SYLLABUS

FOR THE

BACHELOR OF SCIENCE
(4 year)

IN

ZOOLOGY

FOUR YEAR FULL-TIME PROGRAMME

DEPARTMENT OF ZOOLOGY

FACULTY OF SCIENCE

DEEN DAYAL UPADHYAYA, GORAKHPUR UNIVERSITY,

GORAKHPUR-273009
2024

PROGRAME: B. Sc. 4 Year ZOOLOGY

Year	Semester	University Code	Paper Title	Theory/Practical	Course category	Credits	Semester Credit
1	I	ZOO-101F	Cytology, Genetics and Immunology	Theory	Compulsory	4+0	
		ZOO-102F	Cell Biology & Cytogenetics Lab	Practical	Compulsory	0+2	
	II	ZOO-103F	Biochemistry and Physiology	Theory	Compulsory	4+0	12
		ZOO-104F	Physiological, Biochemical & Hematology Lab	Practical	Compulsory	0+2	
2	**III**	ZOO-201F	Molecular Biology, Bioinstrumentation & Biotechniques	Theory	Compulsory	4+0	
		ZOO-202F	Bioinstrumentation & Molecular Biology Lab	Practical	Compulsory	0+2	
	IV	ZOO-203F	Gene Technology and Human Welfare	Theory	Compulsory	4+0	12
		ZOO-204F	Genetic Engineering Lab, Genetic Counselling& Telemedicine	Practical	Compulsory	0+2	
3	**V**	ZOO-301F	Diversity of Non-Chordates, Parasitological and Economic Zoology	Theory	Compulsory	4+0	
		ZOO-302F	Diversity of Chordates and Comparative Anatomy	Theory	Compulsory	4+0	
		ZOO-303F	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitological	Practical	Compulsory	0+2	
	VI	ZOO-304F	Evolutionary Biology and Developmental Biology	Theory	Compulsory	4+0	20
		ZOO-305F	Ecology, Ethology, Environmental Science and Wildlife	Theory	Compulsory	4+0	
		ZOO-306F	Lab on Environmental Science, Behavioural Ecology, Developmental Biology, Wildlife, Ethology	Practical	Compulsory	0+2	
4	**VII**	ZOO-401F	Biology of invertebrates	Theory	Compulsory	4+0	
		ZOO-402F	Advances in modern scientific tools and techniques	Theory	Compulsory	4+0	
		ZOO-403F	Comparative Animal Physiology	Theory	Compulsory	4+0	20
		ZOO-404F	Biological Chemistry	Theory	Compulsory	4+0	
		ZOO-405 F	Practical based on ZOO-401F, ZOO-	Practical	Compulsory	0+4	

			402F, ZOO-403F & ZOO-404F				
	VIII	ZOO-406F	Biology of Chordates	Theory	Compulsory	4+0	20
		ZOO-407F	Systematics, Biodiversity and its conservation	Theory	Compulsory	4+0	
		ZOO-408F	Molecular genetics	Theory	Compulsory	4+0	
		ZOO-409F	Animal Development	Theory	Compulsory	4+0	
		ZOO-410F	Practical based on ZOO-406F**,**ZOO-407F, ZOO-408F & ZOO-409F	Practical	Compulsory	0+4	

CourseCode:ZOO-101F	**Semester: I**
CourseTitle:Cytology	
Credits:4+0	
Unit	**Topic**
I	**StructureandFunctionofCellOrganellesI** • Plasmamembrane:chemicalstructure—lipidsandproteins • Endomembrane system: protein targeting and sorting, endocytosis, exocytosis Introduction to all national Biologists (Zoologists) who have contributed/contributing to Zoological and Life Sciences as a mark of tributetoancientandmodernbiologywillbeincludedaspartofthe ContinuousInternalEvaluation(CIE)
II	**StructureandFunctionofCellOrganellesII** • Cytoskeleton:microtubules,microfilaments,intermediatefilaments • Mitochondria:Structure,oxidativephosphorylation • Peroxisomeandribosome:structureandfunction
III	**NucleusandChromatinStructure** • Structureandfunctionofnucleusin eukaryotes • ChemicalstructureandbasecompositionofDNAand RNA • DNAsupercoiling,chromatinorganization,structureofchromosomes • TypesofDNAandRNA
IV	**Cellcycle,CellDivisionandCell Signaling** • Celldivision:mitosisandmeiosis • Cellcycleanditsregulation,apoptosis,Signaltransduction:intracellular signalingandcellsurfacereceptorsviaG-proteinlinkedreceptors,JAK-STAT pathway
V	**MendelismandSex Determination** • Basicprinciplesofheredity:Mendel's laws,monohybridanddihybrid crosses • CompleteandIncompleteDominance, • Penetranceandexpressivity, • GenicSex-DeterminingSystems,EnvironmentalSexDetermination,SexDetermination in *Drosophila,* Sex Determination in Humans, • Sex-linkedcharacteristicsandDosagecompensation
VI	**ExtensionsofMendelism,GenesandEnvironment** • ExtensionsofMendelism:MultipleAlleles,Gene Interaction, • CytoplasmicInheritance,GeneticMaternal Effects, • GenomicImprinting,Anticipation, • Interaction Between Genes and Environment: Environmental Effects on Gene Expression, Inheritance of Continuous Characteristics
VII	**HumanChromosomesandPatternsof Inheritance** • Humankaryotype,Chromosomalanomalies:Structuralandnumerical aberrations with examples, • Pedigreeanalysis

VIII	**ImmuneSystemandits Components** • Historical perspective of Immunology, Innate and Adaptive Immunity, Structure and functions of different classes of immunoglobulins, Hypersensitivity, • Immune system: innate and adaptive immunity, clonal selection, complement system, • Humoralimmunityandcellmediatedimmunity, • Immunoglobulin and T-cell receptor genes: organization of Ig gene loci, molecular mechanism of generation of antibody diversity • HLAcomplex:organization,classIandIIHLAmolecules,expressionofHLA genes

CourseCode:**ZOO-102F**	**Semester: I**
CourseTitle:CellBiology&CytogeneticsLab	
Credits:0+2	

Unit	**Topic**
I	1. Tostudydifferentcelltypessuchasbuccalepithelialcells,neurons,striated muscle cells using Methylene blue. 2. TostudythedifferentstagesofMitosisinroottipof onion. 3. TostudythedifferentstagesofMeiosisingrasshoppertestis. 4. To prepare molecular models of nucleotides, amino acids, dipeptides using bead and stick method. 5. Tocheckthepermeabilityofcellsusingsaltsolutionofdifferent concentrations.
II	1. TostudydifferentmammalianbloodcelltypesusingLeishmanstain. 2. DeterminationofABOBloodgroup 3. Cellcountingandviabilitytestfromsplenocytesoffarmbredanimals/celllines. 4. Enumerationofredbloodcellsandwhitebloodcellsusinghaemocytometer
III	1. Studyofmutantphenotypesof*Drosophila.* 2. Preparationofpolytenechromosomes. 3. Studyofsexchromatin(Barrbodies)inbuccal smearandhairbudcells (Human). 4. Preparationofhumankaryotypeandstudythechromosomalaberrationswith respect to number, translocation, deletion etc. from the pictures provided. 5. Topreparefamilypedigrees.
IV	**VirtualLabs** 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in 5. www.powershow.com, 6. https://vlab.amrita.edu 7. https://sites.dartmouth.edu

Course Code:**ZOO-103F**	**Semester: II**
CourseTitle: Biochemistry and Physiology	
Credits:4+0	
Unit	**Topic**
I	**StructureandFunctionofBiomolecules** • StructureandBiologicalimportanceofcarbohydrates(Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates) • Lipids(saturated andunsaturated fatty acids,Tri-acylglycerols,Phospholipids, Glycolipids, Steroids) • Structure, Classification and General properties of α-amino acids; Essential and non-essential α-amino acids, • Levels of organization in proteins;Simple and conjugate proteins
II	**EnzymeActionand Regulation** • Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action; • Isozymes;Mechanismofenzyme action; • Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Enzyme inhibition; • Allostericenzymesandtheirkinetics;Regulationofenzyme action
III	**MetabolismofCarbohydratesandLipids** • Metabolism of Carbohydrates:glycolysis,citricacidcycle, gluconeogenesis, phosphate pentose pathway Glycogenolysis and Glycogenesis Lipids---Biosynthesisofpalmiticacid;Ketogenesis,β-oxidationandomega-oxidation of saturated fatty acids with even and odd number of carbon atoms
IV	**MetabolismofProteinsandNucleotides** • Catabolismofaminoacids:Transamination,Deamination,Ureacycle • Nucleotidesandvitamins • Reviewof mitochondrialrespiratorychain,Oxidativephosphorylation,and its regulation
V	**DigestionandRespiration** • Structuralorganizationandfunctionsofgastrointestinaltractandassociated glands • Mechanicalandchemicaldigestionoffood;Absorptionsofcarbohydrates, lipids,proteins,water,mineralsandvitamins; • Histologyoftracheaandlung, • Mechanism of respiration, Pulmonary ventilation;Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood,Respiratory pigments,Dissociationcurvesandthefactorsinfluencingit;Controlof respiration
VI	**Circulationand Excretion** • Componentsofbloodandtheirfunctions • Haemostasis:Bloodclottingsystem, • Bloodgroups: Rhfactor,ABOandMN • Structure of mammalian heart, Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation Structureofkidneyanditsfunctionalunit;Mechanismofurineformation
VII	**NervousSystemandEndocrinology** • Structureofneuron,restingmembrane potential • Originofactionpotentialanditspropagationacrossthemyelinatedand unmyelinated nerve fibers • Typesof synapse • Endocrineglands-pineal,pituitary,thyroid,parathyroid,pancreas,adrenal; hormones secreted by them

	• Classificationofhormones;MechanismofHormoneaction
VIII	**Muscular System** • Histologyofdifferenttypesof muscle, • Ultrastructureofskeletalmuscle; • Molecularandchemicalbasisofmusclecontraction; • Characteristicsofmuscletwitch;Motorunit,summationandtetanus

CourseCode:**ZOO-104F**	**Semester: II**
CourseTitle:Physiological,Biochemical&HematologyLab	
Credits:2+0	
Unit	**Topic**
I	1. EstimationofhaemoglobinusingSahli's haemoglobinometer 2. Preparationofhaeminandhaemochromogencrystals 3. Recordingofbloodpressureusingasphygmomanometer 4. Recordingofbloodglucoselevel byusing glucometer 5. Preparationofmolecularmodelsofaminoacids,dipeptidesetc.
II	1. StudyofpermanentslidesofMammalianskin,Cartilage,Bone, 2. Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid 3. Recordingofsimplemuscletwitchwithelectricalstimulation(or Virtual) 4. Demonstrationoftheunconditionedreflexaction(Deeptendonreflexsuchas knee jerk reflex)
III	1. Ninhydrintestfor-aminoacids. 2. Benedict'stestforreducingsugarandiodinetestfor starch. 3. Testforsugarandacetonein urine. 4. Qualitativetestsoffunctionalgroupsincarbohydrates,proteinsandlipids. 5. Paperchromatographyofaminoacids. 6. Actionofsalivaryamylaseunderoptimum conditions
IV	**VirtualLabs** 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in 5. www.powershow.com 6. https://vlab.amrita.edu 7. https://sites.dartmouth.edu

CourseCode:ZOO-201F	**Semester: III**
CourseTitle:MolecularBiologyandBioinstrumentation&Biotechniques	
Credits:4+0	
Unit	**Topic**
I	**Processof Transcription** • Finestructureof gene • RNApolymerases • Transcriptionfactorsandmachinery • Formationofinitiationcomplex • Initiation,elongationandterminationoftranscriptioninprokaryotesandeukaryotes
II	**Processof Translation** • TheGeneticcode • Ribosome • Factorsinvolvedintranslation • AminoacylationoftRNA,tRNA-identity,aminoacylTrnasynthetase • Initiation,elongationandterminationoftranslationinprokaryotesandeukaryotes
III	**RegulationofGeneExpressionI** • Regulationofgeneexpressioninprokaryotes:*lac*and*trp*operonsin*E.coli* • Regulationofgeneexpressionineukaryotes:Roleofchromatiningene expression • Regulationattranscriptionallevel,Post-transcriptionalmodifications:Capping, Splicing, Polyadenylation, RNA editing.
IV	**RegulationofGeneExpressionII** • Regulationofgeneexpressionineukaryotes: • Regulationattranslationallevel,Post-translationalmodifications:proteinfolding etc. • Intracellularproteindegradation • Genesilencing,RNAinterference(RNAi)
V	**PrincipleandTypesofMicroscopes** • PrincipleofMicroscopyandApplications • TypesofMicroscopes:lightmicroscopy,darkfieldmicroscopy,phase-contrast microscopy, • Fluorescencemicroscopy,confocalmicroscopy,electronmicroscopy
VI	**CentrifugationandChromatography** • Principleof Centrifugation: • TypesofCentrifuges: highspeedand ultracentrifuge • Typesofrotors:Vertical,Swing-out,Fixed-angle etc. • PrincipleandTypesofChromatography:paper,thinlayer,column---ion-exchange, gel filtration, HPLC, affinity
VII	**SpectrophotometryandBiochemicalTechniques** • Colorimetryandspectrophotometry:Beer-lambertlaw,absorptionspectrum • Biochemicaltechniques:MeasurementofpH, • Preparationofbuffersandsolutions • Measurement,applicationsandsafetymeasuresofradio-tracertechniques
VIII	**MolecularTechniques** • Nucleic acid fractionation, detection by electrophoresis, DNA sequencing, Polymerase Chain Reaction (PCR), primer designing, DNA fingerprinting, site directed mutagenesis, RFLP • Molecular cloning, genomic libraries, Gene transfer techniques: electroporation, microinjection • Detectionofproteins,PAGE,ELISA,Western blotting, • Hybridomatechnology

CourseCode:ZOO -202F	Semester: III
CourseTitle:Bioinstrumentation&MolecularBiologyLab	
Credits:0+2	

Unit	Topic
I	1. To study the working principle and Simple, Compound and Binocular microscopes. 2. To study the working principle of various lab equipments such as pH Meter, Electronic balance, vortex mixer, use of glass and micropipettes, Laminar flow, Incubator shaker, Waterbath, Centrifuge, Chromatography apparatus, etc.
II	1. Topreparesolutionsand buffers. 2. TolearntheworkingofColorimeterand Spectrophotometer. 3. Demonstration of differential centrifugation to fractionate different components in a mixture
III	1. Topreparedilutionsof Riboflavinandverifytheprincipleof spectrophotometer. 2. Toidentifydifferentaminoacidsinamixtureusingpaperchromatography. 3. DemonstrationofDNAextractionfrombloodortissuesamples. 4. To estimate amount ofDNAusingspectrophotometer.
IV	**VirtualLabs** 1. www.labinapp.com 2. www.uwlax.edu 3. www.labster.com 4. www.onlinelabs.in 5. www.powershow.in 6. https://vlab.amrita.edu 7. info@premiereducationaltechnologyies.com 8. https://li.wsu.edu

CourseCode:ZOO-203F	Semester: IV
CourseTitle:GeneTechnologyandHuman Welfare	
Credits:4+0	

Unit	Topic
I	**PrinciplesofGeneManipulation** • RecombinantDNATechnology • RestrictionEnzymes,DNAmodifyingenzymes,CloningVectors,Ligation • Genetransfertechniques,Genetherapy • Selectionandidentificationofrecombinantcells
II	**ApplicationsofGeneticEngineering** • Singlecell proteins, • Biosensors,Biochips, • Cropandlivestock,Improvement,Developmentoftransgenic organisms, • DevelopmentofDNAdrugsand, vaccines.
III	**Enzyme Technology** • Microbialculture, • Methodsofenzyme production, • Immobilizationofenzymes, • Applications
IV	**DNADiagnostics** • Geneticanalysisofhumandiseases,detectionofknownandunknownmutations • DNAfingerprinting • Conceptofpharmacogenomicsandpharmacogenetics • Personalizedmedicine—optimizingdrugtherapy
V	**BiostatisticsI** • Calculationsofmean,median,mode,variance,standard • Deviation, • Conceptsofcoefficientofvariation,Skewness,Kurtosis • Elementaryideaofprobabilityandapplication
VI	**BiostatisticsII** • Datasummarizing:frequencydistribution,graphical,presentation—bar,pie diagram, histogram, • Testsofsignificance:oneandtwosampletests,t-testandChi-squaretest
VII	**BasicsofComputers** • Basics(CPU,I/Ounits)andoperatingsystems, • ConceptofhomepagesandwebsitesWorldWideWeb,URLs,usingsearch engines
VIII	**Bioinformatics** • Databases:nucleicacids,genomes,proteinsequences,andstructures, Bibliography, • Sequenceanalysis(homology):pairwiseandmultiple,sequence alignments-BLAST,CLUSTALW, • Phylogeneticanalysis

CourseCode:ZOO-204F	**Semester: IV**
CourseTitle: GeneticEngineeringLab,GeneticCounseling& Telemedicine	
Credits:0+2	

Unit	**Topic**
I	1. Measurethepreandpostclitellarlengthsofearthwormsandcalculatemean, median, mode, standard deviation etc. 2. Measuretheheightandweightofallstudentsintheclassandapplystatistical measures.
II	1. Toperformbacterialcultureandcalculategenerationtimeof bacteria. 2. TostudyRestrictionenzymedigestionusingteaching kits. 3. TostudyPolymeraseChainReaction(PCR)usingteaching kits. 4. DemonstrationofagarosegelelectrophoresisfordetectionofDNA. 5. DemonstrationofPolyacrylamideGelElectrophoresis(PAGE)fordetectionof proteins. 6. Tocalculatemolecularweightofunknown DNAandproteinfragmentsfromgel pictures.
III	1. Tolearnthebasicsofcomputerapplications 2. TolearnsequenceanalysisusingBLAST 3. TolearnMultiplesequencealignmentusingCLUSTALW 4. TolearnaboutPhylogeneticanalysisusingtheprogrammePHYLIP. 5. TolearnhowtoperformPrimerdesigningforPCRusingavailablesoftwares etc.
IV	1. GelDocumentationSystemhttps://youtu.be/WPpt3-FanNE 2. Colorimeter-https://youtu.be/v4aK6G0bGuU 3. PCRPart1-https://youtu.be/CpGX1UFSl4A 4. PCRPart2-https://youtu.be/6IcHAYPTAEw 5. DNAisolationPart1-https://youtu.be/QE7Ul0JnY9A 6. DNAisolationpart2-https://youtu.be/-efr_HFeHxM 7. DNAcurve-https://youtu.be/ubL8QxTeuG4 8. Spectrophotometer-https://youtu.be/ubL8QxTeuG4 9. AgarosePart1-https://youtu.be/7gvHPFww--g 10. Agarosepart2-https://youtu.be/j_bOZCHNsSg

CourseCode:ZOO-301F	**Semester: V**
CourseTitle:DiversityofNon-Chordates,ParasitologyandEconomicZoology	
Credits:4+0	
Unit	**Topic**
I	**ProtozoatoCoelenterate** • Protozoa-*Euglena*,*Monocystis*and*Paramecium* • Porifera–*Sycon* • Coelenterata-*Obelia*and*Aurelia*
II	**Ctenophorato Nemathelminthes** • Ctenophora-Salientfeatures • Platyhelminthes - *Fasciola* (Liver fluke) and *Taenia* (Tape worm) Nemathelminthes - *Ancylostoma*(Hook worm)
III	**AnnelidatoArthropoda** • Annelida-*Nereis*and*Hirudinaria*(Leech) • Arthropoda-*Palaemon*(Prawn)and*Schistocerca*(Locust)
IV	**MolluscatoHemichordata** • Mollusca-*Lamellidens*(Freshwatermussel)and*Pila* • Echinodermata-*Pentaceros*(excludingdevelopment)
V	**Parasitology** • Structure, life cycle, pathogenicity, including diseases, causes symptoms and control of thefollowingparasitesofdomesticanimalsandhumans:*Trypanosoma*,*Giardiaand Wuchereria*
VI	**Vectorsandpests** • Lifecycleandtheircontroloffollowingpests:Gundhibug,Sugarcaneleafhopper, Rodents. Termites and Mosquitoes and their control.
VII	**EconomicZoology-1** • Animalbreedingandculture:Aquaculture,Pisciculture,Poultry
VIII	**EconomicZoology-2** • Sericulture,Apiculture,Lac-culture,Vermiculture

CourseCode:ZOO-302F	**Semester: V**
CourseTitle:DiversityofChordatesandComparativeAnatomy	
Credits:4+0	
Unit	**Topic**
I	**OriginofChordates&Hemichordata** • Origin of Chordates. • ClassificationofPhylumChordatauptotheOrder. • Hemichordata: General characteristics, classification and detailed study of *Balanoglossus* (Habit and Habitat, Morphology, Anatomy, Physiology and Development).
II	**CephalochordataandUrochordata** • Cephalochordata:Generalcharacteristics,classificationanddetailedstudyof *Branchiostoma*(*Amphioxus*) (Habit and Habitat, Morphology, Anatomy, Physiology). • Urochordata:Generalcharacteristics,classificationanddetailedstudyof *Herdmania*(HabitandHabitat,MorphologyAnatomy,PhysiologyandPost Embryonic Development).
III	**ClassificationandGeneralCharacteristicsofVertebrates** • GeneralcharactersandClassificationofdifferentclassesofPiscesandAmphibia up to the order with examples. • NeotenyandPaedogenesis
IV	**ClassificationandGeneralCharacteristicsofVertebrates** • GeneralcharactersandClassificationofdifferentclassesofReptilia,Avesand Mammalia up to the order with examples. • PoisonousandNonPoisonousSnakes,Bitingmechanismof snakes. • FlightAdaptationsinBirds • AdaptiveRadiationsin Eutheria
V	**IntegumentarySystem** • Structure,functionsandderivativesofintegument **SkeletalSystem** • Overviewofaxialandappendicularskeleton, JawsuspensoriumVisceral arches
VI	**DigestiveSystem** • Alimentarycanalandassociated glands **RespiratorySystem** • Skin,gills,lungsandairsacs;Accessoryrespiratoryorgans
VII	**CirculatorySystem** • Generalplanofcirculation,evolutionofheartandaortic arches **UrinogenitalSystem** • Successionofkidney,Evolutionofurinogenitalducts,Typesofmammalianuteri
VIII	**Nervous System** • ComparativeaccountofbrainAutonomicnervoussystem,Spinalcord,Cranial nerves in mammals **SenseOrgans** • ClassificationofreceptorsBriefaccountofvisualandauditoryreceptorsinman

CourseCode::ZOO-303F	**Semester: V**
CourseTitle: LabonVirtualDissection,Anatomy,EconomicZoologyandParasitology	
Credits:0+2	
Unit	**Topic**
I	1. Studyofanimalspecimensofvariousanimalphyla. 2. Topreparepermanentstainedslideofseptalnephridiaof earthworm. 3. Totakeoutthenerveringofearthworm Totakeouthastateplatefrom*Palaemon*
II	1. Studyofanimalspecimensofvariousanimal phyla 2. Studyonuseandethicalhandlingofmodelorganisms(Mice,rats,rabbit andpig). 3. Topreparestained/unstainedslideofplacoid scales 4. Comparativestudyofbonesofdifferentvertebrates 5. Comparativestudyofhistologicalslidesofdifferenttissuesofvertebrates.
III	1. PermanentPreparationof:*Euglena*,*Paramecium* 2. Study of prepared slides/ specimens of *Entamoeba Giardia, Leishmania, Trypanosoma,PlasmodiumFasciola,Cotugnia,Taenia,Rallietina,Polystoma Schistosoma, Echinococcus, Enterobius, Ascaris and Ancylostoma*; 3. Permanent Preparation of *Cimex* (bed bug)/ *Pediculus*(Louse), *Haematopinus*(cattlelouse),freshwaterannelids,arthropods;andsoilarthropods,Larvalstages of helminths and arthropods 4. Permanentmountofwings,mouthpartsanddevelopmentalstagesofmosquito and house fly 5. Permanentpreparationofticks/mites,abdominalgillsofaquatidinsectsviz. Chironomus larva, dragonfly and mayfly nymphs, preparation of antenna of housefly Identification of pests. 6. Lifehistoryofsilkworm,honeybeeandlacinsect 7. DifferenttypesofimportantediblefishesofIndia 8. Slidesofplantnematodes 9. Studyofanaquaticecosystem,itsbioticcomponentsandfoodchain 10. ProjectReport/modelchartmaking 11. **Dissections**:throughmultimedia/ models *12.* **Cockroach**:Centralnervous system *13.* ***Wallago***:AfferentandefferentbranchialvesselsCranialnerves,Weberian ossicles
IV	**VirtualLabs** 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. https://www.vlab.co.in 5. https://zoologysan.blogspot.com 6. www.vlab.iitb.ac.in/vlabwww.onlinelabs.in 7. www.powershow.comhttps://vlab.amrita.edu 8. https://sites.dartmouth.edu

CourseCode:ZOO-304F	**Semester: VI**
CourseTitle:EvolutionaryandDevelopmentalBiology	
Credits:4+0	
Unit	**Topic**
I	**Theoriesof Evolution** • Originof Life • Historicalreviewofevolutionaryconcept:Lamarckism,Darwinism(Natural, Sexual and Artifical selection) • Modernsynthetictheoryofevolution • Patternsofevolution(Divergence,ConvergenceParallel, Coevolution)
II	**PopulationGenetics** • MicroevolutionandMacroevolution:allelefrequencies,genotypefrequencies, • HardyWeinbergequilibriumandconditionsforitsmaintenance • Forcesofevolution:mutation,selection,geneticdrift
III	**DirectEvidencesof Evolution** • Typesoffossils,Incompletenessoffossilrecord, • Datingoffossils,Phylogenyofhorse
IV	**SpeciesConceptand Extinction** • Biologicalspeciesconcept(AdvantagesandLimitations); • Modesofspeciation(Allopatric,Sympatric) • Massextinction(Causes,Namesoffivemajorextinctions)
V	**GameteFertilizationandEarlyDevelopment** • Gametogenesis,Fertilization • Cleavagepattern • Gastrulation,fatemaps • Developmentalmechanicsofcellspecification • Morphogenesisandcelladhesion
VI	**DevelopmentalGenes** • Genesanddevelopment • Molecularbasisofdevelopment • Differentialgeneexpression
VII	**EarlyVertebrate Development** • Earlydevelopmentofvertebrates(fish,birds&mammals) • Metamorphosis,regenerationandstem cells • Environmentalregulationofdevelopment
VIII	**LateDevelopmentalProcesses** • Thedynamicsoforgandevelopment • Developmentofeye,kidney,limb • Metamorphosis:thehormonalreactivationofdevelopmentinamphibians,insects • Regeneration:salamanderlimbs,mammalianliver,Hydras • Aging:thebiologyof senescence

CourseCode:ZOO-305F	**Semester: VI**
CourseTitle:Ecology,Ethology,EnvironmentalBiologyandWildlife	
Credits:4+0	
Unit	**Topic**
I	**IntroductiontoEcology** • Historyofecology,AutecologyandsynecologyLevelsoforganization,Lawsoflimiting factors Study of physical factors
II	**Organizationof Ecosystem** • Levelsoforganization,LawsoflimitingfactorsStudyofphysicalfactors, • Population:Density,natality,mortality,lifetables,fecunditytables,survivorship curves, age ratio, sex ratio, dispersal and dispersion, Exponential and logistic growth, • Typesofecosystemswithoneexampleindetail,Foodchain:Detritusandgrazing food chains, , Food web, Energy flow through the ecosystem • EcologicalpyramidsandEcologicalefficiencies,Nutrientandbiogeochemical cycle with one example of Carbon cycle
III	**CommunityEcology** • Communitycharacteristics:speciesrichness,dominancediversity,abundance, Ecologicalsuccessionwithone example
IV	**EnvironmentalHazards** • SourcesofEnvironmentalhazards • Climate changes • Greenhousegasesandglobal warming • Acidrain,Ozonelayerdestruction
V	**EffectsofClimateChange** • Effectofclimatechangeonpublichealth • Sourcesofwaste,typesandcharacteristics Sewagedisposalandits management,Solidwastedisposal,Biomedicalwastehandlinganddisposal, • Nuclearwastehandlinganddisposal,Wastefromthermalpowerplants, • CasehistoriesonBhopalgastragedy,Chernobyldisaster,Sevesodisasterand Three Mile Island accident and their aftermath.
VI	**BehaviouralEcologyandChronobiology** • Originandhistoryof Ethology • Instinctvs.LearntBehaviour • Associativelearning,classicalandoperantconditioning,Habituation,Imprinting • Circadianrhythms;TidalrhythmsandLunarrhythms • Chronomedicine
VII	**IntroductiontoWildLife** • Valuesofwildlife-positive and negative; • Conservationethics; • Importanceofconservation; • Causesof depletion; • Worldconservationstrategies.
VIII	**Protectedareas** • Nationalparks&sanctuaries, • Communityreserve; • Importantfeaturesofprotectedareasin India; • Tigerconservation-TigerreservesinIndia; • ManagementchallengesinTigerreserve

CourseCode:ZOO-306F	Semester: VI
CourseTitle:LabonEcology,EnvironmentalScience,BehavioralEcology&wildlife	
Credits:0+2	

Unit	Topic
I	1. Studyoflifetablesandplottingofsurvivorshipcurvesofdifferenttypesfromthe hypothetical/real data provided. 2. Studyofpopulationdynamicsthroughnumericalproblems. 3. Studyofcircadianfunctionsinhumans(dailyeating,sleepandtemperature patterns).
II	1. ReportonavisittoNationalPark/BiodiversityPark/Wildlifesanctuary
III	1. Demonstrationof basicequipmentneededinwildlifestudiesuse,care and maintenance(Compass,Binoculars,Spottingscope,RangeFinders,Global Positioning System, Various types of Cameras and lenses) 2. Familiarization and study of animal evidences in the field; Identification of animalsthroughpugmarks,hoofmarks,scats,pelletgroups,nestantlersetc. 3. Demonstrationofdifferentfieldtechniquesforfloraand fauna
IV	**VirtualLabs** 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab

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CourseCode:ZOO-401F	Semester: VII
CourseTitle:Biology of Invertebrates	
Credits: 4+0	

Unit	Topics
I	• Nutrition and reproduction in protozoa; • Origin of Metazoa; • Organization and Affinities of Porifera; • Polymorphism and Colony formation in Cnidaria; • Coral reefs.
II	• Life cycle patterns in Helminth parasites; • Ecology of soil Nematodes; • Segmental organs in Annelida; • Adaptive Radiation in Annelida.
III	• Organization and Affinities of Onychophora; • Larval forms in Crustacea; • Parasitism in molluscs, • Torsion its effect and significance in Gastropods.
IV	• Larval forms in Echinodermata; • Affinities of Echinodermata and Hemichordata; • Brief outlines of the structure and affinities of minor phyla with special reference to Ctenophore, Rotifera, Acanthocephala, Sipunculoidea and Echiuroidea

CourseCode:**ZOO-402F**	**Semester: VII**
CourseTitle:Advances in Modern Tools and Techniques	
Credits: 4+0	
Unit	**Topics**
I	Principles and uses of analytical Instruments: • Balances, • Flame Photometer, • Spectrophotometer, • Spectrofluro-photometer, • Atomic Absorption Spectrophotometer
II	Microbial technique: • Media preparation and Sterilization, • Inoculation and Growth Monitoring, • Use of microbes in Fermentation, • Microbial Assays.
III	Separation and Identification of Bio-molecules by Chromatography: • Paper and thin layer Chromatography, • Gel exclusion Chromatography, • High performance Liquid Chromatography (HPLC), • Affinity Chromatography.
IV	Electrophoresis techniques: • General principles, • Support media; • Electrophoresis of proteins and nucleic acid; • Capillary Electrophoresis, • Principles of Differential and Density centrifugation.

CourseCode:**ZOO-403F**	**Semester: VII**
CourseTitle:Comparative Animal Physiology	
Credits:4+0	
Unit	**Topics**
I	• Modes of nutrition, • Types of digestion and absorption of food; • Neurons, Neuroglial cells, irritability, axonal and synaptic transmission • Mechanism of conduction and transmission of nerve impulses; • Sodium-Potassium ATPase pump, ion channels; • Nernst equation, ionic basis of resting and spike potential, electrical potential • Types of synapse and neurotransmitters.
II	• Osmotic conformity and role of membranes in ionic regulation • Stenohaline, Euryhaline animals • Hypo and Hyper environment and terrestrial life • General characteristics of stimulus and response reaction • Chemoreceptors, • photoreceptors, • phonoreceptors, • mechanoreceptors, • equilibrium reception; • Respiration: Oxygen and Carbon dioxide transport, • factors affecting oxygen dissociation • Respiratory adaptation to low oxygen tension, • regulatory process in respiration.
III	• Thermoregulation in animals: • Temperature relationship in poikilotherms, homeotherms, endotherms and heterotherms, • Thermal acclimatization; • Circulation: Types of circulation, • Physiological categories of heart, conduction system, • Cardiac cycle, • Electrocardiogram; • Body fluids, blood coagulation; • Hematological abnormalities, • Effectors organs; • Types of muscles, its composition, mechanism of muscle contraction.
IV	• Pattern of nitrogen excretion in different animals • Types of excretory products, • Pattern of excretion, • Excretory devices in invertebrates and vertebrates; • Biosynthesis of urea and uric acids; • Comparative study of endocrines organs and their hormonal secretion in non-chordates and chordates

Semester: VII	**Semester: VII**
CourseTitle:Biological Chemistry	
Credits: 2+0	
Unit	**Topics**
I	• Chemical equilibrium, • Law of Mass action; • Elementary thermodynamic system; • Calculation of free energy change during biological Redox Reactions, • Acid base Reactions • Amphoteric, Zwitter ions.
II	• **Kinetics of enzyme of reaction**: 1. Kinetic of Enzyme– Catalyzed reactions, 2. Order of enzyme reaction, 3. Rate equations, 4. Two substrate reactions; 5. Temperature Coefficient, 6. Activation Energy; • Enzyme Inhibition, • Competitive and Noncompetitive inhibitors; • Applications of Enzyme Inhibition Techniques in pest control, • Allosteric Enzyme
III	• **Structure and function of**: 1. Vitamins 2. Coenzymes; • **Aerobic and anaerobic energy production from**: 1. Carbohydrates, (Glycolysis, HMP Shunt) 2. Energy production from lipids (Beta oxidation of fatty acids) 3. Catabolic breakdown of amino acids, (Deamination, and transamination of amino acids (Phenyl alanine, Tryptophan, Aspartate, Proline and Threonine)
IV	• **Biosynthesis of**: 1. Amino Acids (Phenylalanine, Tryptophan, Aspartate, Proline and Threonine), 2. Nucleotides, 3. Glycogen 4. Urea • Immobilized enzymes and their applications.

CourseCode:**ZOO-405F**	**Semester: VII**
CourseTitle:Practicals Based on ZOO-401F, ZOO-402F, ZOO-403F & ZOO-404F	
Credits:0+4	
Unit	**Topics**
I	• General characters and classification of the non- chordates phyla (Protozoa to Echinodermata) with the help of museum specimens and slides. • **Protozoa:** Vital staining and staining preparation of *Paramecium;* Study of cyclosis and trichocysts in *Paramecium;* Permanent preparation of *Ceratium, Noctiluca,Paramecium, Vorticella,* Study of prepared slides: *Balantidium, Nyctotherus, Opalina. Paramecium* conjugation/binary fission, *Entamoeba histolytica, Giardia, Trypanosoma, Leishmania, Trichomona.* • **Porifera:** Permanent preparation of gemmules, sponging fibres and different kinds of spicules, Study of museum specimen's specimens/models; *Lecuosolania, Sycon,Grantia, Euplectella, Hyalonema, Oscarella, Chondrilla, Chliona, Chalina, Spongilla, Spongia, Hippospongia.* • **Cnidaria and Ctenophora:** Study of nematocycsts of *Hydra,* Permanent preparation of*Hydra; Obelia and* other hydrozoan colonies and *Obelia* Medusa; Study of museum specimens/ models:*Tubularia, Bougainvillia, Pennaria, Hydractinia, Sertularia, Campanularia, Millepora, Stylaster, Physalia, Porpita, Valella, Aurelia, Rhizostoma, Tubipora, Alcyonium, Gorgonia, Corallium, Pennatula, Zoanthus, Metridium, Adamsia, Cerianthus, Fungia, Madrepora, Cestum.* • **Helminths:** Permanent preparation of selected soil and plant nematodes , cestode and trematode parasites of cattle and poultry , and different larval stages of liver fluke, Study of museum specimens/ whole mounts: *Convoluta, Dugesia, Bipalium, Fasciola , Paramphistomum, Schistosoma, Taenia, Moniezia , Echinococcus, Trichuris, Trichinella, Heterodera, Enterobius, Ascaris, Ancylostoma, Dracunculus, Wuchereria; study of prepared slides: Scolex of tape worm ,mature and gravid proglottid of tape worm; Study of cysticercus larva, hydatid cyst, larval stage of Fasciola .* • **Annelida:** Study of museum specimens*/models: Aphrodite, Tomopteris, Glycera, Chaetopterus, Arenicola, Sabella, Amphitrite, Serpula, Tubifex, Branchiobdella, Eisenia, Metaphire, Placobdella, Pontobdella, Branchellion, Polygordius,* Study of prepared slides*:* T.S. of body of leech passing through various places. • **Arthropoda:** Study of museum specimen: *Limulus, Palamnaeus, Lycosa, Apus, Argulus,Balanus, Sacculina, Mysis, Gmmarus, Squilla*, Prawn, Lobster, true crab, hermit crab, *Julus, Scolopendra, Scutigerella, Lepisma, Mantis,* stick insect, grass hopper, *termites ,Forficula, Pediculus, Ranatra, Dysdercus, Musca* ,Lady bird beetle, butterfly, wasp, *Xenopsylla,* life history of honey bee, lac insect and silk moth; Study of prepared slides: Mouth parts of mosquitoes, house fly, honey bee, butterfly , *Sarcoptes, Ixodes, Cimex, Daphnia, Cypris, Cyclops, Pediculus, Pthirus.* • **Mollusca:** Study of museum specimen/models:*Chiton, Dentaliun, Pila, Aplysia, Baccinum, Doris, Lymnaea, Mytilus, Patella, Pecten, Limax,* pearl oyster, *Teredo, Nautilus, Loligo, Sepia, Octopus.* Study of prepared slide: Radula, T.S of shell of *Unio,* T.S of gill lamina *of Unio,* T.S of body of *Unio* passing through middle region; Larvae of molluscs.

	• **Echinodermata:** Study of museums specimen/ models: *Astropecten, Asterias, Ophio*thrix, *Opiura, Echinus, Clypeaster, Echinocardium, Thyone, Holothuria, Antedon*; Study of prepared slides: Larvae of echinoderms: Aristotle's lantern. • **Hemichordate:** Study of museum specimens: *Balanoglossus, Cephalodiscus: Tornaria*larva, • **Minor phyla:** Representative specimens of Onychophora (*Peripatus*), Sipunculida*(Sipunculus*), Echiurida (*Bonelia)*
II	• Basic principles and Application of: 1. Microtome, 2. Spectro-photometer, 3. Flame photometer, 4. Atomic absorption, 5. Spectrofluorometer-photometer, 6. Paper and thin layer chromatography, 7. Centrifuge.
III	• Comparative study of total count of erythrocyte and leukocytes of fish bird, and rat. • Comparative study of different leukocyte count (DLC) of fish, bird and rat, • Colorimetric estimation of hemoglobin content of the blood, Color index and mean corpuscular hemoglobin in fish, bird and rat, • Determination of hematocrit in fish, bird and rat, • Determination of respiratory rate of rat in relations to size and sex; • Determination of respiration rate in fish at different temperatures.
IV	• Isolation and colorimetric determination of glycogen content of rat liver; • Demonstration of effect of epinephrine on the glycogen yield from the liver; • Estimation of nucleic acids in testis of rat. • Comparative estimation of the protein content and total lipid in fat body of cockroach, liver of fish and rat. • Quantitative estimation of total free amino acid in tissues of cockroach and paper chromatographic separation of these amino acids; • Kinetic essay of salivary amylase and to study the effects of time, temperature and pH on its activity; • Study of effect of substrate concentration on the activity of urease enzyme; • Inhibition of cholinesterase activity in the brain of rat organophosphate.

CourseCode:**ZOO-406F**	**Semester: VIII**
CourseTitle:Biology of Chordates	
Credits:4+0	
Unit	**Topics**
I	• Origin of chordates: • Characteristic of Ostractoderms (Cephalaspida, Anaspida, Pteraspida, Coelolepida) • Placodermi (Rhenanida, Acanthothoraci, Petalichthyida ,Arthrodira , Ptyctodontida, Phyllolepida, Antiarchi , Brindabellaspida); • Inter-relationship among Ostracoderms and Placodermis.
II	• General organization (external characters, endoskeleton alimentary canal, respiratory organ, blood vascular system, sense organs, urinogenital system) of Holocephali; • Affinities of Holocephali, Dipnoi and Crosspterygii; • Origin of paired fins in teleosts; • Origin of tetrapoda from Lung fishes, Bichirs and Crosspterygians.
III	• Rhynchocephalia, • Origin and Evolution of Reptiles (Seymouria, Cotylosaurs, Captorhinomorphs, *Diadetomorphs plesiosaurs* and Ichthyosaurs, Archosaurs, Saurischia, Bronotosaurs and Diplodocus, Ornithischia) • Origin and evolution of Birds (Jurassic birds, Cretaceous birds, Cenozoic birds); • Aerodynamics in Birds (modification in skeleton and musculature aspects ratio, take off, gliding and soaring flapping flight, slow and fast flight, perching mechanism, hovering; landing); • Origin and evolution of mammals; • Diagnostic characters of mammals and reptiles with mammalian features (Seymouriamorph, Captorhynomrph, Theromorphs) Cynognathus, • Conversion stage of reptiles in mammals; firstmammals, • Adaptive radiation in Eutheria.
IV	• Comparative study of heart in different classes of vertebrates, e.g. fish, amphibians' reptiles, birds and mammals; • Arterial and venous channel in different vertebrate group; • Comparative study of urinogenital system in different groups, e.g Amphibians, Reptiles, Birds and Mammals.

CourseCode:**ZOO-407F**	**Semester: VIII**
CourseTitle:Systematics, Biodiversity & its Conservation	
Credits:4+0	
Unit	**Topics**
I	• Definition and basics concept of biosystematics & Taxonomy: Historical resume of systematic and its importance and application in biology; • Trends in biosystematics: Concepts of different conventional and newer aspects– 1. Chemotaxonomy, 2. Cytotaxonomy, 3. Ethotaxonomy, 4. Molecular taxonomy, 5. DNA fingerprinting & Molecular markers for detection and evaluation of polymorphism, 6. RFLP, 7. RAPD, 8. Numerical taxonomy.
II	• Dimensions of Speciation and Taxonomic Characters: Types of lineage changes, • Production of additional lineage, • Species concepts and its categories, • Subspecies and infra-specific categories, • Theories of biological classification, • Hierarchy of categories, • Taxonomic and non- taxonomic characters.
III	• Procedure in taxonomy: 1. Collection, 2. Preservation, 3. Identification, 4. Different kinds of taxonomic keys, their merits and demerits, 5. Different kinds of Systematic publications, • Type of concept – different zoological types, • Zoological Nomenclature, • Formation of scientific names of various taxa, • International Code of Zoological Nomenclature (ICZN) –its operative principles, • Interpretation and Application of important rules
IV	• Lamarckian theories, Neo- Lamarkism, • Darwin's theory of natural selection: merits and demerits, • Darwinian and pre-darwinian concepts of evolution: Birth of concept of organic evolution; • Post–Darwinain concepts of evolution: Neo-darwinian concepts and sources of variation. • Gradualistic vs. non-gradualistic theories, • Mayr's Founder Principle, • Gould's punctuated equilibrium theory, • Kimura's neutral theory, • Neo–Darwinism'ssynthetic theory of evolution. • Isolation and speciation;

	• Genes in population; • Hardy-Weinberg Law, • Sewall Wright Effect, • Micro evolution, Macro evolution and Mega evolution, • Evolution in action

CourseCode:**ZOO-408F**	**Semester: VIII**
CourseTitle:Molecular Genetics	
Credits:4+0	
Unit	**Topics**
I	• Mendel's Law and their chromosomal basis; • Extension of Mendel's principles; • Allelic variations and gene function, • Incomplete dominance and co- dominance, • Gene mutation for allelism, • Gene action– from genotype to phenotype • Penetrance and Expressivity, • Gene interaction, • Epistasis Pleiotropy, • Interaction of gene.
II	• Chromosomes and gene, • Cytoplasmic inheritance, • Environment and Heredity, • Lethal genes; • sex–linked inheritance; • Pedigree Analysis, • Chromosomal Mapping, • Elements of Eugenics, • Imprinting of genes, • Gene Therapy
III	• Sex chromosome, • Sex determination, • Multiple allelism, • Numerical and Structural chromosome aberrations and their significance; • DNA replication, • Transposable elements in Prokaryotes and Eukaryotes, • Role of transposable elements in genetic regulation
IV	• Microbial Genetics: Bacterial transformation, transduction, conjugation, • Bacterial chromosome, • Bacteriophages, • Molecular CytogeneticTechniques (FISH, GISH, DNA Fingerprinting, Flow cytometry and Chromosome painting)

CourseCode:**ZOO-409F**	**Semester: VIII**
CourseTitle:Animal Embryology	
Credits:4+0	
Unit	**Topics**
I	• Basic concepts of Development Biology • Cellular Differentiation, • Signaling, • Role of genes in Embryonic Development of *Drosophila*, • Mutant screening in *Drosphila*, • Pattern Regulation in Insect- Imaginal Discs; • Development Pattern in Zebra fish; chicken and rat, • Determination of polarity and symmetry.
II	• Early Embryonic Development of Vertebrates and Invertebrates; • Gametogensis, • Structure of the gametes – the sperm and eggs, its types; • Function of Vitellogenins, Yolk and Egg membranes; • Hormonal control of ovulation; • Fertilization, mechanism and types, capacitation, acrosome formation, fertilizin and anti-fertilizin reactions, • Amphimixis, • Patterns and planes of cleavages in different types of animal eggs, • Role Yolk in egg organization, • Morulation and blastulation, • Types of blastulas.
III	• Fate maps and cell lineages; • Gastrulation; • Axis and germs layers; • Morphogenesis, morphogenetic movement; cell adhesion, • Neural tube formation, cell migration, tubulation, exogastrulation delamination, • Fate of germinal layers, • Notogenesis and mesogenesis; • Axis specification in Drosophila; • Anterior –Posterior and Dorsal –Ventral patterning • Role of maternal genes; • Growth and Differentiation its regulation at the level of chromosome;
IV	• Introduction and organizer concept; • Stem cell types and its biomedical application, • Tetraogensis, neoplasia, tumerogenesis, allometric growth, nucleocytoplasmic interaction, • Regulation of tissue regeneration and gradients in development system in Hydra and an amphibian, transplantation, • Ageing, theories and age-related changes at molecular level, biological ageing effect of various nutrients and hormones on ageing,cell death, • Transgenic animals: methods of formation, gene targeting, • Production and biomedical application of transgenic animals, mosaics, chimeras and knock out animals, • Metamorphosis in Insect and Amphibians.

CourseCode:**ZOO-410F**	**Semester: VIII**
CourseTitle:Practical based on ZOO-406F, ZOO-407F, ZOO-408F & ZOO-409F	
Credits:0+4	
Unit	**Topics**
I	• General character and Classification of chordate phyla. • **Urochordata:** Study of museum specimens/ whole*: Oikopleura, Herdmania, Ascidia, Pyrosoma, Doliolum, Salpa.* • **Cephalochordata:** Study of museum specimens/ models: Branchiostoma. • **Cyclostomata:** Study of museum specimens /models: *Petromyzon, Myxine; Ammocoete*larva. • **Pisces:** Study of museum specimens/ models: *Sphyrna (hammer – headed shark), Trygon, (string –rays), Pristis, Raja (skate), Torpedo (electric–rays), Chimaera, Polypterus, Acipener, Polydon, Amia, Lepidosteus, Hilsa, Harppodon, Notopterus, Labeo, Catla, Cyprinus, Cirrhina, Heteropneustes, Clarias, Wallago, Mystus, Anguilla, Exocoteus, Hippocampus, Channa, Amphipinous, Anabas, Synaptura, Echeneis, Neoceratodus, Protopterus, Lepidosiren;* Study of disarticulated bones of carp. • **Amphibia:** Study of museum specimen/models*: Ichthyophis, Uraeotyphlus, Cryptobrunchus, Ambystoma, Axolotl larva, Salamandra, Amphiuma, Triturus, Proteus, Necturus, Siren, Alytes, Bufo, Hyla, Rhacophorus,* Study of disarticulated bones of Frog.
II	• **Reptilia*:*** Study of museum specimen/models Chelone, *Kachua, Sphenodon, Hemidactylus, Calotes, Draco, Phrynosoma, Iguana, Heloderma, Varanus, Ophiosarus, Typhlops, Python, Natrix, Ptyas, Dendrophis, Bungarus, Naja, Russlle's viper, Pit viper, Hydrophis, Cerotalus, Crocodilus, Alligator, Gavialis, Ichthyosarus, Dimentron, Brontosarus, Tyranosarus, Stegosarus,* • Study of disarticulated bones of varanus • **Aves:** Study of museum specimens/*models: Arhaeopterys*, *Milvus* (Kite), *Gyps (*Vulture*), Pavo* (Peacock*), Columba* (Pigeon*), Eudynamys*(Koel*), Psittacula*(Parrot*), Bubo* (Owl), *Coracias* (Nilkanth*), Dinopium*(Woodpecker*), House sparrow, Corvus* (Crow). • Study of disarticulated bones of fowl. • **Mammals:** Study of museum specimens models: *Echidna, Ornithorhynchus, , Erinaceus, Shrew, Pteropus, Bat, Loris, Manis, Hystrix, Funambulus, Rattus, Oryctologus* or *Lepus, Herpestes, Lutra*, (otter), Civet cat, *Macaca*. • Study of disarticulated bones of rabbit, Skull of dog.
III	• Study of different stages of mitosis in onion root tip • Study of different stages of meiosis in testis of grasshopper or any other insect with the acetocarmine squash method, • Study of the salivary gland chromosomes of *Drosophila* and C*hironomus.*

IV	• Experiments on artificial ovulation, insemination • Study of the post embryonic stages of frog and insects, • Mounting of egg and embryos of snail, • Study of hormonal control of amphibian metamorphosis, • Incubation and mounting of chick embryos, • Study of prepared slides of the embryology of frog, chick and mammals & mammalian placenta, • Application of window techniques for in –situ study of chick embryo with special reference to morphogenetic movements, • Determination of the effect of temperature on the embryonic development of chick, • Study of the development of selected organs through preserved specimen and prepared slides, • Experiments on regeneration in Hydra, Earthworm and Lizard.

SKILL ENHANCEMENT COURSES (SEC)

Four years Zoology B Sc. honors course

List of Skill Enhancement Course (SEC) Course Credits: 3+0

S.No.	Course name	Semester	Course code	Credits	Lectures	Max marks
1	Vermiculture	I	SEC Z-1	3	3 lectures/week	100
2	Apiculture	II	SECZ -2	3	3 lectures/week	100
3	Sericulture	III	SEC Z-3	3	3 lectures/week	100

Objective of the AEC Courses

1. To provide basic conceptual understanding of skill enhancement.
2. To understand approaches of skill development.
3. Use skills and knowledge for self employability.

Course Code: SEC Z-1	**Semester: I**
CourseTitle:Vermiculture	**Total teachings hrs: 45**
Credits: 3+0	**Max Marks 100**

Unit	Topics
I	• Vermiculture: definition, meaning, history, biology of earthworms, and biology of earthworms' key to identify the species of earthworms. • Economic importance, values in maintenance of soil structure, role of four 'r's in recycling (reduce, reuse, recycle and restore). • Vermicomposting and vermiculture methods.
II	• Useful species of earthworms for vermicomposting, • Local and exotic species of earthworms, • Complementary activities of auto-evaluation; • Application and significance of vermicompost in agro-ecosystem, • Use of vermiwash as liquid bio-fertilizer.
III	• Role of earthworm in bio-transformation of the human waste, residues and bio-organic matter. • Use of humus and organic matter for production of fertilizer (product, qualities), ground population of earthworm.
IV	• Effect of combination of vermiwash with biopesticides on crop productivity, • Role of earthworms in improvement of soil fertility, • Benefits of Vermiculture,

	• Role of vermicomposting in generation of self-employment.

CourseCode: SECZ -2	**Semester: II**
CourseTitle:Apiculture	**Total teachings hrs: 45**
Credits: 3+0	**Max Marks 100**

Unit	Topics
I	• Introduction to Apiculture - scope, importance, history of beekeeping: Beekeeping in India, South East Asia and world. • Origin, systematics and distribution of honey bees, • honey bee morphology, anatomy and life cycle, • species of honey bee - indigenous, exotic. • Study of social behavior of honey bee: attack, bee dance, annual biological cycle of the bee colony • Identification of swarming tendency in a colony.
II	• Tools and equipment, • Basic requirements for beekeeping start up, • Honey bee keeping methods; Traditional and Modern bee keeping, urban or backyard beekeeping, migration and swarming of bees. • Role of Central Honey Bee Research & Training Institute BIS standard Tools used in apiculture,
III	• Honey - its composition, properties and medicinal use, • Honey extraction & handling - Quality control standards, • Processing of honey, packaging, storage, marketing • Role of apiculture in self-employment
IV	• Honeybee Enemies and Diseases [with the help of Photographs], • enemies: Mites, Wax Moths, Ants, Bee Eaters, Garden Lizards, and Bears. • Microbial diseases with special reference to Nosema, Sac brood Virus, Thai sac brood virus, American foul brood, and European foul brood diseases, • Prevention and control measures of the diseases.

Course Code: SECZ-3	**Semester: III**
CourseTitle:Sericulture	**Total teachings hrs: 45**
Credits: 3+0	**Max Marks 100**

Unit	Topics
I	• Origin and history of Sericulture, • Introduction of silk and silk worm, • Habitat, and life cycle of *Bombyx mori*, egg, larva, pupa and adult, host plants. • Morphology of mulberry plant, egg production, development biology of silkworm, rearing of larva and cocoon, equipment; disinfection and hygiene. • Biochemistry of silk, types of silk produced in India, fibroin structure, and; Importance of mulberry silk.
II	• Components of Sericulture, • Physical and commercial characteristics of cocoons; cocoon sorting, • Rearing operations: brushing, young and late-age silkworm rearing, molting, mounting, spinning, cocoon harvesting and marketing. • Cocoon Production and Silk Reeling Technology, • Sericulture Economics and Extension, • Diseases and pests of Mulberry plant, their preventive and control measures.
III	• Cocoon stifling Mulberry Physiology and Mulberry breeding and Genetics, • Cocoon Production and Silk Reeling Technology, • Post Cocoon Technology • Sericulture Organization & Management, • Role of state departments of Sericulture, Central Silk Board, Universities and NGOs in Sericulture development.
IV	• Mulberry and Silkworm Physiology, • Non - Mulberry Sericulture, • Sericulture Technology and Entrepreneurial Development, • Sericulture marketing. • Role of women in sericulture and employment generation.

Syllabus for

ABILITY ENHANCEMENT COURSES (AEC)

Four years Zoology B Sc. honors course

Objective of the AEC Courses

1. To provide basic conceptual understanding of ability enhancement. 2. To understand approaches of ability development 3. To build ability to prepare students for self employability

List of ability Enhancement Course (AEC) 2+0

S.No.	Course name	Semester	Course code	Credits	Lectures	Max marks
1	Biostatistics, bioinformatics and Computer applications	I	AECZ- 1	2	2 lectures/week	100
2	Disaster risk reduction and management	II	AECZ- 2	2	2 lectures/week	100
3	Animal ethics & model organisms	III	AECZ- 3	2	2 lectures/week	100
4	Aquaculture skills	IV	AECZ- 4	2	2 lectures/week	100

AECZ- 1: Ability enhancement course

Title: Biostatistics, Computer applications and Bioinformatics Credits 2 total teachings hrs 30 Max marks 100

Unit-I

Concepts of population and sample, need for sampling, census and sample surveys, mean, median, mode, standard error and standard deviation, kurtosis, graphical presentation of data, probability, sample size determination, Multinomial and binomial sampling distributions, confidence intervals, Poisson's, distribution, Chi-squared test, sample t-tests, variance and covariance, correlation and regression analysis

Unit-II

Introduction of Computers, classification of Computers, organization of Computer, Key boards, memory hierarchy, Primary Memory - memory unit, SRAM, DRAM, SDRAM, RDRAM, Flash memory. Secondary storage devices Magnetic Disk, Floppy Disk, Optical Disk, Magnetic Drum , Input Devices, Output Devices, applications of MS-office (MS-Word, MS-excel and Power point).

Unit III Introduction to bioinformatics and its relation with molecular biology. Examples of related tools (FASTA, BLAST, BLAT), databases (GENBANK, Pubmed, PDB) and software (RASMOL, Ligand Explorer), applications of bioinformatics.

Unit IV Biological Database and its Types, Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (primary, composite, and secondary). Specialized Genome databases: (SGD,

TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum), File Format (Genbank, DDBJ, FASTA, PDB, SwissProt), methods of sequence alignments

AECZ- 2**: Ability enhancement course**

Disaster risk reduction and management Credits 2 total teachings hrs 30 Max marks 100

Course Outcomes-

1. To build basic conceptual understanding of disasters.
2. To build ability to integrate knowledge and analyze, evaluate and manage the different aspects of disasters at local and global levels within limited available information.
3. To describe, analyze and evaluate the environmental, social, cultural, economic, legal and organizational aspects influencing vulnerabilities and capacities to face disasters.
4. To work theoretically and practically in the processes of disaster management (disaster risk reduction, response, and recovery) and relate their interconnections.

UNIT I
Fundamentals of Disaster Management
Concept of Disaster, Hazard, Vulnerability, Exposure, Capacity, Disaster Management Cycle: Preparedness, Response, Recovery and Mitigation, Disaster Risk Reduction (DRR), Institutional Framework in India.

UNIT II
Types of Disaster
Natural Disasters: Earthquake, Flood, Drought, Landslide, Land Subsidence, Cyclones, Volcanoes, Tsunami, Avalanches, Global Climate Extremes.
Anthropogenic Disasters: Nuclear Weapons and Spills, Chemical Weapons and Spills, War and Terrorism, Oil Spills, Forest Fires and Accidents (Transportation, Infrastructure Collapse).

UNIT III
Disaster Preparedness of Disasters
Dos and Do not's at individual or household levels (before, during and after a disaster) Communication, Coordination, Cooperation during the Emergencies, Community Based First Aid (CBFA), Community Based Disaster Management (CBDM), Importance of Mock Drills.

UNIT IV
Disaster Risk Assessment Techniques
Risk Identification, Application of Remote Sensing (RS), Geographic Information System (GIS), and Global Positioning System (GPS) in Disaster Management and Risk Assessment.

AECZ- 3: Ability enhancement course

Animal ethics and model organisms Credits 2 total teachings hrs 30 Max marks 100

Unit: I,

Animal ethics; experimental health and welfare issues, captivity and animal behavior, rights of animals, physiological and environmental stress.Feeding and breeding Strategies, use of animals in biomedical research according to CPCSEA/IAEC Regulatory Guidelines, animal ethics in laboratory experimental animals, Use of genetically modified animals in experimental research.

Unit II

Animal handling techniques, tools and techniques, physical and chemical restraint with special reference to euthanasia abiding ethics, basic principles of anesthesia, surgery and post surgical care.

Unit III

Use of animal models i.e. Zebra Fish, Drosophila, mice and rat models in biomedical research and drug development, safety evaluations, regulatory protocols (before clinical trials), Animal age profile, experimental age, dosage, toxicity, survival and death, Animal welfare Board of India– its role, functions and current status

Unit IV

Use of invertebrate models i.e. fruit fly and eukaryotic nematodes as alternate of vertebrate animals to study various diseases such as cancer. The use of computers in predicting the various biological and toxic effects of a chemical, to reduce the usage of animals, computer-aided drug designs, simulations for identifying the receptor binding site for the potential drug

AECZ- 4**: Ability enhancement course**

AECZ- 4**: Aquaculture skills Credits 2 total teachings hrs 30 Max marks 100**

Unit I

Commercially important finfish, freshwater fishes, exotic carps, ornamental fishes, of commercially important shellfish – crabs, prawns and shrimps. Identification of eggs and larval forms of cultivable finfish and shellfish, fish food organisms: collection and identification.

Unit II

Nutritional requirements of finfish and shellfish viz. carps, cat fishes, shrimp and prawn; major nutrients – carbohydrates, proteins and lipids and their importance, Natural food and live feed culture: methods of collection of live feed organisms; identification, isolation and maintenance of phytoplankton and zooplankton; mass culture of spirulina and azolla, culture of rotifers (Brachionus and Moina) and artemia.

Unit III

Hatchery design and Management: Criteria for site selection of hatchery and nursery. Design and operation of different types of hatchery systems- hatchery protocols, larval rearing stages, packaging and transport of seed. Breeding and culture of ornamental fish, aquarium design and fabrication.

Unit IV

Soil and water quality monitoring and management; Hatchery technology for Indian major carps and exotic carps and Catfishes, Induced breeding: Methods of natural and artificial fertilization