VIDYASAGAR UNIVERSITY

MIDNAPORE -721 102, WEST BENGAL, INDIA

Faculty of Science

Department of Zoology

The Syllabus(DRAFT) for the POST-GRADUATE Programme

in

Zoology

Under Choice Based Credit System (CBCS)

1st YEAR

SEMESTER- I

Course No: ZOO 101: Non-Chordate Biology and Chordate Biology

UNIT I: ZOO 101.1: Non-Chordate Biology

Syllabus:

TOPOICS	TEACHER
1. Origin and evolution of Metazoa; phylogenetic overview of major invertebrate phyla.; Phylogenetic relationship among Protozoa, Parazoa, Mesozoa, and Metazoa; evolutionary significance; Concepts and evidence about Super Phyla	S.N.B
2. Foraminifera– characteristics, origin, distribution, biology, and ecological and economicsignificance of foraminifera.	
3. Comparative account of different larval forms of coelomate non-chordates.	
4. Biology of free living nematodes – feeding mechanism and roles of nematodes inecosystem.	
5. Lophophorate relationships; Bryozoa (Ectoprocta and Entoprocta) – anatomicalpeculiarities feeding mechanisms and phylogenetic relationship.	D.M
6. Rotifera – general organization, mastax, reproduction, and cyclomorphosis.	
7. Foraminifera– characteristics, origin, distribution, biology, and ecological role offoraminifera.	
8. Conservation strategies of invertebrates: invertebrate diversity, importance, and threats; alternative approaches to species-focused conservation; conservation status evaluation for invertebrate species.	

UNIT II: ZOO 101.2: Chordate Biology

Syllabus:

TOPICS	TEACHER
1. **Origin of Chordates:** Hemichordata, Cephalochordata, Urochordata, the origin ofcraniates, the evolution of primateswith special reference to *Homo sapiens sapiens.*	S.N.B
2. **Protochordates:** Endostyle and iodine binding capacity in Protochordates.	
3. **Respiratory system & gas bladder:** Function and requirements of the respiratory system; ventilation of internal gills; Agnatha, cartilaginous fishes, bony fishes, larval gills; arial respiration in lung fishes; swimbladder and the origin of lungs and other ducts.	
4. **Excretory System and osmoregulation:** Evolution of kidneys among vertebrates,kidney structure in relation to osmoregulation; basic pattern and the Archinephros, Pronephros, Mesonephros, Metanephros: External salt excretion, osmoregulation infreshwater and marinefishes, association with the urinary system.	
5. **Echolocation:** Structure and function of organs of hearing balance and echolocation;morphological adaptation for echolocation; bat echolocation.	
6. **Integumentary system:** Cellular association and glandular System	

Course No: ZOO102: Histochemistry and Animal Physiology

UNIT I: ZOO102.1: Histochemistry

Syllabus:

TOPICS	TEACHER
1. Introduction to Micro-technique: Microtomy: Parts of a rotary microtome and their functions; Alcohol as an ideal dehydrating agent; Paraffin as an ideal embedding medium; Mayer's albumin; Natural and synthetic mounting media. Routine histopathology: Fixation, dehydration, clearing, infiltration, embedding and block preparation of tissue samples; section cutting and stretching over slides.	
2. Fixation: Objectives of fixation; Preservatives vs. fixatives; Additive and non-additive fixatives; Coagulant vs. non-coagulant fixatives; Action of alcohol, formalin, mercuric chloride, and picric acid on cells; Applications of fixation: Composition, merit and demerit, use of Bouin's fluid, aceto-alcohol and Carnoy's fixative; Fixation artifact; Fixation for electron microscopy (with glutaraldehyde and osmium tetroxide).	D.P
3. Dyes: Stain vs. dye; Properties of dye molecules; Acid and basic dyes; Chemical classification of dyes; Dyes of plant and animal origins; Vital dyes; Amphoteric dyes.	
4. Histological staining: Orthochromatic vs. metachromatic staining; Mordants and mordanting (single-bath and double-bath methods); Applications of staining: single, double, and triple staining of tissues using toluidine blue, hematoxylin-eosin, and Mallory's trichrome staining.	
5. Enzyme histochemistry: (i) Gomori's reaction for alkaline phosphatase: Working principle; Applications in cell biology, cancer biology, ecotoxicology, and developmental biology. (ii) Benzidine reaction for myeloperoxidase in blood smears Working principle; Applications in the detection of myeloid and lymphoid leukemia, and congenital myeloperoxidase deficiency.	S.K.B
6. Immunohistochemistry: Primary and secondary antibodies; Reporter enzyme and chromogenic substrate; Working principles of direct and indirect immunohistochemistry; Applications of immunohistochemistry in the detection of different types of cancer.	

UNIT II: ZOO 102.2: Animal Physiology

TOPICS	TEACHER
1. Blood, Circulation and Respiration: i. Haemopoiesis & haemostasis ii. Blood volume, blood pressure and their regulation iii. Acclimatization to extreme conditions like hypoxia & diving iv. Body oxygen stores: Haemoglobin, Oxyhaemoglobin and Myoglobin v. Oxygen dissociation curve; Bohr's effect; Haldane effect.	**D.M**
2. Cardiovascular System: i. Neurogenic hearts ii. Myogenic heart, heart as a pump; regulation of heart pumping; specializedjunctional tissue iii. Cardiac cycle iv. Neural and chemical regulation of excitation & conduction in the heart v. ECG – principle, measurement and significance.	
3. Stress Physiology: i. Homeostasis, Comfort zone, feedback control systems ii. Oxidative stress; Cellular response; Free radicals and antioxidants	S.D
4. Thermoregulation: i. Body temperature and determinants of body heat – production and loss ii. Physiological events for thermoregulation-physical, chemical, neural; counter-current system.	

Course No: ZOO 103: Immunology and Methods in Biology

(50 Marks, 4 credit)

UNIT I: ZOO 103.1: Immunology

Syllabus:

TOPICS	TEACHER
1. Cells and organs involved in the immune system, types of immunity	S.G
2. a) Antigenicity and immunogenicity b) Concept of the epitope, paratope, agretope, hapten and adjuvants	
3. T-cell and B-cell biology a) Origin and maturation of T and B lymphocyte b) Mechanism of humoral and cell-mediated Immune Response c) T-cell subpopulation	
4. a) Antigen processing and presentation b) Major Histocompatibility Complex (MHC): Mechanism of immune response andgeneration of immunological diversity	
5. The Complement System: The Major Pathways of Complement Activation, the Regulationof Complement Activity, Complement Deficiencies	S.K.B
6. a) Structure and function of Immunoglobulin (Ig) and its Isotypes. b) Enzymatic activity on Ig molecule.	
7. Applied Immunology:-ELISA, RIA, Immunoblotting, and Immunohistochemistry.	

UNIT II: ZOO 103.2: Methods in Biology

Syllabus:

TOPICS	**TEACHER**
1. Molecular Biotechnology a) Recombinant DNA technology b) Restriction & modifying enzymes c) Production of recombinant DNA molecule d) Cloning Vector e) Amplification of DNA by PCR	**S.G**
2. Environmental Biotechnology a) Bioremediation i. *In situ* bioremediation ii. *Ex situ* bioremediation b) Bioremediation of Xenobiotic components and hydrocarbons c) Phytoremediation d) Integration of different rural biotechnological tools and Cryopreservation	
3. Techniques and Bioinstrumentation a) Principle and applications of different types of chromatography, LC-MS. b) Basic Principles of Electrophoresis; Agarose Gel Electrophoresis; SDS-PAGE;Cell fractionation; Ultracentrifugation; Southern Blotting Hybridization. 4. Flow Cytometry, 2D Gel Electrophoresis, and FISH.	**S.K.B**

Course No: ZOO 104: Cell Biology and Cytogenetics

(50 Marks, 4 credit)

UNIT I: ZOO 104.1: Cell Biology

Syllabus:

TOPICS	TEACHER
1. Biomembrane Structure The Lipid Bilayer: Composition and Structural Organization; Membrane Proteins: Structure and Basic Functions, Membrane lipids: Phospholipids, Sphingolipids, and Cholesterol and Intracellular Movement	D.P
2. Transmembrane Transport of Ions and Small Molecules Overview of Transmembrane Transport, ATP-Powered Pumps and the IntracellularIonic Environment, Overview of Trans-cellular Transport	
3. Moving Proteins into Membranes and Organelles Targeting Proteins to and across the ER Membrane, Insertion of Membrane Proteins into the ER, Targeting of Proteins to Mitochondria and Chloroplasts, Transport Into and Out of the Nucleus	
4. Signal Transduction The basic idea of Cell signaling, G Protein–Coupled Receptors: Structure and Mechanism, G Protein–Coupled Receptors and Regulation of Ion Channels, Signaling through second messengers, Receptor tyrosine kinase signaling, MAP Kinase pathway	
5. Cytoskeleton & Cellular Motility Microtubule Dynamics and regulation, Microtubular motor proteins: Kinesins &Dyneins and Cellular motility	S.DAS
6. Cell cycle regulation: Phases of Eukaryotic cell cycle, cyclin and cyclin-dependent kinase, Regulation of CDK-cyclin complexes, Protein kinases in cell cycle, Regulation by ubiquitin ligase, Exit from mitosis, DNA replication and DNA damage checkpoints,chromosome–microtubule attachment	
7. Interactions between Cells and Their Environment: Overview of major cell-cell and cell-matrix adhesive interactions, Cell-Cell and Cell– Extracellular Junctions and their adhesion molecules; the extracellular matrix: The basal lamina and connective tissue; Integrin	

UNIT II: ZOO 104.2: Cytogenetics

TOPICS	TEACHER
1. **Genetic Fine structure:** The CIS-TRANS or complementation test for functional allelism, Fine structure of thephage T4 rII locus, Complementation mapping and deletion mapping.	S.G
2. **Recombination in Bacteria:** F factor, episomes, Hfr, integration of F factor, Interrupted mating Experiment,conjugation mapping, transformation and transduction	
3. **Tumor Inducing Viruses – Viral Oncogenes** Life Cycle of Rous Sarcoma Virus, RSV genome organization, mechanism of integration, formation of transducing retroviruses, protein products of protooncogene, Oncoproteins, regulation of gene expression and signal transduction Cancer induction by Retroviruses, tumor suppressor gene and their function.	D.P
4. **Genetic structure of Populations** - Genotypic frequencies, Allelic Frequencies, the Hardy-Weinberg Law, calculation of genotypic and allelic frequencies where multiple alleles are present, derivation of the Hardy-Weinberg Law.	

Course No: ZOO195 (Practical):

Non-Chordate Biology, Chordate Biology, Histochemistry and Animal Physiology

Syllabus:

TOPICS	TEACHER
1. Non- Chordate Biology: i) Identification of common Invertebrate and Vertebrate taxa ii) Minor Dissection: a. Grasshopper - Reproductive system/ Nervous system b. Cockroach – Stomatogastric Nervous system c. Achatina – Reproductive system & Nervous system	S.G & D.P
2. Chordate Biology: i) Major Dissection: Vth, VIIth cranial nerves of bony fish ii) Minor Dissection: Fish scale and pecten of bird	
3. Histochemistry i) Preparation of laboratory fixative mixtures ii) Microtechnique for routine histological study iii) Histological study of different vertebrate organs	
Animal Physiology iv) Demonstration of blood haemoglobin estimation in the animal model v) Estimation of pH and its impact on any aquatic animal.	

vi) Observation of gut movement in an animal under hypoxia using Dale's apparatus vii) Estimation of Blood Pressure and Heart Rate viii) Determination of Breath-Holding Time (BHT) in humans	

Course No: ZOO 196 (Practical):

Immunology, Methods in Biology, Cell Biology and Cytogenetics

Syllabus:

TOPICS	**TEACHER**
1. Immunology: a. Study of macrophage. b. Study of phagocytosis. c. Determination of human blood group	S.G & S.K.B
2. Methods in Biology a. Characterization of macromolecule through Gel electrophoresis	
3. Cell Biology a. Identification of different stages of cell division and cell organelle. b. Mitochondrial Staining c. Cell isolation and cell counting	
4. Cytogenetics: a. The life cycle of *Drosoplila*. *b.* Analysis and interpretation of genetic crosses with special reference to *Drosophila* c. Study of the polytene chromosome of *Drosophila*.	

1st YEAR

SEMESTER- II

Course No: ZOO 201: Biosystematics and Ecological Principles

(50 Marks, 4 credit)

UNIT I: ZOO 201.1: Biosystematics

Syllabus:

TOPICS	TEACHER
1. **Microtaxonomy:** Phenon, Taxon, Category, type; stages of taxonomy; Aims andtasks of Taxonomists; Importance of taxonomy in Biology.	C.N
2. **Macrotaxonomy:** Theory and practice of Biological classification; Basic principles, Rules for the classification of organisms, Identification criteria, Taxonomic characters, Classification and phylogeny, Is classification a Theory? The functions of classification.	
3. **Concept of Species:** Typological species concept, Nominalistic species concept, Biological species concept, Evolutionary species concept; other species; Polytypic species, Subspecies, Infraspecies and Superspecies.	
4. **Neo Systematics:** Morphological approach, Immature stages and Embryological approach, Ecological approach, Behavioural approach, Ecological approach, Cytological approach, Biochemical approach, Numerical systematics, Differential systematics.	S.G
5. **Molecular Systematics:** Immunological aspect, chromatographic aspect, Electrophoresis, Infrared spectrophotometry, Histochemical studies, genetic complement, DNA hybridization, Karyological studies.	
6. **Macromolecular & Micromolecular Systematics:** based on DNA, RNA, Protein,amino acids, fatty acids and phenols.	
7. **Role of Systematics in applied Biology:**Agriculture& Forestry, Biological control, wild life management, National Defense, Environmental problems, soil fertility, Mineral prospecting, Quarantine measure, Commercial application.	
8. **Systematics and Public Health Management**	

UNIT II: ZOO 201.2: Ecological principles

Syllabus:

TOPICS	TEACHER
1. Basics of Ecology Biosphere and Ecosphere; Types of the food web: Connectedness, energy and functional webs; Features of food web – nodes, links, linkage density, connectance, chain length; cybernetic nature of ecosystem; stability through feedback control and redundancy of components; resistance and resilience stability, Gaia hypothesis.	S.G
2. Population Ecology Survivorship; Life table, fertility schedule. Reproductive strategies; semeloparity, iteroparity, r & k strategies, population interactions- direct and indirect, positive and negative. Lotka-Volterra model of competition and predator-prey interaction. Causes of extinction and endangerment of populations. Anthropogenic impact on extinction, habitat destruction and fragmentation, and the introduction of exotic species.	
3. Community and Ecosystem Structure of biotic community. Community patterns: diversity and stability. Community boundary: Ecotone and edge types, Edge effect and edge species, Edge/Area ratio concerning size, shape and fragmentation of habitat. Organismic and individualistic concepts of community. Leibig's Law of tolerance.	**S.K.B**
4. Habitat Ecology Habitat and niche: spatial, trophic and multi-dimensional niche concepts, fundamental and realized niche, niche breadth and niche overlap. Competitive exclusion: experimental and natural evidence. Keystone species. Foundation species. Species abundance hypothesis. Ecological guilds and ecological equivalents.	
5. Evolutionary Ecology Definition; different approaches, Bet-Hedging strategies, Hamilton's role and limitations ofthe inclusive fitness model.	**S.D**
6. Ecology and organism: **i) Aquatic Ecology**: Types and zonation's of aquatic bodies, lotic and lentic bioticcommunities and limiting factors, **ii) Terrestrial Ecology**: Bio-geography of Indian terrestrial landscape with special referenceto soil subsystem and forests with respective biotic community	

Course No: ZOO 202: Biophysics and Biochemistry

(50 Marks, 4 credit)

UNIT I: ZOO 202.1: Biophysics

Syllabus:

TOPICS	TEACHER
1. Biophysical principles: (i) pH and buffer – Meaning, range and calculation of pH; Mechanism of action of buffers; Significance of pH in the biological system; Buffers of extra- and intracellular fluids. (ii) Osmotic pressure: Laws of osmotic pressure; Isosmotic vs. isotonic solutions; Effect of hypotonic treatment on animal and plant cells; Survival of freshwater teleost fishes in hypotonic lotic water; Survival of marine teleost and elasmobranch fishes in hypertonic sea water. (iii) Membrane transport: Diffusion; Osmosis; Active transport and its types; Ion channels vs. membrane pumps; Facilitated diffusion vs. active transport; Reverse osmosis and its application.	S.GIRI
2. Thermodynamics: Different types of thermodynamic systems; Laws ofthermodynamics; Applicability of thermodynamic principles in living beings.	
3. Colloidal system: Crystalloid vs. colloid particles; Classification of colloids; Lyophilic sol and lyophobic sol – properties and preparation; Brownian movement and Tyndall effect; Dialysis and its clinical importance; Electrodialysis and its application in the production of drinking water.	
2. **Microscopy in biology and medicine:** (i) Fluorescence microscopy – Auto-fluorescence and hetero-fluorescence; Working principle of fluorescence microscope; Application in the detection of chronic myeloid leukemia, tuberculosis infection and catecholamine hormones; Principle of immunofluorescence. (ii) Transmission electronmicroscopy – Comparison of working principles of light microscope and TEM; Biological application with reference to the diagnosis of viral infection and other diseases.	S.G
3. **Biophysics of membrane:** Fluid mosaic model; Intrinsic and Peripheral membrane proteins; Asymmetric distribution of proteins, lipids and carbohydrates in bio- membranes; Movement of membrane lipids and proteins with reference to cell fusion study and fluorescence recovery after photobleaching (FRAP).	
4. **Dynamics of circulation:** Laminar and turbulent blood flow; Reynold number; Basic concept of blood pressure and blood volume; Factors influencing blood pressure andblood volume.	

UNIT II: ZOO 202.2: Biochemistry

Syllabus:

TOPICS	TEACHER
1. **Stabilizing interactions** (Vander Waals, electrostatic, hydrogen bonding, hydrophobicinteraction)	S.GIRI
2. **Protein Conformation**: Primary, secondary, tertiary and quaternary structures;Ramachandran plot; domains; motif and folds.	
3. **Protein Purification:** Salting out, Dialysis, Gel-filtration chromatography, Ion-exchange chromatography, Affinity chromatography, High-pressure liquid chromatography, Gel electrophoresis, Isoelectric focusing, Two-dimensional electrophoresis.	
4. **Enzymes:** Enzyme kinetics, Michaelis-Menton equation, hyperbolic and Lineweaver- Burke plot; co-enzymes and cofactor; competitive and non-competitive inhibitor and their effects on enzyme kinetics; Active site of an enzyme; Enzyme regulation, allosteric modification, its kinetics, covalently modulated enzymes.	
5. **Biological Oxidation:** Redox potential, mitochondrial electron carriers, the respiratory chain (electron transport chain); Mitchell's chemiosmotic theory of oxidative phosphorylation; FoF, ATPase, and Q cycle.	S.K.B
6. **Lipid Metabolism**: denovo synthesis of fatty acids, microsomal fatty acid elongase &desaturase systems; oxidation of saturated fatty acids and unsaturated fatty acids.	
7. **Protein metabolism**: Deamination, transamination, formation of urea, formation of specialized products from amino acids: catecholamine, serotonin, melatonin, glutathione, T_3, and T_4.	
8. **Carbohydrate metabolism**: Anabolic role of TCA cycle, integration of carbohydrate, fat and protein metabolism. Regulation of Glycolysis and TCA cycle, Gluconeogenesis, Pentose phosphate pathway, Glycogenesis, glycogenolysis with special reference to rate- limiting steps.	

Course No: ZOO 203: Molecular Biology and Parasitology

UNIT I: ZOO 203.1: Molecular Biology

TOPICS	TEACHER
1. **DNA Replication:** The chemistry of DNA synthesis, the mechanism of DNA polymerase, the replication fork, the specialization of DNA polymerase, Sliding DNA clamp loading, Initiation of DNA replication in prokaryotes and eukaryotes, helicase loading and activation, elongation and termination of replication.	S.G
2. **The Transcription Process:** Role of RNA polymerase in prokaryotes, initiation of transcription at Promoters, elongation and termination of an RNA in prokaryotes, Different types of RNA ploymerases in eukaryotes Initiation, elongation, and termination of transcription in eukaryotes, Post-transcriptional control of gene expression by Micro RNAs and RNA interference.	
3. **Protein Synthesis** Genetic codes, Ribosome, Charging tRNA, initiation of translation; the role of initiation factors, Elongation: binding of Aminoacyl tRNA, peptide bond formation and translocation; Termination of translation.	S.K.B
4. **Regulation of Gene Expression in Prokaryotes:** The Operon Model; lac an inducible Operon, Positive Control of the lac Operon by CAP and Cyclic AMP. Repressible operon, Gene organization of the tryptophan biosynthesis gene, Regulation of the trp operon.	

UNIT II: ZOO 203.2: Parasitology

1. a) Types of Parasites and hosts. b) The basic concept of Parasitism, symbiosis, phoresis, commensalisms andmutualism.	D.M
2. Molecular, cellular and physiological basis of host-parasite interactions.	
3. Life cycle and immunology of *Plasmodium falciparum*.	
4. Epidemiology and transmission of parasitic diseases. Malaria, Kalaazar.	
5. a) Zoonosis and Zoonotic diseases with special reference to Balantidiasis, GiardiasisFilariasis and Paragonimiasis. b) Life cycle and biology of *Leishmania sp. Schistosom sp.*.	S.N
6. Structure and composition of helminth cuticle.	
7. Vector biology with special reference to mosquito, sand fly, and ticks.	

CBCS

Course No: *C-ZOO 204: Wildlife and Eco-management and Aquaculture (CBCS)*

UNIT I: C-ZOO 204.1: Wildlife and Eco-Management

Syllabus:

TOPICS	TEACHER
1. Wildlife diversity and distribution in India – Mammals, Avifauna and Reptiles;IUCN threatened categories.	S.G
2. Threatened wildlife in India with special reference to Eastern India.	
3. Root causes of depletion of wildlife wealth.	
4. Wildlife conservation strategies-Protected areas-National Parks, Sanctuaries,Biosphere Reserve; Core and Buffer; Nodes and Corridors.	
5. Management of wildlife-Taxonomic Status, Distribution, Habitat UtilizationPatterns, Threats and conservation of Musk Deer; Vultures; Olive Ridley turtle.	
6. Tools and Techniques- PRA methods; Molecular Techniques; Tele satellite images; Radio collaring; Peoples Participation; Ground truth Assessment-Pugmarks, Call counts, Capture-Recapture.	S.K.B
7. Wild life trades, Crimes, Laws & Ethics.	
8. Environment –different relevant terminology.	
9. Environmental Management-Basic steps Sustainability, Ecomonitoring ImpactAssessment.	
10. Pollution-Types: Mode of action and Environmental Consequences; GlobalScenario.	
11. Conservation Biology –different concepts and approaches.	

Course No: ZOO 295 (Practical):

Biosystematics, Ecological principles, Biophysics, and Biochemistry

TOPICS	TEACHER
1. Biosystematics a) Preparation of taxonomic key	S.K,B
2. Ecological principles a) Estimation of primary productivity in aquatic ecosystems b) Estimation of transparency of water c) Measurement of the intensity of light – using Lux meter. d) Determination of the minimum size and number of quadrat – Species area curve method. e) Study of density, diversity, frequency and abundance of the plant community.	
3. Biophysics a) Demonstration of osmosis (Potato osmoscope) b) Microscopic study of hypotonic and hypertonic treatment of mammalian erythrocytes c) Estimation of pH of solutions by pH meter. d) Demonstration of phase-contrast and fluorescence microscopy (Live and virtual)	
4. Biochemistry a) Quantitative estimation of protein- Lowry method / Bradford method. b) Protein denaturation and renaturation assay c) Estimation of Glucose, cholesterol, total protein and	S.G

urea d) Estimation of DNA by Diphenylamine reagent. e) Detection of amino acids by Ninhydrin reaction. f) Determination of Km &Vmax of enzymes Amylase / Alkaline phosphatase.	

Course No: ZOO 296 (Practical):

Molecular Biology, Parasitology and Field Study

Syllabus:

TOPICS	TEACHER
1. Parasitology a) Smear preparation and staining of rectal content of Bufo sp./Cockroach b) Preparation and staining of blood parasite from pigeon blood. c) Identification: *Plasmodium sp., Leishmania sp., Ascaris sp., Fasciola sp., Paramphistomum sp.,Anopheles sp., Culex sp., Aedes sp. Columbicola sp., Pediculus sp., Cimex sp.*	D.P
2. Molecular Biology a) Isolation & purification of DNA from tissue. b) Principle & method of Agarose Gel Electrophoresis 3. Field study	S.G

2nd YEAR

SEMESTER- III

Course No: ZOO 301: Entomology and Ecotoxicology

UNIT I: ZOO 301.1: Entomology

Syllabus:

TOPICS	TEACHER
1. **Importance, diversity and conservation of insects** – Insect biodiversity, uniqueness and adaptability, insect conservation. Insect for food and silk – prospects and problems of sericulture in drought-prone lateritic tracts of South West Bengal, India.	D.T
2. **General characters and classification of Insects (up to order) -** Insect's head, capsule, antennae, legs, wings, the digestive system with special emphasis to the midgut, filter chamber and peritrophic membrane; integument, Insects' neuro-endocrine system and Hormonal regulation – components, the chemical structure of hormones and functions; molting and metamorphosis, insects' egg-type, hatching, growth, development, diapause and aestivation.	
3. **Biology, nature of damage and control of insect pests -** Jute, cashew, betel vine and stored grains; Integrated approach to pest management (Dynamics of Economic InjuryLevel (EIL); Economic Threshold Level); Biological control of pests: Challenges and success.	
4. **Aquatic insects** – Diversity of freshwater and marine insects, Adaptation – waterbalance; Importance for environmental monitoring.	
5. **Insect behavior -** Pheromones – Structure of pheromone glands; types and functions; biochemical synthesis of pheromones. Bioluminescence – Light producing organs, Mechanism of light production, Control and significance of light production.	J.M
6. **Insects and Plants –** Insect plant interaction and co-evolutionary interactions between plants and animals; Plant chemicals and their effect on insects; Pollination by insects; Organic compounds and their biosynthesis pathways in insects.	
7. Insect's Perception of the environment: Pheromones, allelochemicals, semiochemicals, etc.; Intra-specific and inter-specific chemical and mechanical communications in insects.	

UNIT II: ZOO 301.2: Ecotoxicology

TOPICS	TEACHER
1. Xenobiotics General idea of Xenobionts and their Physical & Chemical Properties; Corrosive, Metabolic, Neurotoxic, Mutagenic & Carcinogenic toxins; Characteristics of toxin, Route of Entry, Mechanism of Action.	S.D
2. Toxicity test & bioassay LC_{50}, LD_{50}, Dose-response curve; Biotransformation, Bioaccumulation & Biomagnification of Xenobionts in food chain; Hazardous heavy metals and their toxicity and possible antidotes; Elementary idea on Chelation therapy.	
3. Aquatic Toxicology Aquatic environment, Factors affecting the Environmental Contraction of Chemicals, Toxicological concepts and Principles, Factors that influence Toxicity, Toxic agents and their effects, concentration – Response Relationships, toxicity testing, Biomonitoring Toxicity data and Environmental regulation.	
4. Immunotoxicology Immunology – Defensive responses, Immunological methodology; Immunotoxicology – Effects of classes of Toxicants.	S.DAS
5. **Environmental Genotoxicology** Basic mechanism of DNA damage, Analytical techniques, In situ Environmental Genotoxicity studies with Aquatic species, and potential value of Environmental genotoxicity.	

Course No: ZOO 302: Molecular Evolution and Microbiology

UNIT I: ZOO 302.1: Molecular Evolution

Syllabus:

TOPICS	TEACHER
1. Neo-Darwinism a. Hardy-Weinberg law of genetic equilibrium b. A detailed account of destabilizing forces: (i) Natural selection (ii) Mutation (iii) Genetic drift (iv) Migration	S.G
2. Molecular phylogenies a. Construction of phylogenetic trees b. Phylogenetic Inference-Distance methods, parsimony methods, maximumlikelihood method c. Immunological techniques d. Amino acid sequences and phylogeny e. Nucleic acid phylogeny, DNA-DNA hybridizations, restriction enzyme sites,nucleotide sequence comparisons and homology	

UNIT II: ZOO 302.2: Microbiology

Syllabus:

TOPICS	TEACHER
1. Resolving powers of different microscopes.	H.K.J
2. Microbial classification: various systems and their basis, Bergey's manual.	
3. Categorization of Bacteria: based on Gram-staining, spores, temperature, pH, oxygen; detailed morphology of Bacteria.	
4. General attributes of Algae, Protista, Fungi & Virus: classification, structural uniqueness, reproduction, medical importance.	
5. Microbial Physiology: i. Growth in Bacteria: normal growth curve; methods of measuring growth- directand indirect count (cell number and cell mass). ii. Calculation of Growth rate & Generation time; strategies of cell division.	
6. Microbial identification: colony characteristics and biochemical identification (benchtop tests).	
7. Microbial Nutrition: i. Culture media – types, purpose and examples. ii. Culture techniques; pure cultures.	
8. Microbial ecology: Biofilm; Role of soil microbial community	
9. Bacterial Communication: Chemotaxis and quorum sensing- significance and mechanism.	
10. Microbial fermentation: manufacture of industrially important products.	

SPECIAL PAPER: ECOLOGY

Course No: ZOO303B: Biodiversity and Conservation Ecology and Aquatic Ecology

UNIT I: ZOO 303B.1: Biodiversity and Conservation Ecology

Syllabus:

TOPICS	TEACHER
1. Benefits of biodiversity; CBD, Megadiversity countries.	S.G
2. Biodiversity: status, monitoring (surveys) and documentation; levels of biodiversity measurement; mapping of Biodiversity hotspots.	
3. Threats to Biodiversity; Causes and Consequences of Biodiversity Declines; Biodiversity and Ecosystem Stability.	
4. Major approaches to Biodiversity management and Wildlife Conservation.	S.K.B
5. Necessity and Objectives of Conservation; IUCN Red List Category Version 3.1; Categories of endangered animals; Red Data Book; Red datasheet for India. IUCNcategories of Protected Areas- National Parks, Sanctuaries, Biosphere Reserves. World Heritage Sites.	
6. Globally Threatened Species- Invertebrates and vertebrates; Trends in the Status of Threatened Species; Causes of threat; Ethics of Wildlife Management and Conservation.	
7. Critically Endangered Vertebrates of India with special reference to West Bengal; Endemic Avifauna of India– IBAs of West Bengal.	

8. Indian case studies on conservation/management strategy; Social forestry: Joint Forest management- Arabari concept.	C.N
9. Wildlife crime; CITES.	
10. Types of conservation: (i) Ex-situ conservation: captive breeding; species reintroduction, species translocation; population reinforcement; (ii) In-situ conservation.	
11. Technologies for Wildlife Research and Management. Tools and techniques for wildlife census and survey. Remote sensing: the basic idea of GIS and GPS and theirapplication in habitat & wildlife conservation.	

CBCS

Course No: *C-ZOO 304: Genetics and Basic and Applied Immunology (CBCS)*

UNIT I: C-ZOO 304.1: Genetics

Syllabus:

TOPICS	TEACHER
1. Sex-chromosome inheritance i) Chromosomal Determination of Sex, X-linked inheritance ii) Pedigree characteristics of Human, X-linked inheritance iii) Nondisjunction as proof of the chromosome theory of heredity iv) Chromosome theory of Heredity *v)* Sex Determination in *Drosophila*	S.G & S.K.B
2. Probability in the prediction of progeny distributions i) Using the binomial distribution in genetics ii) Testing goodness of fit to a genetic hypothesis, The Chi-Square Method	
3. Genetic Linkage and Chromosome Mapping i) Linkage and recombination of genes in a chromosome ii) The Chi-square test for linkage iii) Each pair of linked genes has a characteristics frequency of recombination iv) Genetic Mapping, Map distance and frequency of recombination v) Crossing –over vi) Recombination between genes results from a physical exchange betweenchromosomes	
4. Genetic Mapping in Three-Point Testcross i) Chromosome Interference in double crossovers ii) Genetic Mapping Functions, Genetic Map Distance and physical distance	
5. The central dogma of Life i) Overview of Organisation of DNA in chromosome ii) The basic concept of Replication, transcription and translation	

UNIT II: C-ZOO 304.2: Basic and Applied Immunology

Syllabus:

TOPICS	TEACHER
1. Overview of the immune system: Innate and Acquired immune response	D.P
2. Cells and tissues of immune system: Hemopoietic tissues: Structure & function [Annelida/ Arthropoda/ Mollusca; Chordata (Class-Fish/mammals)], Blood cells: Structure & function	
3. Organs and Immune System Microenvironments: Primary Lymphoid Organs,Secondary Lymphoid Organs	
4. Outline for the Humoral and Cell-Mediated (Cellular) Branches of the ImmuneSystem	J.M
5. Structure and types of Antibody, T- cell receptor, and Major Histocompatibilitycomplex (MHC)	
6. Applied Immunology:- ELISA, RIA, Immunohistochemistry, Vaccination	

Course No: ZOO 395: Practical

Entomology, Ecotoxicology, Molecular Evolution and Microbiology

Syllabus:

TOPICS	TEACHER
1) Entomology a) Collection and preservation of insects b) Study of the behavioral modification of legs in the honey bee. c) Entomological comments on common Pests, Aquatic insects, and Insects of medical and economic importance. Galls & Seed cocoon d) Mounting of sting apparatus & coupling device of Honey bee.	S.K.B
2) Ecotoxicology a) Dose-response curve b) Lethal dose estimation c) MATC in a fish species d) Lethal dose50 mortality curve	
3) Molecular evolution a. Construction of phylogenetic trees b. Hardy-Weinberg law of genetic equilibrium c. Estimation of gene frequency	
4) Microbiology a. Staining and identification of bacteria, endospores, etc., from a culture media. b. Different methods of staining: Gram staining, Negative and differential staining. c. Preparation of different culture media with Sterilization	

techniques. d. Inoculation of microbes to respective culture media through proper culture methods. e. Enumeration of Coliform bacteria using multiple tube fermentation method.	

Special Paper Practical

Course No: ZOO 396B: Ecology Practical-I

(50 Marks, 4 credit)

Syllabus:

TOPICS	TEACHER
1. Preparation of Climograph 2. Estimation of transparency, TSS, TDS, conductivity, hardness, salinity and alkalinity of water. 3. Estimation of N, P, and K content of water/ soil. 4. Basic principle pertaining to acid digestion for the estimation of heavy metals in the watersample. 5. Ecological comments on major biotic components in the Aquatic system 6. Recording/documentation and submission of terrestrial/aquatic faunal components in and localareas – (Collection, preservation, identification and analysis of aquatic biota – phytoplankton, zooplankton, benthos, periphyton, aquatic insects, nekton and macrophytes). 7. Applicability of GPS/GIS in recording bioresources and mapping the landscape. 8. Submission of Laboratory notebook. 9. Field study	C.N

2nd YEAR

SEMESTER- IV

Course No: ZOO 401: Environmental Pollution, Management and Biodiversity and Biostatistics

UNIT I: ZOO 401.1: Environmental Pollution, Management and Biodiversity

Syllabus:

TOPICS	TEACHER
1. Global environmental problems; Bioinvasion-Principles, threats and management	S.G
2. **Environmental pollution**: Types, natural versus man-made; Global scenario.	
3. **Air pollution**: Composition of air, zonations of the atmosphere; classification, properties/behavior and the fate of air pollutants; properties and role of oxides of nitrogen and sulfur as an air pollutant, greenhouse effect and global warming; photochemical smog, acid rains, the impact of pollutants on human health and plants.	
4. **Water pollution**: Classification and behavior of water pollutants, point and non-point pollution, water pollution by agricultural wastes (fertilizers and pesticides); sewage, oil, thermal power plants; and eutrophication.	
5. **Soil pollution**: Soil pollution through agricultural and solid wastes; soil erosion – types and causative agents; Bioinvasion and its environmental impact; Biosafety and its significance.	
6. **Environmental management:** Ecodegradation and pollution; sustainableenvironmental management; indicators of quality of life. Objectives of conservation; world conservation strategies. Biomonitoring. Green movements; traditionalenvironmental knowledge and people's participation.	M.K
7. **Forests and wildlife in India:** Ecological perspectives, the definition of wildlife	

UNIT II: ZOO 401.2: Biostatistics

TOPICS	TEACHER
1. **Concepts of Biostatistics:** Data, population, sample and sampling, frequency distribution, graphical representation of data, parametric and nonparametric statistics	S.K.B
2. **Measures of Central Tendency:** Mean, median and Mode	
3. **Measures of Dispersion:** Range, quartile deviation, mean deviation and standarddeviation, standard error, variance and covariance	
4. **Probability distribution**: Normal distributions, Properties and uses of binomialdistributions and Poisson's distributions	
5. **Set theory and probability**	S.DAS
6. **Testing of Hypothesis**: Null Hypothesis. Level of significance. The error ofinterference and degrees of freedom.	
7. **Analysis of frequencies**: Chi-square test for goodness of fit.	
8. **Student 't' distribution**	
9. **Z test and Fisher's F test**	
10. **Correlation and regression**: Properties and types of correlation. Pearson's product- moment correlation coefficient- properties, assumptions, computation from ungrouped data and significance test. Partial and multiple correlations. Rank correlation Regressions- types and models, simple linear regression – assumption, properties and analysis. Multiple regression.	
11. **Analysis of Variances**: Types and models of analysis of variances. The assumption for ANOVA. One-way ANOVA- computation and interpretation of F ratio, multiple comparison t-test, Scheffe's multiple comparison f-test.	
12. **Nonparametric Tests**	

Course No: ZOO 402: Developmental Biology and Neuroendocrinology

(50 Marks, 4 credit)

UNIT I: ZOO 402.1: Developmental Biology

Syllabus:

TOPICS	TEACHER
1. Early development and molecular mechanism of Amphibian axis formation: Inductive interactions, organization of a secondary axis, the dorsal and ventral signal ofthe organizer, functions of the organizer, epidermal induction.	S.N
2. Regeneration: Regeneration of animals with special emphasis on the process ofregeneration in Hydra and Amphibia.	
3. Beginning a new organism: Fertilization in sea urchins and Mammals, the chemoattraction of sperm and egg, species-specific binding of acrosomal process, the fast and slow block of polyspermy, the role of calcium and egg activation in sea urchins. Translocation and Capacitation in mammals, recognition at zonapellucida, mouse acrosome reaction and gamete fusion	

UNIT II: ZOO 402.2: Neuroendocrinology

Syllabus:

TOPICS	TEACHER
1. Electrical properties of the nerve cell membrane, voltage-gated and ligand-gated ionchannels	D.P
2. Action potential, local circuit, synapses & synaptic transmission, gap junctions.	
3. Ionotropic and metabotropic receptors	
4. Neuropeptides, neuromodulation, neuron vs. NSC	
5. Hypothalamic releasing and inhibiting hormones	
6. Neuroendocrine glands in invertebrates (Insect & crustaceans)	
7. Neuroendocrine integration	
8. Common neural disorders: Alzheimer's and Parkinson's disease	
9. Mechanism of protein and steroid hormone action	
10. Hormone and disease: Type-I and Type-II diabetes, Ordinary and Exophthalmic goiter,Addison's disease	

Course No: ZOO 403B: System Ecology and Human Ecology

(50 Marks, 4 credit)

UNIT I: ZOO 403B.1: System Ecology

Syllabus:

TOPICS	TEACHER
1. Community Ecology: a) Nature of communities; Characterizing Communities; community structure andattributes; b) Levels of species diversity and its measurement; c) Species diversity hypotheses; edges and ecotones. d) Metacommunity concept: Metapopulation structure; Fragmentation;Metacommunity dynamics.	S.G
2. Ecological Restoration: a) Philosophy and types of eco-restoration (ER); Restoration Ecology vs. Conservation Ecology; ER and sustainability; Process of ER; Trajectory; casestudies.	
3. Ecotourism: a) Foundation of ecotourism, Sustainable development and ecotourism,management issues, merits and demerits.	
4. Ecosystem services (ES) and human wellbeing: a) Significance; Categories of ES; Ecological Economics.	

5. Mathematical Ecology: a) Basic concept of ecological modeling; Deterministic and Stochastic models; b) Patterns of Spatial distribution - Random, clumped and uniform coefficient ofdispersion. c) Index of similarity and index of association.	S.K.B
6. System structure and function of some Indian ecosystems: a) Terrestrial system (forest): Ecological processes in Tropical forest ecosystem -Vertical stratification of plants and animals. Production and nutrient cycling. Leaf litter decomposition. Assessment of vegetation health. b) Aquatic system (freshwater). Physiography of freshwater ecosystems, stratification, distributions and mixing patterns. Ecology of Wetland Ecosystems:Water, Substrate, and Life.	

UNIT II: ZOO 403B.2: Human Ecology

Syllabus:

TOPICS	TEACHER
1. Global Environmental Issues; Global warming – climate change; Acid rain; Stratospheric ozone layer destruction; Thermal Inversion – Smog, Point and Non- point pollution – fertilizers and pesticides. Carbon sequestration and landscape change.	S.G
2. Solid waste recycling: Agriculture, Municipal, Biomedical Wastes – nature, source, environmental impact and management. Wastes in ecosystems and management-urban waste, industrial waste, agricultural waste, radioactive waste, medical waste- effects and control.	
3. Environmental Management and Acts: Environmental Impact Assessment:Definition; Types of EIA, EIA process and methodologies – scoping, prediction, evaluation, mitigation and monitoring; Socioeconomic impact assessment; EIA	

Notification. Environmental Management System, Ecomark.	
4. Urbanization: Urban environment – criteria and its present global status, major environmental problems of cities. Urban impact on air and water environment, biodiversity, agriculture; Indoor Pollution – characteristic of the indoor environment, common indoor pollutants, their sources and mode of action; Effect of urbanization on biodiversity.	S.K.B
5. Wasteland and watershed management: Concept – integrated process and mechanism of wasteland restoration and watershed management; Soil erosion – types and factors.	
6. Sustainable environmental management: Roles of traditional knowledge andpeople's participation.	
7. Bioinvasion: Related terminologies; Underlying operating principles; EcologicalConsequences—Case Studies.	

Course No: ZOO 403C: Genetic diseases and Molecular Analysis and Applied Genetics

UNIT I: ZOO 403C.1: Genetic Diseases and Molecular Analysis

Syllabus:

TOPICS	TEACHER
1. Molecular & Biochemical basis of a) **Autosomal Disorders:** Cystic fibrosis, Thalassemia b) **X-linked Disorders:** Hemophilia-A, Muscular dystrophy c) **Metabolic Disorders:** Phenylketonuria, Alkaptonuria d) **Dynamic Mutations:** Huntington's disease e) **Late-onset disorders:** Alzheimer's disease	S.G

2. **DNA Markers in Genetic Analysis:** Restriction Fragment Length Polymorphism (RFLP), Tandem Nucleotide Repeat Marker, PCR-based markers, Random Amplified Polymorphic DNA (RAPD), Amplification of DNAs by the polymerase chain reaction and variations, RT-PCR.	S.D
3. **Protein blotting and Fluorescence:** Western Blotting techniques for the analysis of Proteins. Mechanism of Fluorescence and Phosphorescence, Fluorescence spectroscopy. In situ localization by FISH.	
4. **DNA and RNA Sequencing:** Southern Blotting and analysis of DNAs, Analysis of RNA by Northern Blot; Sanger Dideoxy Sequencing, Second generation DNA sequencing- pyrosequencing.	
5. **Recombinant DNA, Plasmid Cloning Vectors:** Restriction Endonuclease, Recombination of DNA fragments, Plasmid cloning vector and expression vectors; Linker DNA, Homopolymer tailing, Blunt end ligation, Shotgun Cloning, cDNA cloning, cDNA microarray, T-A cloning.	
6. TALEN and CRISPR/Cas9 Genome editing systems, current perspective andapplication.	

UNIT II: ZOO 403C.2: Applied Genetics

Syllabus

TOPICS	TEACHER
1. Genetic changes in differentiation of vertebrate immune cell Genetic control of human antibody, Multigene organization of Ig gene, The mechanism of V(D)J recombination, Bcell and T cell receptor genes and expression.	S.G
2. The Human Genome Initiative: classical tools of positional cloning, identifying genes mutated in Huntington's disease by RFLP, vectors for large-scale genome project, studying and comparing Genomic sequences, Human genome.	

Course No: ZOO 403D: Vector Biology and Vector borne Parasites and Molecular Diagnosis and Clinical Parasitology

Syllabus:

UNIT I: ZOO 403D.1: Vector Biology and Vector-borne Parasites

TOPICS	TEACHER
1. **General concept about vector- mode of transmission**	
2. Biology, importance and control of some vectors a) Mosquito (Anopheles, Culex, Aedes) b) Sandfly c) Fleas d) Ticks e) Mites f) Black fly g) Tsetse fly	D.P
3. **Life cycle, pathogenicity and control of some vector-borne parasite** *Plasmodium, Leishmania, Wuchereria, Babesia*	
4. General idea on Zoonosis and Myiasis	
5. Lice as vectors of human disease: Typhus, Trench fever, Relapsing fever	
6. Climate change: Impact on Vector borne diseases	
7. Laboratory diagnosis of *Wuchereria bancrofti*	

UNIT II: ZOO 403D.2: Molecular Diagnosis and Clinical Parasitology

Syllabus:

TOPICS	**TEACHER**
1. General concept of molecular diagnosis for parasitic infection a) Fundamental techniques used in molecular diagnosis of endoparasites	J.M
2. Parasitic adaptation: Morphological, Anatomical, Physiological, and Biochemical	
3. Biology, clinical and laboratory diagnosis of *Hymenolepis nana, Clonorchis sinensis, Enterobius vermicularis, Dracunculus medinensis, Toxoplasma gondii and Trichomonasvaginalis*	C.N
4. Clinical features of hookworm anaemia	
5. Laboratory diagnosis of Amoebiasis	
6. Xenodiagnosis of Parasites	
7. Parasites as Therapeutic Organisms	
8. Marker molecule-based immunodiagnosis of endoparasites: Immunoassay or serological techniques for laboratory diagnosis of endoparasitesbased on marker moleculeslike *Giardia.intestinalis, Balantidium. coli, Entamoeba. histolytica, Leishmania. donovani,* *Plasmodium sp.* using a) ELISA, RIA b) Counter Current Immunoelectrophoresis (CCI) c) Complement Fixation Test (CFT) d) PCR, DNA, RNA probe e) Indirect fluorescence antibody test f) Rapid test and strip test	

8. Epidemiology: Classification, landscape epidemiology, methods of epidemiological studies a) Epidemiology of Filaria, Kala-azar	S.DAS
9. Antigenic variation in Trypanosomiasis: the perfect camouflage	

Course No: ZOO 494 (Practical):

Environmental Management, Biostatistics, Developmental Biology & Neuro-endocrinology

Syllabus:

TOPICS	TEACHER
1. Biostatistics i. Computation of column statistics ii. Testing of hypothesis: t-test, Z-test, and F test iii. Computation and significance test of product-moment (r) between two continuousmeasurement variables. iv. Computation of simple linear regression. v. One-way Anova and their interpretation.	S.G
2. Developmental biology i. Extraction and identification of different stages of chick embryos (24 hours,48 hours and72 hours) ii. Histological sectioning and staining of different stages of the chick embryo.	S.N
3. Neuro-Endocrinology i. Neuroendocrine structure in invertebrates ii. Endocrine structure in vertebrates iii. Photomicrograph of neurosecretory elements. iv. Neurohistological techniques • Electrical properties of membranes • Single neuron recording, patch-clamp recording, EEG, brain activity recording, lesionand stimulation of	D.P

the brain, pharmacological testing, PET, MRI, CAT • Demonstration of modern neurodiagnostic tools & techniques (EEG, CT-Scan, MRI)	

SPECIAL PAPER PRACTICAL

Course No: ZOO 495B: Ecology Practical-II

TOPICS	TEACHER
1. Estimation of the degree of faunal similarity and association between species. 2. Computation of micro-distribution pattern for spatial distribution. 3. Estimation of alpha, beta and gamma diversity. 4. Analysis of the structure of biotic community: Abundance, Relative abundance, Frequency, Species diversity and Dominance indices; Shannon-Weiner diversity indexand Importance Value Index. 5. Estimation of textural composition and Water Holding Capacity of soil. 6. Evaluation of Restoration sites; Study of forest/vegetation health- Estimation of tree height, DBH, stand density, canopy density and tree biomass 7. Vermitechnology and related matters: Analysis of biota from urban waste materials and identification of suitable specimen for vermicomposting. 8. Air pollution monitoring: demonstration of the operating principles High Volume Sampler 9. Submission of Laboratory notebook. 10. Viva-voce	S.G

Course No: ZOO495C: Genetics & Molecular Biology Practical -II

Syllabus:

TOPICS	TEACHER
1. Study of life cycle of *Drosophila*. 2. DNA isolation and Agarose Gel electrophoresis (from blood and liver tissue) 3. Family pedigree analysis for autosomal /sex-linked, dominant /recessive trait. 4. Isolation & characterization of proteins through SDS-PAGE 5. Western blotting 6. PCR and colony PCR	

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