaslowGE.AnalysisofVertebrateStructure,JohnWileyandSons
2. JordanEL,VermaPS.2003.ChordateZoology.S.Chand&CompanyLtd.NewDelhi.
3. KardongKV.2005.ComparativeAnatomyofVertebrates,FunctionandEvolution;McGraw-Hill
4. Norman,J.R.AhistoryofFishes,HillandWangPublishers
5. ParkerTJ,HaswellW.1972.TextBookofZoology,VolumeII:MarshallandWillamEds.MacmillanPr.
6. PoughH,ChristineMJ,HaiserB.2002.Vertebratelife,VIIIEdition,PearsonInternatl.
7. RomerAS,ParsonsTS.1986.Thevertebratebody.6thEd.SaundersCollegePublishing
8. Som,D.K.,Bhowal,S.K.,Ghosh,N.andMukherjee,A(2024)AconciseTextBookonPracticalZoology,
9. RainbowPublisher,Kolkata
10. Ghosh,K.C.andManna,B.(2009)PracticalZoology,NewCentralBookAgency(P)Ltd.Kolkata
11. YoungJZ.1981.TheLifeofVertebrates.IIIEdition.OxfordUniversitypress

CORECOURSE-10:ENDOCRINOLOGYANDREPRODUCTIVEBIOLOGY

1. GardnerDG,ShobackD.2011.Greenspan'sBasicandClinicalEndocrinology.McGrawHillLange.
2. HadleyME,LevineJE.2009.6thEdn.Pearson
3. MelmedS,PolonskyK,LarsenPR,KronenbergH.2016.William'sTextBookofEndocrinology.Elsevier.
4. MolinaPE.2013.EndocrinePhysiology.McGrawHillLange.
5. NorrisDO.2007.VertebrateEndocrinology.4thEdn.ElsevierAcademicPress
6. StraussJF,BarbieriRL.2014.Yen&Jaffe'sReproductiveEndocrinology.ElsevierSounders

CORECOURSE-11:ANIMALPHYSIOLOGY

1. Ganong'sReviewofMedicalPhysiology;McGrawHill
2. HallJE.2015.GuytonandHallTextbookofMedicalPhysiology.Saunderspublication.
3. HillRW,WyseGA,AndersonM.2012.AnimalPhysiology.3rdEdn.SineuerAsso
4. RandallD,BurggrenW.2001.EckertAnimalPhysiologyby.4thedition.W.H.Freeman.
5. SembulingamK,SembulingamP.2012.EssentialsofMedicalPhysiology.JaypeePub,NewDelhi
6. SherwoodL.2013.HumanPhysiologyfromcellstosystems.8thEdn.Brooks&Cole
7. Tortora,G.J.andDerrickson,B.H.;2009.PrinciplesofAnatomyandPhysiology,XIIEd,WileyandSons,Inc.

CORECOURSE-12:BIODIVERSITYANDCONSERVATIONBIOLOGY

1. CaughleyG,SinclairARE.1994.WildlifeEcologyandManagement.BlackwellScience
2. Hunter ML, Gibbs JB, Sterling EJ. 2008. Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. BlackwellPublishing
3. Hunter,M.L.,J.James&P.Gibbs–FundamentalsofConservationBiology–JohnWilley&Sons.
4. Maiti, P. K. and P. Maiti (2017) Biodiversity: Perception, Peril and Preservation in the Indian Perspective. PHI. LeaningPvt.Ltd.NewDelhi.*ISBN978–81-203-4380-1,(3ndEds)*
5. MajupuriaT.C.–WildlifeofIndia–Techpress,Bangkok
6. MukherjeeA.K.–EndangeredanimalsofIndia–Z.S.I
7. NewT.R.–InvertebrateSurveysforConservation–OxfordUniv.Pr
8. SahaG.K.&S.Majumdar–ThreatenedMammalsofIndia–DayaPublicationHouse
9. SahaGK,MazumdarS.2017.WildlifeBiology:anIndianPerspective,PHILearning,
10. SahariaVB.1998.WildlifeinIndia.NatrajPublishers.
11. SutherlandWJ.1997.EclogicalCencusTechniques,AHandbook.CambridgeUniversityPress.
12. SutherlandWJ.2000.TheConservationHandbook:Research,Management&Policy.BlackwellSc
13. Van Dyke F. 2008. Conservation Biology: Foundations, Concepts, Application. 2nd Ed. Springer Science Wild life (Protection)Act1972–WildlifeSocietyofIndia(NatarajPublication)
14. Wilson, E. O. – Biodiversity – National Academic Press Woodroffe R., Thirgood S, Rabinowitz A. 2005. People and Wildlife,ConflictorCo-existence?CambridgeUniv.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(2ND Edn.).McGrawHill,NewYork
2. Quicke,D.L.J.(1997)PrinciplesandTechniquesofContemporaryTaxonomy.(1st 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 (3rd 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.(1st Edn). Rainbow Publishers, Kolkata, India
7. Hall,B.K.(2008)Strickberger'sevolution(4th Edn.)JonesandBarlettPublishers,USA
8. Futuyma,D.J.(2024)Evolution(5TH Edn.)OxfordUniversityPress.

CORECOURSE-12:ANIMALBEHAVIOR

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

UNIVERSITYOF CALCUTTA

MODALITIESOFINTERNSHIPINZOOLOGY

GuidelinesfortheSummerInternship/ApprenticeshipProgramme(of3years Credits) for the students of Zoology

DURATIONOFINTERNSHIP:
15days(60workinghours)from16th Mayto30th Mayeach year

FULLMARKS: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/researchInstitutions/duringthesummerterm.One/two/moreofthefollowingactivitiescanbe chosen during the training period.

ACTIVITIES

1. Biodiversitystudyofbirds/butterfly/insects-campus/localarea
2. Laboratoryexposure[self/otherHEIInstitutes]inclusiveof
    a. LaboratoryreagentsPreparation
    b. Handling of Instruments
    c. Museummaintenance[preservingandcatalogingspecimens]
    d. Data analysis
    e. ReportPreparation
3. Fieldbasedsurvey/minorprojectstostudyanybranchofZoology/Alliedsciences[likeEcological survey/Epidemiological study/Nutritional assessment of the local area of the candidate.
4. Service-LearningprojectsinvolvingcommunityonanyaspectofZoology[examples:Water quality assessment of community; Assessment of vectors of a particular locality for any given human diseases etc.]

FOR EXAMINATION:

- OncompletionoftheSummerInternshipProgramme,thestudentswillsubmitareportwith relevantphotographsaspartofthereportandinclusiveofanAttendanceDocumentandan **Authenticated Certificate** jointly signed by the **Supervisor/Mentor** and the **Head of the Institution**.
- ThereportistobesignedbytheSupervisor/Mentorwithofficialseal.
- Aviva-vocewillbeconductedbytheDepartmentwith1FacultyactingasInternalExaminerand 1 External Examiner Appointed from Calcutta University
- **ThefollowingMarksdistributionistobefollowedforevaluation**
    1. Attendance:**15 marks**
    2. AssessmentonworkdoneduringtheInternship:**15 marks**
    3. Submissionofreport:**20 marks**
    4. VivaVoce:**25marks**

PARTIV:SEMESTER-VII

CORECOURSE-16:BIOTECHNOLOGY&ITSAPPLICATION [DSCC-16Theory]

FullMarks75	3Credits	46Hours
Unit1:IntroductionandMolecularTechniquesinGenemanipulation		**8**
Organizationof*E.coli;*RecombinantDNATechnology,Restrictionendonucleases. **CloningVectors&theirfeatures**:Plasmids,Phagevectors,Cosmids,Phagemids,BAC,YAC,and HAC. Shuttle and Expression Vectors. Construction of Genomic libraries and cDNA libraries. **Transformation techniques**: Cloning in bacteria and detection technique of clone. Polymerase chain reaction: DNA Fingerprinting		
Unit2:GeneticallyModifiedOrganisms		**5**
Productionofclonedandtransgenicanimals: NuclearTransplantation,RetroviralMethod, DNA microinjection.		
Unit3:CultureTechniquesandApplications		**5**
Animalcell culture, Expressingcloned genesin mammalian cells,Moleculardiagnosisofgenetic diseases(Cysticfibrosis,SickleCellAnaemia).Dolly&Pollycloning.GeneTherapy		
Unit4:IntroductiontoBioinformatics		**9**
Overview of Bioinformatics: Definition, scope, and significance in modern biology and biotechnology;Typesofmolecularbiologicaldata:Genomicsequences;Proteinsequencesand structures; Gene expression data **BiologicalDatabasesandDataSources** • **NucleotideSequenceDatabases:**NCBIGenBank;NCBIRefSeq(Ref.SequenceDatabase) • **ProteinStructureandSequenceDatabases:**RCSBPDB(ProteinDataBank) • **FunctionalGeneDatabases:**GeneCards®–TheHumanGeneDatabase • **ExpressionDataRepositories:**NCBIGEO(GeneExpressionOmnibus)		
Unit5:ToolsofBioinformatics		**9**
Sequence Alignment and Comparative Genomics: Importance and applications in functional and evolutionary biology; **Key Concepts:** Similarity vs Homology; Homology, Paralogy, Orthology, Analogy, Xenology **SequenceAlignmentTechniques** • **PairwiseAlignment:**Localandglobalalignment;Dotmatrixmethod • **MultipleSequenceAlignment(MSA):**Purposeandsignificance;Tools:ClustalW **SequenceSearch** • **BLAST(BasicLocalAlignmentSearchTool):**WorkingprincipleandtypesofBLAST • **FASTAFormat:**Representationandstructurefornucleotideandaminoacidsequences **PhylogeneticAnalysis** • Usingsequencedatatoinferevolutionaryrelationships • **Distance-BasedMethods:** o UPGMA(UnweightedPairGroupMethodwithArithmeticMean) o NeighbourJoining(NJ)		
Unit6:MicrobialBiotechnology		**5**
FoodProduction-Diaryproducts&probiotics,Pharmaceuticals-productionofantibioticsand antifungals and Biofuel production		
Unit7: Biosafety		**5**
Biosafety Principle: Primary and Secondary Barriers; Types of Risk (occupational, environmental, ethical) & Risk management process; Biosafety level (BSL-1 to BSL-4), Biosafety Cabinet, (I, II, II) Occupational health support of Biomedical Research, Personal Protective equipment (PPE)		

BIOTECHNOLOGY&ITSAPPLICATIONLAB;DSCC-16-P

FullMarks25	1 Credit	20Hours
Listof Practical		

7. PlasmidDNAisolation(pUC18/19)from *E.coli*
8. **BLASTAnalysis**
   - Performing**BLASTn**fornucleotidesequencesimilaritysearch.
   - Performing**BLASTp**forproteinsequencesimilaritysearch.
   - Understandingandinterpreting**BLASTresults**:E-value,identity,andalignmentscore
9. **MeltingTemperature(Tm)CalculationofPCRPrimers:**DesigningshortoligonucleotideprimersforPCR.; Calculating **melting temperature (Tm)** using standard formulas or online tools.
10. **PhylogeneticTreeConstruction:** Applicationof**distancematrixmethods-UPGMA(UnweightedPairGroup Method with Arithmetic Mean); Neighbour Joining (NJ)** method
11. **LNB**

Note: Each college department should have computer lab with software and internet support forthetheory item Unit 5 and the the practical item of serial no. 2,3,4.

PARTIV:SEMESTERVII

CORECOURSE-17:NEUROBIOLOGY[DSCC-17Theory]

FullMarks75	3Credits	45Hours
Unit1:StructuresofNervousSystem		**9**
Types of Invertebrates nervous system: Nervous system in Cnidarians (Nerve net of Hydra, medusanervenet and pacemakernerveinAurelia),LadderAnnelida(Earthworm),andInsects (Cockroach),Mollusca(Octopus),Echinodermata(Asterias).Generalplanandorganizationsof central, peripheral and autonomic nervous system in Vertebrate. Different nuclei/lobes/areas andfunctionofthalamus,hypothalamus,cerebellum,cerebralcortexandbrainsteminHuman.		
Unit2:NerveAndNerve-MusclePhysiology		**5**
Structureofneuromuscularjunctionandmechanismofneuromusculartransmission. Modulation of Synaptic transmission.		
Unit3:SensoryNervousSystem		**8**
Structure of retina, Photochemistry of vision and visual pathways, Modern concept of color vision, Structure and functionof organ of Corti, Auditorypathways, Structure of gustatoryand olfactoryorgans.Gustatoryandolfactorypathways.Neuronalpathwayscarryingpain,thermal, touch and kinesthetic impulses. Corticospinal, corticobulbar and bulbo-spinal tracts carrying motor information from the brain to the periphery.		
Unit4:NeurodevelopmentAndHigherBrainFunctions		**8**
Neurogenesis,neuronalmigrationandneuronaldifferentiationinvertebratemodels.Human Brainevolution.Brainandcognitivedevelopment.NeuralcontrolofLearningandBehaviour, Higher Brain Functions: Sleep, Memory, Emotions and Speech.		
Unit5:NeurochmistryAndNeuroendocrineSystem		**5**
CellularandMolecularfoundationofNeuro-biochemistry(Human):Neurotransmittersand Neuromodulators[Acetylcholin,Dopamine,GABA,Serotonin,Nor-epinephrineandGlutamine and receptors for Acetycholine., Blood brain barrier		
Unit6:ToolsInNeuroscience		**5**
Techniquesandtoolsapplicableinneuroscience:CT,MRI,PET,Optogenetics,PatchClamp,EEG, Neural stimulation, Brain-computer interface.		
Unit7: Neuropathology		**5**
DegenerationandregenerationofnervefibersinPeripheralandCentralNervousSystem. CellularandMolecularMechanismsandgeneticsoftheNeurologicalDiseases:Alzheimer's disease, Parkinson's Disease, Cerebral Stroke, Epilepsy, Muscular Dystrophy.		

NEUROBIOLOGYLAB;DSCC-17-P

FullMarks25	1Credit	20Hours
ListofPractical		

1. IdentificationofCNSandPNSstructuresinanimalmodels(Mouse/Chick/Zebrafish/Drosophila).
2. GrossanatomyofHumanbrainanditsdifferentparts(withmodels).
3. Studyingearly,midandlatedevelopmentalstagesofCNS inanimalmodels(Chick,Zebrafish).
4. Identificationofdifferent brainareasin CTandMRI images.
5. **LNB**

PARTIV:SEMESTERVII

CORECOURSE-18:TOXICOLOGY[DSCC-18Theory]

FullMarks75	3Credits	47 Hours
Unit1:IntroductiontoToxicology		**10**
DefinitionandTypes ofToxin,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];Heavymetals[Chromium&Cadmium]Pesticides[Organochlorineand organophosphates],Microplastics.Acutetoxicity,chronictoxicity,systemictoxicity,local toxicity (concept only); Scope of Toxicology		
Unit2:Toxicants:Routes,DoseToxicitytestandinfluencing factors		**10**
Exposure to Toxicants. Routes and Sites of Exposure (Inhalation, Injection, Intestinal) **Factors influencing toxicity**. Species, Strains, Age, Sex, Nutritional Status, Environmental Stressors. **Dose of toxicants:** Measurement of Dose response relationship. Graded and Quantal Response; Cumulative response, Threshold limit, Toxicokinetics (Basic concept) Toxicitytest–Acutetoxicitytest,Chronictoxicitytest,Subacutetoxicitytest Concept of LC50, LD50 and EC50		
Unit3:XenobioticClassificationandMetabolism		**7**
Xenobiotics:Definition,typesand significance Target organ toxicity: Hematotoxicity; Hepatotoxicity; Nephrotoxicity; Neurotoxicity PhasesofXenobioticMetabolism[Phase-I;Phase-II;Phase-IIIReaction;enzymes involved and 1 example for each]		
Unit4:Action of Toxicants		**10**
Receptors,MechanismofactionofLead, DDT Bioremediationinsoilandaquaticsystem. TherapeuticIndexPotencyand Efficacy.		
Unit5:EnvironmentalContaminants		**6**
Foodadditives[MetanIlyellow,Argemoneoil,RhodamineB]; Bioindicators [Chironomid larva, Dragonfly, *Tubifex sp.*]. Genotoxicology:Definition,Effects,Molecularmechanismsandpreventionof Acrylamide, Ethylene oxide, Formaldehyde, Acridine Orange and EMS.		
Unit6:EndocrineDisruptors		**4**
Source,Types,Effects,Mechanismofactiononbehaviorandneuroendocrinesystem: Phthalate; BPA; PCB; DDT; DES; and PAH		

TOXICOLOGY LAB; DSCC-18-P

FullMarks25	1Credit	20Hours
Listof Practical		
1. StudyofAcute, SubacuteandChronictoxicityofFomaldehydeon *Drosophila*larva. 2. StudyofLC50 for24,48, 72,96hoursofTemephosonmosquitolarva. 3. MicronucleusstudyfromBuccalSmear. 4. Demonstrationofinstrumentsusedinmonitoringair[airqualityanalyzers/airfilters/measurement of SPM] and water pollution [water quality meters/TDS] through online images/videos. 5. **LNB**		

PARTIV:SEMESTERVII

CORECOURSE-19:IMMUNOLOGY[DSCC-19Theory]

FullMarks75	3Credits	47 Hours
Unit1:Introduction		**5**
Cellsand Organs[Primary,SecondaryandTertiary]oftheImmunesystem		
Unit2:InnateandAdaptiveImmunity		**7**
Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity [PAMPS & PRR], Adaptive immunity (Overview of the pathway of activation for Cell Mediated Immunity and Humoral Immunity).		
Unit3:Antigens		**4**
AntigenicityandImmunogenicity,Immunogens,AdjuvantsandHaptens,Factors influencingimmunogenicity,BandT-Cellepitopes		
Unit4:Immunoglobulins		**7**
Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA, RIA and Immunoprecipitation), Monoclonal antibody production		
Unit5:MajorHistocompatibilityComplex		**6**
StructureandfunctionsofMHCmolecules.Processingofexogenousand endogenous antigens [Pathway only] StructureofTcellReceptorand itsSignaling,Tcelldevelopment & selection		
Unit6:Cytokines		**3**
Types,propertiesandfunctionsofcytokines.		
Unit7:ComplementSystem		**4**
Componentsandpathwaysofcomplementactivation.		
Unit8:Hypersensitivity		**6**
Gell and Coombs' classification and brief description of various types of hypersensitivities; Autoimmunity: Major factors that contribute to the development of autoimmunity; Geneticsusceptibilityandenvironmentaltriggers.Examples-Rheumatoidarthritis& Systemic lupus erythematosus.		
Unit9:Vaccines & Immunotherapy		**5**
Various types of vaccines. Active & Passive immunization (Artificial and natural); Cancer immunotherapy: i) MABs in treating cancer; ii) cytokine augmentation; iii) therapeutic vaccines.		

IMMUNOLOGYLAB;DSCC-19-P

FullMarks25	1Credit	20Hours
Listof Practical		

1. Widaltest.
2. DemonstrationofLymphoidOrgans(bypicture).
3. HistologicalstudyofBursaofFabricius,Spleen,ThymusandLymphnodesthrough slides/ photographs
4. DemonstrationofELISA,ImmunoprecipitationandOuchterlonymethodthroughphotographs
5. **LNB**

PARTIV:SEMESTERVII
CORECOURSE-20:ANIMALMODELSINRESEARCH
[DSCC-20Theory]

FullMarks75	**3Credits**	**48 Hours**
Unit1:ConceptofAnimalModelandtheirApplicationin Research		**6**
DifferentAnimalModelsandtheir Advantageand Limitations Cnidaria;*C.elegans*;*Drosophila*;StarfishandSeaurchin;Zebrafish;Mouse,Rat andMonkey		
Unit2: Cnidaria		**6**
• ClassicHydraRegenerationExperiments *Spemann, H. (1938). Embryonic Development and Induction. Yale University Press. Lenhoff, H.M., &Lenhoff, S.G. (1986). Hydra and the Birth of Experimental Biology: 1744. Boxwood Press.* • GFPDiscoveryin *AequoreaVictoria;* *Shimomura,O.,Johnson,F.H.,Saiga,Y.(1962).J.Cell.Comp.Physiol.,59(3),223–239.*		
Unit3:*C. elegans*		**6**
• Genetic Regulation of Organ Development & Programmed Cell Death).Nobel Prize: 2002 in Physiology or Medicine*Yuan, J., Shaham, S., Ledoux, S., Ellis, H.M., Horvitz, H.R. (1993). "TheC.eleganscelldeathgeneced-3encodesaproteinsimilartomammalianinterleukin-1β–converting enzyme." Cell, 75(4), 641–652.* • RNAInterference(RNAi)DiscoveryNobelPrize:2006inPhysiologyandMedicine.*Fire, A.,Xu,S.,Montgomery,M.K.,Kostas,S.A.,Driver,S.E.,&Mello,C.C.(1998).* *Potent and specific genetic interference by double-stranded RNA in Caenorhabditis elegans. Nature, 391(6669), 806–811.*		
Unit4: *Drosophila*		**10**
• SexdeterminationandDosagecompensation • CytologicalDemonstrationofCrossingover[SternsExperiment]; • MullersexperimentforBalanced-lethalsystem;ConceptofBalancer; • Positioneffect variegation. • Conceptofaxisformationandhomeoticgenein*Drosophila* • CharacterizationofBX-C:DiscoveryNobelPrize**.**1995inPhysiologyorMedicine. Lewis,E.B.(1978).*AgenecomplexcontrollingsegmentationinDrosophila*.Nature,277(5688),565–570.		
Unit5:StarfishandSea-urchin		**6**
Starfish: • ClassicStarfishLarvaPhagocytosisExperimentByÉlieMetchnikoff. [NobelPrizein Physiology or Medicine, 1908] *Metchnikoff,E.(1905).ImmunityinInfectiveDiseases.CambridgeUniversityPress.* **Sea Urchin:** • Tim Hunt – Discovery of Cyclins: Nobel Prize in Physiology or Medicine, 2001 (withLeland Hartwell & Paul Nurse) *Evans,T.,Rosenthal,E.T.,Youngblom,J.,Distel,D.,&Hunt,T.(1983). Cyclin: A protein specified by maternal mRNA in sea urchin eggs that is destroyed at each cleavage division. Cell, 33(2), 389–396.* • Understandingofacetyl-CoAastheuniversalintermediateinmetabolism;cornerstone of the Krebs cycle. *Hans Adolf Krebs & Fritz Lipmann – Discovery of Coenzyme A. Nobel Prize in Physiology or Medicine, 1953. Lipmann, F. (1945). J. Biol. Chem., 160, 173–190.*		
Unit6:Zebra fish		**6**
• Establishingthezebrafishdevelopmentalstagingseries.		

Kimmel, C.B., Ballard, W.W., Kimmel, S.R., Ullmann, B., & Schilling, T.F. (1995). Stages of embryonic development of the zebrafish. Developmental Dynamics, 203(3), 253–310. https://doi.org/10.1002/aja.1002030302. • Large-scalemutagenesisscreensledby ChristianeNüsslein-VolhardandWolfgang Driever, which became a landmark in zebrafish genetics. *Haffter, P., Granato, M., Brand, M., Mullins, M.C., Hammerschmidt, M., Kane, D.A., Odenthal, J., van Eeden, F.J.M., Jiang, Y.J., Heisenberg, C.P., Kelsh, R.N., Furutani-Seiki, M., Vogelsang, E., Beuchle, D., Schach, U., Fabian,C.,&Nüsslein-Volhard,C.(1996).Theidentificationofgeneswithuniqueandessentialfunctions inthedevelopmentofthezebrafish,Daniorerio.Development,123(Suppl.),1–36.*	
Unit7:Mouse/RatandMonkey/Horse	**8**
• Conceptofgeneknockout,knockdownandknockin. • **Mice:** Treated with anti-CTLA-4 antibodies experienced tumor rejection and long-term immunityagainstre-inoculationwiththesametumortype.[Experimentdemonstration of vaccine immunogenicity;The Experiment — James P. Allison's CTLA-4 Blockade (mid-1990s)-2018 Nobel Prize in Physiology or Medicine] ; *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.* • **Monkey**:Primatevisualcortexphysiology(Hubel&Wiesel)-NobelPrizeinPhysiology or Medicine, 1981] *HubelDH,WieselTN."Receptivefieldsandfunctionalarchitectureofmonkeystriatecortex."JPhysiol 195:215–243(1968).* • **Horse**:Immunizationofhorses(toraiseanti-venom antibodies)]	

ANIMALMODELSINRESEARCHLAB;DSCC-20-P

FullMarks25	**1Credit**	**20Hours**
ListofPractical		
1. IdentificationofX-linkedandautosomaldominantandrecessivemutationin*Drosophila* 2. Useofmutationininheritancestudythroughgeneticcrosses. 3. Demonstrationofdifferentimaginaldiscandexpressionofgenesthroughphotographs. 4. DemonstrationofdevelopmentalstagesofZebrafishthroughphotographs. **5. LNB**		

PARTIV:SEMESTER-VIII

CORECOURSE-21:RESEARCHMETHODOLOGY-1[DSCC-21Theory]

FullMarks75	3Credits	45Hours
Unit1:PlanAndDesignofResearchFramework:		**7**
(Basic concept) Formulation of research problem,Types of investigation; Aim, Objective, Hypothesis; Items, Observation, Sample and types of sampling, Population, Treatment, variables, Test and controls, Replica, Repeatability, Questionnaires, Focus group, Determination of Sample size, Collection of data, Criteria of good research. Problems encountered by researchers in India.		
Unit2:Data:		**7**
Type of Data : Qualitative, Quantitative, Descriptive, Discrete, Continuous, Rankable,Nominal,Ordinal,Interval,DerivedVariable.DistributionofData(basic idea): Normal distribution, Binomial distribution, Poisson distribution, Exponential distribution. Parametric and Non-parametric data.		
Unit3:EstimateOfTheCentralTendency:		**5**
Concept and calculation of mean, median and mode (only for normal distribution). Estimation of variance and standard distribution of normally distributed data.		
Unit4:HypothesisTesting:		**10**
Typesofhypothesis,samplingerror,teststatistics,P-value,one-tailedandtwo-tailed test, degree of freedom, chi-squared goodness of fit test, Student's t-test (matched and unmatched data).		
Unit5:CorrelationAndRegression:		**6**
Correlationco-efficient,Positiveandnegativecorrelation,co-variance,Linear regression and regression line, concept of outlier.		
Unit6:ResearchEthics:		**5**
Basic codes for research ethics, Objective of research ethics, Emergence of concept of biomedical research ethics, Types of biomedical research (Basic, Preclinical, Clinical, translational), International guideline (WMA guideline Helsinky 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,Animalethicscommittee.AnimalWelfareBoardinIndia(AWBI)andits activity,CCASEAguidelineinIndia.		
Unit7:BiologicalResearchAndSociety:		**5**
Societal perception on biomedical research, contemporary factors shaping societal perception, Public mistrust and strategies for trust building, science-societydialogue;Socio-economic,political,commercialaspectofbiomedical research.		

PARTIV:SEMESTERVIII

CORECOURSE-22:RESEARCHMETHODOLOGY-2[DSCC-22Theory]

FullMarks75	3Credits	46Hours
Unit1:WritingOfAScientificPaper:		**8**
Concept and importance of scientific research and review paper; shape and organizationofscientificpaper,ethicsinscientificpublishing,conceptoftypesof plagiarismsanddatapiracy,organizationofapaper,selectionoftitle,authorship criteria,abstract,materialandmethods,resultsanditsinterpretation,discussion. Acknowledgement, Citation and its style. Writing a dissertation report.		
Unit2:LiteratureReview:		**8**
Definition, Purpose, types (narrating, systemic, scoping, meta-analyses, annotated bibliography), steps of literature review, criteria of good literature review,commonpit-falltoavoid,Webresourcesforliteraturereview: attributeand use of Google scholar, Semantic scholar, PubMed, ScienceDirect, Scopus,WebofScience,Sodhganga/INFLIBNET,NationalDigitalLibraryofIndia.		
Unit3: Bibliography:		**4**
Definition, types, purpose, branches of bibliography, components of a bibliography, Indian National bibliographies, Bibliographical controls. Online bibliographicaltools:UseandkeyfeaturesofZotero,JabRef,CiteFast,Mendeley, EndNote. UGC-care list.		
Unit4:PresentationOfResearch:		**10**
Definition, criteria of a good presentation, Basic structure of scientific power-point presentation, slide designing principle, presenting scientific data, scientific writingstyleonslide,strategyforverbalpresentation,Commonmistaketoavoid, evaluationofgoodscientificpresentation.		
Unit5:WritingAResearchProposalForGrantAndPreparingItsReport:		**7**
Component of grant proposal: Abstract/Summary, Introduction and Background, Aims & objective, Hypothesis, Methodology, Work-plan and Timeline(GanttChart),Budgetestimateandjustification,Expectedoutcomeand deliverables,Grantreportformatandimportanceofgrantreport.IndianGrant agenciesandtheirprojectformat:DST-SERB,DBT,ICMR.		
Unit6:IntellectualPropertyRight(IPR)		**4**
DefinitionofIPandIPR,CategoriesofIP,ScopeofIP,TypesofIP,Importanceof IPR, Evolution of IP acts and treaties, Agencies responsible for IP registration, Issues affecting IP internationally.		
Unit7:CopyrightAndPatent:		**5**
Copyright definition, importance, originality of material, Indian copyright act, copyright registration and its application. Patent definition, types of patent, Foundation of patent law, patent search in India, patent status, Basic criteria for patentability,		

PARTIV:SEMESTERVIII
CORECOURSE-23:BIOPHYSICSANDLABORATORYTECHNIQUES
[DSCC-23Theory]

FullMarks75	3Credits	40Hours
Unit1:Elementsof Biophysics		**6Hours**
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 biologicalsystems – Poisson-Boltzman equation.		
Unit2 : Chromatography		**6Hours**
PrinciplesandApplications:PaperChromatography,Thin-layerChromatography, Adsorption chromatography, Affinity Chromatography, Ion-exchange Chromatography, Molecular sieve Chromatography, High performance liquid Chromatography, Gas Chromatography		
Unit3 : Spectroscopy		**10Hours**
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		
Unit4 :FlowCytometry		**5Hours**
Basiccomponentsofaflowcytometer(Fluidics,OpticsandElectronicssystem);ConceptofFluorescenceActivatedCellSorting(FACS);AnalysisofApoptosisandCell CyclethroughFlow Cytometry		
Unit5:BasicLaboratoryInstruments		**4Hours**
Applications of Water distillation plant, Dry bath and Water bath, BOD incubator, pH meter, Vortex, Magnetic stirrer, Weighing balance (manual and digital), Autoclave		
Unit6:PolymeraseChainReaction (PCR)		**5Hours**
Basicconcept;StagesinPCR;PCRprimerdesigning;TypesofPCR(AllelespecificPCR, RT-PCR, qRT-PCR, RAPD PCR), Applications of PCR		
Unit7:MedicalDiagnostic Tools		**4Hours**
Working Principles and Applications of Blood Pressure machine (manual and digital), Glucometer, Pulse Oximeter, Electrocardiogram (with brief idea on data analysis), X-Ray.		

BIOPHYSICSANDLABORATORYTECHNIQUESLAB:DSCC-23-P

FullMarks25	1Credit	20Hours
ListofPractical		
1. Analysisof:-a)Apoptosisandb)CellCyclefromflowcytometrydatasheets.[PI&AnnexinV] 2. PackingandSterilizationofglassandplasticwaresusing Autoclave. 3. PaperChromatography–DemonstrationandRfvaluecalculation.[amino acids] 4. EstimationofRandombloodsugarusingaGlucometer. 5. EstimationofbloodoxygensaturationusingPulseoximeter. 6. AnalysisofElectrocardiogramdatasheets. **7. LNB.**		

PARTIV:SEMESTERVIII
CORECOURSE-24:DISEASEBIOLOGYANDPUBLICHEALTH
[DSCC-24Theory]

FullMarks75	3Credits	46Hours
Unit1:Introduction		**7**
DefinitionandTypesofdiseasewithexample(communicableandnon-communicable disease, Epidemic endemic and pandemic); modes of transmission of diseases – routes of entry and different agents with examples.		
Unit2:Zoonosis		**7**
Definition,ListOfZoonoticDiseases,ConceptofZoonosiswithrespectto Taeniasis, Chikungunya, Typhus, Dengue.		
Unit3:Communicablediseases		**4**
Causes,Symptoms,Epidemiology,Prevention,DiagnosticTechniquesofAIDS, HepatitisB,Tuberculosis,anditsTypes,SARS,MARS,Ebola,Zika		
Unit4:Non-Communicablediseases		**10**
Causes, Types, Symptoms, Epidemiology, Prevention, Risk Factorsof Obesity and Hypertension.		
Unit5:Occupationaldisease		**6**
DefinitionanddetailofSilicosis,Anthracosis,Byssinosis,Asbestosis,Farmer's Lung,LeadpoisoningandOccupationaldermatitis.		
Unit6:Mentalhealth		**3**
TypesaccordingtoICD10,theircausesandprevention.		
Unit7:Nutritionandhealth		**5**
Nutrients classification with sources and functions; Dietary fibres – types and functions;Malnutrition–definitionandtypes;Deficiencydiseasesofvitamins and minerals; Balanced diet and dietary goals.		
Unit8:Healthplanningandmanagement		**4**
Objective,targetsandgoals,planningcycleandhealthsectorplanning.		

DISEASEBIOLOGYANDPUBLICHEALTHLAB;DSCC-24-P

FullMarks25	1Credit	20Hours
Listof Practical		
1. CalculationofBMIfromdatasheetandassessmentofhealthstatus. 2. Identificationandclinicalsignificance(withpicture)of *Mycobacteriumtuberculosis,*HIV,*Xenopsyllacheopis*,HepatitisB,Hexacanth/Oncosphere, Ebola, Zika 3. CBC,LipidprofileandLFTreportanalyses. 4. LNB		

SUGGESTEDREFERENCES

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*(2nded.).AcademicPress.ISBN:9780123850638
3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2017). *Molecular biotechnology: Principles and applications of recombinantDNA*(5thed.).ASMPress.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:Amolecularapproach*(3rded.).PearsonEducation.ISBN:9780321772896
7. Thieman,W.J.,&Palladino,M.A.(2018).*Introductiontobiotechnology*(4thed.).Pearson.ISBN:9780134604718
8. Weaver,R.F.(2011).*Molecularbiology*(5thed.).McGraw-HillEducation.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:Databasesandalgorithms*.NarosaPublishingHouse.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).*Introductiontobioinformatics*(5thed.).OxfordUniversityPress.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. PrinciplesofNeuralScience,EricR.Kendel;
2. Neuroscience,DalePurves;
3. TheHumanNervousSystem,MaiPaxinos;
4. InstantNotesinNeuroscience,AlanLongstaff;
5. Netter'sAtlasofHumanNeuroscience,DavidL.FeltenandRalphF.Jozefowicz;
6. TextBookofMedicalPhysiology,GuytonandHall;
7. Ganong'sReviewsofMedicalPhysiology,Barrett, Barman;
8. PrinciplesofAnatomyandPhysiology,G.J.Tortotora,B.Derrickson;
9. PrincipleofCognitiveNeuroscience,DalePurves;
10. CognitiveNeuroscience,MarieT.Banich,RebeccaJ.Compton;
11. DevelopmentalBiology,ScottF.Gilbert;
12. DevelopmentoftheNervousSystem,DanSanes,ThomasReh,WilliamHarris;
13. DevelopmentalNeurobiology,GregLemke
14. NeuromuscularDisorders,Amato&Russell;
15. ClinicalNeurology,Simon,Greenberg,Aminoff;
16. HandbookofNeuroendocrinology,GeorgeFink;
17. William'sTextbookofEndocrinology,Krorenberg,Meaund;
18. BasicandClinicalPharmacology,Katzung

IMMUNOLOGY

1. Abbas,K.A.,&Lichtman,A.H.(2003).*Cellularandmolecularimmunology*(5thed.).SaundersPublication.
2. Abbas, K. A., &Lichtman, A. H. (2011).*Basic immunology: Functions and disorders of the immune system*(4th ed.).SaundersElsevier.
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).*Textbookofimmunology*(2nded.).JaypeeBrothersMedicalPublishers.
6. Parija,S.C.(2012).*Textbookofmicrobiologyandimmunology*(2nded.).Elsevier.
7. Playfair,J.H.L.,&Chain,B.M.(2001).*Immunologyataglance*(7thed.).BlackwellPublishing.
8. Reed,J.C.,&Green,D.R.(2011).*Apoptosis:Physiologyandpathology*.CambridgeUniversityPress.
9. Shetty,N.(2005).*Immunology:Introductorytextbook*.NewAgeInternationalPublishers.
10. Virella,G.(2007).*Medicalimmunology*(5thed.).InformaHealthcare.

TOXICOLOGY

1. DerelankoMichaelJ.(2018)TheToxicologist'spocketHandbook,CRCPress,Taylor&Francis Group ISBN 10: 0849300096
2. HodgsonErnest:ATextbookofModernToxicology(2010)Wiley;4thedition,ISBN-10;0470
3. LeeByung-Mu,SamKacew,HyungSikKim:Lu'sBasicToxicology(Fundamentals,TargetRisk Assessment), Seventh Edition, (2017), CRC Press, Taylor & Francis Group,
4. PaniBalram:TextbookofToxicology,DrermtechPress(2019),ISBN-10
5. Pandey,K.,Shukla.J.P,andTrivedi.S.P.FundamentalsofToxicology.CentralBookAgency.

BIOPHYSICSANDLABORATORYTECHNIQUES

1. Fundamentals and Techniques of Biophysics and Molecular Biology (2018- 2ndEdition): Pranav Kumar. *PathfinderPublication*.
2. Principles and Techniques of Biochemistry and Molecular Biology (2008– 6thEdition): Keith Wilson and John Walker. *Cambridge University Press*.
3. BiophysicsandBiophysicalChemistry(2022–6thEdition):DebajyotiDas.*AcademicPublishers.*
4. FundamentalsofBioanalyticalTechniquesandInstrumentation(2010)–SabariGhoshal,A.K.Srivastava. *Prentice-HallofIndiaPvt.Ltd.*
5. BiologicalInstrumentationandmethodology(2010)-P.K.Bajpai.*S.Chand&Company*.
6. ATextbookofPracticalPhysiology(2012)-C.L.Ghai.*JaypeeBrothersMedicalPublishersPvt.Limited.*
7. TextbookofMedicalPhysiology(2006–11thEdition)–GuytonandHall.*ElsevierSaunders*.
8. HandbookofBiomedicalInstrumentation(2022 –3rdEdition)–R.S.Khandpur.*McGrawHillEducation(India) Private Limited.*

DISEASEBIOLOGYANDPUBLICHEALTH

1. Boldaun, Charles Frederick, Nils William Boldaun 1949, Public health and Hygiene (4thedn) Philadelphia Saaunders
2. Dass,K2021.PublichealthandHygiene.Notionpress.
3. Goel,ArvindKumar2005.AcollegeTextbookofHealthandHygiene,ABDpublishers.
4. Park,K.2007.PreventiveandSocialmedicine.B.B.Publishers.
5. Shanmugavel,G,BinuGeorge.2021.Textbookofpublichealthandhygiene.Darshanpublishers.
6. Wagh,SudhirR.,VinodB.kakade,Jiwanp.sarwade.PublichealthandHygiene.SuccessPublication.
7. Kumaresan,V.,R.somaraj.PublicHealthandHygiene.SarasPublication.,NewDelhi

NOTE:
ForSemester-1to Semester-6theQuestionPatterngivenfrompage43topage48 is tobefollowed 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 semesters

Zoology Major Core Papers:

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

Time: 3 hours

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

Zoology Major Skill Enhancement Course (SEC) Papers:

Time 2 hours

Multiple Choice Questions

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

Zoology Minor Core Papers

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

Time: 3 hours

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

Zoology Multi-disciplinary Papers

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

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

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

UNIVERSITY OF CALCUTTA

Notification No. CSR/52/2025

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

1) Amendments in the Course Structure (clause no. 9) for semester-5,6,7 & 8: Detail Course Structure is laid down in the accompanying pamphlets.

2) Students shall study two papers from a single Minor subject (both either from m1 or from m2) in semester-V and shall study two papers from another Minor subject (both either from m1 or from m2) in semester-VI and shall appear in the semester-5 & 6 examinations accordingly.

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

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

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

31/7/2025

SENATE HOUSE
KOLKATA-700073
The 31st July, 2025

Prof. (Dr.) Debasis Das
Registrar

AmendmentsinCoursestructure,asmentionedinAdmissionRegulationsfor4-YearB.A./B.Sc.--Honours&HonourswithResearch (clause no. 9 of CSR/05/2023, dt. 23.07.2023)

RevisedCourseStructurefor4-YearHonours&HonourswithResearch(semester-1to6)-CCF,2022

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

Marks=25markspercredit.

SummerInternshiphastobeundertakeninsemester-2/4/6.

MinorCourseswillcomefromtwosubjectsofsamebroaddisciplineasMajor(m1&m2)

StudentsshallstudytwopapersfromasingleMinorsubject(botheitherfromm1orfromm2)insemester-VandshallstudytwopapersfromanotherMinorsubject(botheither from m1 or from m2) in semester-VI

TheMinorsubjecttobestudiedinsemester-6shallbedifferentfromtheMinorsubjectstudiedinsemester-5.

RevisedCourseStructure(semester-7&8)underCCF,2022

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

SEMESTER-7

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

SEMESTER-8

SEMESTER	1st paper&2nd paper From Major subject (4 Credits each) 2papersx4 credits =8 credits	3rd paper&4th paper From Major subject (4 Credits each) 2papersx4 credits =8 credits	5th paper FromMajorsubject (4Credits) 1paperx4credits =4 credits	Totalcredits
#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

RevisedCourseStructure(semester-7&8)underCCF,2022

4-YEARB.A./B.Sc.HONOURSWITHRESEARCHCOURSESOFSTUDIES

SEMESTER-7

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

SEMESTER-8

SEMESTER	1st paper&2nd paper From Major subject (4 Credits each) 2papersx4 credits = 8credits	3rd paper FromMajorsubject (4Credits) 1paperx4credits = 4credits	4th paper FromMajorsubject (8Credits) 1paperx8credits = 8credits	Totalcredits
#8	2papersofResearchMethodology (RM-1 & RM-2) (3TH+1viva)	ResearchInternship (3 TH+1 viva)	Dissertation/Project (6 TH+2 viva)	20

Note:-

***Insemester-7:**

The5DSCC/Corepaperstobestudiedinthe7thsemesteroftheHonoursProgrammeshallbeidenticalwithcorepaperstobestudiedbythestudents pursuing Honours with Research programme.

#Insemester-8:

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

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 Modalitiesfor the papers, taught at semester-7 & 8

Semester-7:5papers--(20credits):fromtheMajorsubject

Thestudentspursuing**Honours**or**HonourswithResearch**CoursesofStudiesat U.G.Level,shallstudy:-

5corepapers(4creditseach:3Th+1P/TU:5x4credits=20credits)

Semester-8:(20credits)

- **ThestudentspursuingHonoursCoursesofStudiesatU.G.Level,shallstudy5 papers from the Major subject:**

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

OR

2Corepapers:(4creditseach:3Th+1P/TU)---(2x4credits=8credits)inlieu of2ResearchMethodologypapers**.**

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

c) **5th paper:1Project/Review**(4Credits:3Th+1viva**)**:1x4credits:4credits.

OR

1Corepaper:4credits:(3Th+1P/TU)**:**1x4credits:4creditsinlieuofProject/ Review

Note:-

For sl. No. (a) : Respective **U.G.B.O.S. shall decide** whether 2 papers of ResearchMethodologyor2corepapersofMajorsubjectshallbe included.

For sl. No. (c) :Respective **U.G.B.O.S. shall decide** whether 1 paper of Project/Reviewor1coreofMajorsubjectshallbeincluded.

Semester-8:(20credits)

- **ThestudentspursuingHonourswithResearchCoursesofStudiesat U.G. Level, shall study 4 papers from the Major subject:**

- **1st&2ndpaper:2papersofResearchMethodology-(RM-1&RM-2):** (4creditseach)—2x4credits=8credits

- **3rdpaper:1paperonResearchInternship:**1x4credits=4credits

- **4thpaper: 1 paper on Research oriented Dissertation/ Project: 1 x 8 credits= 8 credits.**

Broad guidelines and examination modalities and evaluationprocedure 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 beformulated according to thefollowing genericformat:

i) **FundamentalsofResearch:ResearchProcessandDesign**
ii) **ResearchEthicsandSocialImpact**
iii) **LiteratureReview**
iv) **Methods,TechniquesandTools**
v) **Citation& Bibliography**

Thedetailedformulationofthecontentwithregardtotheaboveitemswillbe done by the respective U.G.B.O.S.

TheformatofquestionsinResearchMethodologyshallbe**eitheressaytype**(non **MCQ)**or**MCQ**andthatshallbedecidedbytheconcernedUGBOS.

ForMCQ/nonMCQquestionpatterns-(100marks): Thereshallbetheory componentof3credits-75marksandviva-voceof1credit-25marks**.**

QuestionpatternforTheorycomponentofMCQtype(75marks):

15questionsx3marks=45marks
15questionsx2marks=30marks

Evaluation: TheTheoryexaminationshallbeheldinawaycentreandviva-voce shall be held in home centre in presence of External examiners (external examiners shall be recommended by the colleges).

- **ResearchInternship:(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 evaluatedby the internal examiners (faculty members of the concerned college) in presence of External examiners (External examiners shall be recommended by the colleges).