

UNIVERSITY OF NORTH BENGAL

**M.Sc. SYLLABUS IN ZOOLOGY
Choice Based Credit System
(Implemented from Session 2022-23)**

Detail Syllabus

2022

PG Syllabus in Zoology

FIRST SEMESTER:

Course Type	Course Code		Marks (Theoretical + Class Test)	Credit
CORE (THEORY and PRACTICAL)	CC-101	Functional Biology of Non-chordates	42+8=50	02
	CC-102	Functional Biology of Chordates	42+8=50	02
	CC-103	Insect Biology & Pest Management	42+8=50	02
	CC-104	Ecological Principles and Applications	42+8=50	02
	CC-105	Cell Biology and Genetics	42+8=50	02
	CC-106	Practical Related to CC-101 & CC-102	50	02
	CC-107	Practical Related to CC-103 & CC-104	50	02
	CC-108	Practical Related to CC-105	50	02
DSE (Discipline Specific Elective)	DSE-101	A- Seminar Presentation OR B- Poster Presentation	50	02
AEC	AEC-101	University prescribed course	50	02
FULL MARKS AND CREDITS			500	20

SECOND SEMESTER:

Course Type	Course Code		Marks (Theoretical + Class Test)	Credit
CORE (THEORY and PRACTICAL)	CC-201	Immunology: Organization and Function of Immune System	42+8=50	02
	CC-202	Animal Biotechnology: Tools-Techniques & Applications	42+8=50	02
	CC-203	Biochemistry	42+8=50	02
	CC-204	Fish Biology, Fisheries and Aquaculture	42+8=50	02
	CC-205	Biosystematics	42+8=50	02
	CC-206	Practical Related to CC-201 & CC-202	50	02
	CC-207	Practical Related to CC-203 & CC-204	50	02
	CC-208	Critical analysis of published original research article and review paper (one each)	25+25	01+01
DSE (Discipline Specific Elective)	DSE-201	A- Field Based Biodiversity Study OR B- Preparation and presentation of a research project proposal	50	02
SEC (Skill Enhancement Course)	SEC-201	University prescribed course	50	02
FULL MARKS and CREDITS			500	20

THIRD SEMESTER:

Course Type	Course Code		Marks (Theoretical+ Class Test)	Credit
CORE (THEORY and PRACTICAL)	CC-301	Animal Physiology and Endocrinology	42+8=50	02
	CC-302	Practical Related to CC-301	50	02
	CC-303	Seminar Presentation	50	02
	CC-304	Institutional Visit/Field Studies	50	02
DSE (Discipline Specific Elective) (DSE -301-305)	DSE-301A	Cellular Immunology	A. 60+15=75	03
	DSE-301B	Molecular Immunology		
	DSE-302A	Environment and Chemical Ecology		
	DSE-302B	Environmental Toxicology & Environmental Risk Assessment		
	DSE-303A	Insect Physiology and Communication & Coordination	B. 60+15=75	03
	DSE-303B	Industrial Entomology		
	DSE-304A	Fish Biology and Applied Ichthyology		
	DSE-304B	Fisheries and Hydrobiology		
	DSE-305A	Molecular Cell Biology		
	DSE-305B	Molecular Genetics		
Generic Elective (GE)	GE-301	Techniques in Molecular Biology, Biochemical & Biophysical Methods	75+25=100	04
	GE-302	Biophysics and Biostatistics	75+25=100	04
AEC	AEC-301	University prescribed course	50	02
FULL MARKS AND CREDITS			500	20

N.B.- Student will have to choose any one pair (A+B) course among DSE-301 - DSE-305 and any one course from the GE courses offered.

FOURTH SEMESTER:

Course Type	Course Code		Marks (Theoretical + Class Test)	Credit
CORE (THEORY and Practical)	CC-401	Gamete Biology and Developmental Biology	42+8=50	02
	CC-402	Evolution & Population Genetics	42+8=50	02
	CC-403	Practical related to CC-401	50	02
	CC-404	Comprehensive Viva Voce	25	01
	CC-405	Dissertation/Review	50	02
DSE (Discipline Specific Elective) (DSE -301- 305)	DSE-401	Clinical Immunology and Immunotechnology	60+15=75	03
	DSE-402	Chronobiology, Behavioural Ecology & Environmental Biotechnology		
	DSE-403	Insect Pests & Vectors and their Management		
	DSE-404	Fish Technology		
	DSE-405	Molecular Cell Biology & Genetics		
	DSE-406 (A to E)	DSE Related Practical Courses	50	02
Generic Elective (GE)	GE-401	Environment and Public Health	75+25=100	04
	GE-402	Wildlife Conservation, Biodiversity & Taxonomy	75+25=100	04
SEC (Skill Enhancement Course)	SEC-401	University prescribed course	50	02
FULL MARKS AND CREDITS			500	20

N.B.- Student will have to choose one course from DSE-401 - DSE-405 and any one course from the GE courses offered.

Question Pattern:**Two Units for Each Theoretical Paper. Each Unit will have following Pattern.**

- Objective/MCQ Type: $1 \times 3 = 03$ (Answer any Three out of Five)
- Short Answer Type: $2 \times 3 = 06$ (Answer any Three out of Five)
- Descriptive Answer Type: $6 \times 2 = 12$ (Answer any Two out of Four)

Total Marks: 21

Two Units for Each Theoretical Paper of DSE course in 3rd and 4th Semester. Each Unit will have following Pattern.

- Objective/MCQ Type: $1 \times 4 = 04$ (Answer any Four out of Six)
- Short Answer Type: $2.5 \times 4 = 10$ (Answer any Four out of Six)
- Descriptive Answer Type: $8 \times 2 = 16$ (Answer any Two out of Four)

Total Marks: 30

Two Units for Each Theoretical Paper of GE course in 3rd and 4th Semester. Each Unit will have following Pattern.

- Objective/MCQ Type: $1 \times 4 = 04$ (Answer any Four out of Six)
- Short Answer Type: $3.5 \times 5 = 17.5$ (Answer any Five out of Eight)
- Descriptive Answer Type: $8 \times 2 = 16$ (Answer any Two out of Four)

Total Marks: 37.5

**M.Sc. in Zoology Programme:
FIRST SEMESTER**

CORE COURSE THEORY

CC-101: Functional Biology of Non-chordates

Course credit: 02

Unit-1: Functional Biology of Maintenance Systems

Marks 21

1. Nutrition and Digestion:
 - a) Source of nutrition, optimal foraging theory and its categories related to structure of feeding organs
 - b) Feeding patterns in non-chordates
2. Respiration:
 - a) Abiotic and biotic factors associated with respiration, uptake of oxygen, respiratory pigments in non-chordates
 - b) Mechanism of respiration by gills, book lungs and tracheae
3. Excretion:
 - a) Excretory products, structures, mechanisms and metabolic economy of excretion in non-chordates
 - b) Osmoregulation in non-chordates

Unit-II: Functional Biology of Support, Control & Development System

Marks 21

1. Locomotion:
 - a) Locomotory structures; Amoeboid, Flagellar and Ciliary movements; hydrostatic movement in Cnidaria, Annelida and Echinodermata
 - b) Significance of segmentation with reference to locomotion
2. Nervous system:
 - a) Primitive and advanced type of Sensory and Nervous system
 - b) Trend of neural evolution in Non-chordates
3. Non-chordate larva:
 - a) Types, structure and organization of non-chordate larval forms
 - b) Evolutionary significance of larval forms

CC-102: Functional Biology of Chordates

Course credit: 02

Unit-I: Functional Biology of Chordates-I

Marks 21

1. Basic vertebrate body plan and characteristics
2. Form-function analysis
3. Mechanics of body support and movement
4. Ectothermic and Endothermic mode of life
5. Aerodynamics of soaring, gliding and parachuting and active flying
6. Auditory system: Structure, evolutionary changes and adaptive advantage
7. Organs and cells of olfaction and taste

Unit-II: Functional Biology of Chordates-II

Marks 21

1. Respiratory system and its functional requirements; ventilator mechanisms in chordates.
2. Heart and circulation in chordates.
3. Functional and evolutionary significance of digestive system; foregut vs. hindgut fermentation in mammals.
4. Overview of Skull Morphology: Chondrocranium, Splanchnocranium and Dermatocranium); cranial kinesis in fish, reptiles, birds; intracranial mobility in feeding mechanisms.

5. Vertebrate nervous system; functional association of CNS and information processing, evolution of cerebrum, cerebellum and vertebrate brain; structure and function of limbic system and reticular formation.

CC-103: Insect Biology and Pest Management

Course credit: 02

Unit I: Insect Biology

Marks 21

1. Insect Classification – Major order with characters and examples
2. Nutritional physiology and ecology
3. Reproductive strategies in insects
4. Insect Development and Metamorphosis
5. Dealing with environmental extremes
6. Insect Predation, Parasitism and Defence

Unit II: Insect Pest Management

Marks 21

1. Concept of pest status, reason for becoming pest and classification of Pesticides
2. Introduction to major pests and vectors of medical, veterinary and agricultural importance from India and their Control
3. Influence of climate and environment change on insect & mite pests
4. Pest Forecasting, Assessing of Crop damage and Protection
5. Methods of insect pest and vector control: Conventional and Non-Conventional
6. Concept of Integrated Pest Management (IPM); Integrated Resistance Management (IRM).

CC-104: Ecological Principles and Applications

Course credit: 02

Unit-I: Ecology and organism- I

Marks: 21

1. **Principles and concepts pertaining to limiting factors, habitat and niche:** Liebig's law of the minimum, Shelford's Law of tolerance, law of limiting factors, factor compensation and ecotypes, combined concept of limiting factors, habitat and microhabitat, development of niche concept, niche width, niche overlap, diffuse competition, niche dynamics, ecological equivalents, character displacement, sympatry, allopatry.
2. **Community Ecology:** Biotic community concept, ecological dominance, community analysis, species diversity, ecotone and edge effects, community analytics.
3. **Population Ecology:** Growth patterns, dynamics, life table, survivorship curve, doubling time, natality, mortality, age distribution, intrinsic rate of natural increase, oscillation, regulation, dispersal, concept of metapopulations.

Unit-II: Ecology and organism- II

Marks: 21

1. **Aquatic Ecology:** Characteristics, limiting factors, nutrient status, classifications of aquatic organisms, lentic communities, lotic communities, zonation of aquatic bodies.
2. **Terrestrial Ecology:** Terrestrial environment, terrestrial biota, bio-geographic regions, structure of communities, soil subsystem and vegetation subsystem.
3. **Wildlife Ecology:** Wildlife biology – an overview, food, nutrition and water requirements and cover, wild life census techniques: line transect method, pug mark analysis, basic concept of radio and satellite telemetry in monitoring wild animals.
4. **Behavioural Ecology:** Proximate and ultimate reasoning, animal communication, altruism and reciprocal altruism; kin selection

CC-105: Cell Biology and Genetics**Course credit: 02****Unit-I: Cell Biology****Marks 21**

1. Genome Organization: (i) Prokaryotes, (ii) Eukaryotic Chromosomes, Centromere, Telomere, (iii) Sequence organization of Non-coding DNA in Eukaryotes, (iv) Reassociation kinetics and genome complexity, C-value paradox, G-value Paradox
2. Cell Cycle: (i) Phases and Cell Cycle Control, (ii) Check points and DNA Damage Response (Sensor, mediator, Effector, Regulator) and regulation (iii) Regulations of Meiosis
3. Transcription in Eukaryotes: General transcription factors, RNA Polymerases, Mechanism of transcription, Splicing, Exon and Intron
4. Definition, Transcription Coupled Repaired & XP
5. Translation in Eukaryotes: tRNA, rRNA and mRNA, tRNA synthetase, Mechanism of Translation, Post translational modifications
6. Cell Surface Molecules: (i) Ca²⁺ dependent cell-adhesion molecule (ii) Ca²⁺ independent cell-adhesion molecules, (iii) ECM, Integrins, (iv) Connexins, (v) Cell Signaling
7. Apoptosis: (i) Definition and features of apoptic cells, Anoikis, Necrosis (ii) Mechanism and apoptotic pathways: Receptor mediated and Mitochondria mediated pathways, Apoptosis and Disease
8. Extracellular organelle: Mitochondrial DNA
9. Cytogenetic Techniques: C-banding, G-banding, Q-Banding, NOR Banding, R-Banding

Unit-II: Genetics**Marks 21**

1. Gene Concept: (i) Overview of Mendelism (ii) One gene one polypeptide hypothesis, (iii) Complementation Test, Concept of Cistron: Benzer's experiment and Mutoon & Recon, (iv) Modern view
2. Recombination: (i) Concept of homologous recombination, Gene Conversion (ii) Site Specific Recombination: Ser/Tyr recombinases & mechanism of action (iii) FLP-FRT and Cre-lox systems and applications in gene analysis.
3. Microbial genetics: Transformation, Conjugation, Sexduction and Transduction,
4. Gene Regulation: (i) Operon and regulon, (ii) Lytic and lysogeny in Bacteriophage (iii) Methylation & Gene regulation (Brief idea)
5. Mobile genetic elements: (i) IS elements, transposons (Prokaryotes and eukaryotes), Sleeping Beauty (ii) Retroelements, LINES and SINES, (iii) Mechanism of Transposition, (iv) Exon-Shuffling, Lateral Gene transfer, v) Hybrid dysgenesis, Germ line transformation by P-element,
6. Gene mapping: (i) Three point test cross, (ii) Southern hybridization, Northern hybridization, *In situ* hybridization, FISH, (iii) Somatic Cell hybridization and gene mapping, iv) Molecular Marker: RFLP, RAPD, AFLP, SNP
7. Molecular Diagnosis and Genetic Screening: Sickle-cell anemia, Cystic fibrosis.

CORE COURSE PRACTICAL**CC-106: Non-chordate and Chordate****Course credit: 02**

1. Mounting of protozoan gut parasites from cockroach /Toad.
2. Mounting of gut nematode of fish /Toad.
3. Study of Setae and Spermatheca of *Eisenia*.
4. Mounting and identification of economically important Arthropods: (i) *Cyclops*, (ii) *Daphnia*
5. Key preparation to different categories of Non-chordate specimen (up to Sub-class/order) with typical examples.
6. Location and extraction of pituitary gland of a carp (market specimen)
7. Accessory air-breathing organs of *Anabas/Clarias/Heteropneustes* (market specimen)

8. Gallus head (market specimen): 5th and 7th cranial nerves
9. Preparation of key to different categories of Chordate specimens up to orders (preferably considering one typical specimen of each order).

CC-107: Insect Biology and Ecology

Course credit: 02

1. Study of insect mouthparts/legs/antennae.
2. Study of insect developmental studies (hemimetabolan/holometabolan)
3. Measurement of Insect diversity/richness/abundance
4. Determination of Lethal Dose/Concentration of Insecticides
5. Water Analysis – Estimation of dissolved oxygen; free carbon dioxide; total alkalinity; total hardness and chloride.
6. Soil analysis – Estimation of percentage of calcium carbonate by rapid titration method; estimation of Organic-carbon by wet oxidation method
7. Estimation of phyto- and zoo-planktons of fish ponds/streams.
8. Determination of requisite size of quadrat by species area curve.
9. Comments on Ecological specimens and Limnological apparatus.

CC-108: Cell Biology and Genetics

Course credit: 02

1. Study of mitosis from root tip of *Allium cepa*.
2. Study of meiosis from grasshopper testes.
3. Study of mitosis and meiosis of Rat/mouse by Flame dry method
4. Karyotype preparation (Human)
5. Study of Barr body preparation
6. Study of polytene chromosome from the salivary glands of *Drosophila*
7. Study of common mutants in *Drosophila*, *Drosophila* food preparation.
8. Detection of ABO Blood groups and determination of gene frequencies in human population
9. Genomic DNA extraction. Quantitation of DNA by UV-spectrophotometer
10. Electrophoretic separation of Protein and DNA (Demonstration)

CONTINUING EVALUATION (CE)

CE-101 – 105 (Class Test)

Marks 8 x 5=40

Discipline Specific Elective (DSE)

DSE-101: A- Seminar Presentation
OR
B- Poster Presentation

Marks 50

Course credit: 02

ABILITY ENHANCEMENT COURSE

AEC-101: University prescribed

Marks 50

SECOND SEMESTER

CORE COURSE THEORY

CC-201: Immunology: Organization and Function of Immune System Course credit: 02

Unit-I: Organization of Immune System Marks 21

1. Properties and overview of Immune Responses, Concepts for Understanding the Mammalian Immune Response, Concept of Inappropriate or Dysfunctional Immune Responses.
2. Cells, Organs, and Microenvironments of the Immune System, Primary and secondary Lymphoid Organs.
3. Immunogen characteristics, Antigenic determinants in antibody, B-Cell and T-cell Antigen.
4. Antibody: Structural Features of Antibody molecule, Synthesis, assembly and expression of Ig molecules, Antibody diversity.
5. Complement, Major Pathways of Complement Activation, Functions of Complement system, Regulation of Complement Activity.

Unit-II: Function of Immune System Marks 21

1. Lymphocyte activation, Two-Signal Hypothesis, Helper CD4 T-Cell Differentiation, T-Cell Memory.
2. Concept of Major Histocompatibility Complex of mouse and human, Antigen processing and presentation, Structure and Function of MHC Class I and II Molecules,
3. Cytotoxicity, Cytotoxic T Lymphocytes and Natural Killer Cell Activity.
4. Cytokines, Interferons.
5. Concept of tolerance and autoimmunity.
6. Concept of Hypersensitivity reactions.

CC-202: Animal Biotechnology Course credit: 02

Unit-I: Tools and Techniques Marks 21

1. Recombinant DNA technology: Restriction endonucleases, Vectors, Cloning strategies, selection of recombinant DNA, DNA sequencing: Sangers method and NGS (brief idea), PCR, Genomic and cDNA libraries: constructions and screening
2. Expression Vectors and expression of fusion proteins; protein purification strategies
3. Site directed mutagenesis: strategies and prospects

Unit-II: Applications Marks 21

1. Transgenic Animals: production, prospects, advantages and disadvantages
2. Applications of recombinant DNA technology in human gene therapy, vaccine development, environmental bioremediation and protein engineering
3. Microbial synthesis of commercial products, restriction endonucleases, antibiotics, vitamins, amino acids and industrial dyes

CC-203: Biochemistry Course credit: 02

Unit-I: Structure and Function Marks 21

1. Amino Acids, Protein structure and function
2. Enzymes: Kinetics, function, inhibition and regulation; Ribozymes and Deoxyribozymes
3. Coenzymes and vitamins
4. Carbohydrates: Structure and functions
5. Lipids: Storage lipids, Structural lipids in membranes, Lipids as signals, cofactors and pigments

Unit-II: Bioenergetics and Metabolism**Marks 21**

1. Bioenergetics: Principle of bioenergetics, Glycolysis and its regulation, Citric acid cycle and its regulation,
2. Oxidative Phosphorylation, Electron-transfer reactions in mitochondria.
3. Biosynthesis: Biosynthesis of Carbohydrates, Lipids, Amino Acids and Nucleotides.
4. Amino Acid and Fatty acid catabolism.
5. Bio-transformations: Principle of detoxifications, Detoxifying enzymes, Phase I and Phase II reactions.

CC-204: Fish Biology, Fisheries and Aquaculture**Course credit: 02****Unit I: Fish Biology and Fisheries****Marks 21**

1. Overview of fish classification.
2. Definition, scope, importance and types of fisheries
3. Fish reproduction: Hypothalamo-hypophyseal-gonadal-liver axis; chronobiological events in the fish ovary, maturation of oocyte, hypophysation technique and induced breeding in fish.
4. Concept of ornamental fisheries; specific diseases and their cures.
5. Coldwater/Hill stream fishery, definition, characteristics of cold water/ Hill stream bodies, Adaptations of cold water/ Hill stream fishes.
6. Culture of Larvicidal fishes. Characters and importance
7. Sewage-fed Fisheries

Unit II: Aquaculture**Marks 21**

1. Fish culture: Physico-chemical factors associated with aquaculture; biota of pond water; carrying capacity of water body;
2. Types of pond culture.
3. Traditional, extensive, semi-intensive and intensive fish culture.
4. Concepts of different systems of aquaculture with their definition, objectives, principle and prospects; Monoculture; Mono-sex culture, Composite fish culture, Integrated fish farming, Integrated Fish Farming with Live Stock, Cage culture, Raceway culture.
5. Control and management of aquatic weeds, insects and predatory fishes in aqua farms.
6. Mariculture – Definition, scope and types.
7. Biofloc farming: Definition and scope.

CC-205 BIOSYSTEMATICS**Course credit: 02****Unit-I: Biosystematics-I****Marks: 21**

1. Taxonomy and Systematics, Role of Taxonomy, Stages of Taxonomy, Importance of taxonomy.
2. Application of biosystematics (In war, pest & disease management and resource generation etc.)
3. Species Concept
4. Linnean hierarchy, Category, Supra- and infra-specific categories
5. Taxonomic Characters and character states
6. Zoological classification, rules and criteria of zoological classification, identification, functions of classification, homology, analogy and homoplasy
7. Zoological nomenclature; application of important rules

UNIT-II: Biosystematics-II**Marks: 21**

1. Taxidermy and preparation of specimens for taxonomic purpose
2. Identification and keys
3. Phenetics and cladistics, holophyly, monophyly, polyphyly and paraphyly, Weighting and

anagenetic analysis

4. Molecular systematics: Cytotaxonomy, RFLP, PCR and DNA sequencing data, Barcoding
5. Molecular Phylogeny, phylogenetic trees: Cluster (UPGMA), Neighbor joining method & cladistic methods, parsimony and maximum likelihood method
6. Bioinformatics tools in systematic.

CORE COURSE PRACTICAL

CC-206: Immunology and Biotechnology

Course credit: 02

1. Collection of plasma and serum
2. Study of lymphoid organs *in situ*
3. Determination of antibody titre by Haemagglutination test
4. Preparation of lymphocytes suspension from solid lymphoid tissues
5. Separation of immune-reactive cell types and viability test, fixation, staining and identification
6. Electrophoresis for separation of plasma proteins, Ig classes (demonstration).
7. Bacterial Culture: Agar plate, slant, liquid media and culturing of bacteria in different media types (solid and liquid)
8. Transformation of *E. coli* with plasmid (demonstration)
9. Plasmid isolation: Boiling miniprep method only
10. Electrophoretic analyses of uncut and linearized plasmids.

CC-207: Biochemistry, Fish Biology, Fisheries and Aquaculture

Course credit: 02

1. Estimation of sugars by Somogyi Nelson method.
2. Estimation of proteins by Folin Lowry method.
3. Estimation of saponification Values of Oils and Fats.
4. Electrophoretic study of proteins by SDS-PAGE
5. Physico-chemical parameters of water.
6. Study of bucco-pharyngeal region, gill-rakers of fish.
7. Studies on haematological parameters of fish blood.
8. Identification of different fishes
9. Limnological apparatus.

CC-208 Critical analysis of published original research article and review paper (one each)

Course credit: 02
Marks: 25+25

CONTINUING EVALUATION

CE-201 – 205 (Class Test)

Marks 8 x5=40

Discipline Specific Elective

DSE-201: A- Field Based Biodiversity Study

Marks: 50
Course credit: 02

OR

B- Preparation and presentation of research project proposal

SEC-201(Skill Enhancement Course): University prescribed

Marks: 50
Course credit: 02

THIRD SEMESTER

CORE COURSE THEORY

CC-301: Animal Physiology and Endocrinology

Course credit: 02

Unit I: Animal Physiology

Marks: 21

1. Respiration: Respiratory pigments; Structure of Hemoglobin in human, Positive cooperative binding and Oxygen dissociation curves of hemoglobin, Transport of oxygen and carbon dioxide; Bohr effect, Root effect & Haldane effect.
2. Excretion: Concept of excretory organs in animals, Structure and function of kidney in mammals, structure of nephron, Formation of hypertonic and hypotonic urine, Obligatory Urine Volume, Counter current mechanism, Osmolar Clearances and Free Water Clearances.
3. Osmoregulation: Control of Extracellular Fluid Osmolarity and Sodium Concentration, osmoreceptor-ADH system and thirst mechanism, Angiotensin II and Aldosterone in Controlling Extracellular Fluid Osmolarity and Na⁺ Conc., Osmoregulation in aquatic animals.
4. Neurotransmitters: Classification, synthesis, release, distribution and functions.
5. Synaptic Transmission of Nerve Impulse: Types of synapses, Mechanisms of storage and release of neurotransmitter in synaptic cleft, mobilization of synaptic vesicle and attachment presynaptic and postsynaptic membrane, excitatory postsynaptic potential, inhibitory synaptic transmission, neuromodulatory transmission, Inactivation of neurotransmitter.
6. Adaptation: (i) The nature and levels of adaptation, (ii) Fundamental mechanisms of adaptation
7. Thermoregulation: Mechanism of thermoregulation, Concept of Temperature Coefficient (Q₁₀); Adaptations to cold and heat by aquatic & terrestrial animals; Adaptive Hypothermia and Adaptive Hyperthermia; Thermal Neutral Zone; Thermogenesis, Evaporative cooling. Aestivation and hibernation.
8. Physiology of cardiovascular system: Characteristics of vertebrate cardiac muscle. Initiation, conduction and regulation of heart beat. Cardiac cycle and cardiac output. Regulation of cardiac amplitude and frequency. ECG and myocardial infarction. Blood pressure and its regulation, Concepts of haemodynamics

Unit-II: Endocrinology

Marks: 21

1. Mechanism of hormone action: Protein hormones and steroid hormones, hormone receptors and their specificity, number and distribution, G-proteins and control of adenylate cyclase, Cyclic AMP cascade and intracellular actions, MAPK cascade, JAK-STAT and Ca²⁺/DG messenger pathways.
2. Neuro-endocrine integration: Components, orders and feedback regulation.
3. Pituitary gland: Anatomy of pituitary gland, phylogeny of vertebrate pituitary gland, cell types, hormones; chemical structures, regulation of secretion, mode of action and its functions; dysfunctions.
4. Thyroid gland: Anatomy of thyroid gland; development and shape of thyroid gland in vertebrates; synthesis of thyroid hormones, function of sodium-iodide symporter, pendrin, thyroid peroxidase etc.; mode of action thyroid hormones, function of thyroid hormones, thyroid hormone dysfunction.
5. Parathyroid gland: Parathyroid hormone (PTH) source, Actions of PTH on bone and on the kidneys, PTH, 1,25(OH)₂D and Ca²⁺ homeostasis, PTHrp, Calcitonin (CT), endocrine regulation of intestinal Ca²⁺ absorption, Renal Ca²⁺ reabsorption, and bone resorption.
6. Adrenal gland: Structural/functional zonation of the mammalian adrenal gland, pathophysiologic effects associated with mineral imbalance, renin-angiotensin-

aldosterone system (RAAS), Addison's-like disease, Cushing's disease, catecholamine biosynthesis, release and its physiological roles.

7. Endocrine pancreas: Biosynthesis and physiological actions of Insulin and Glucagon, Regulation of blood sugar, GLP-1, and also its effects on insulin and glucagon secretion.
8. Hormones and reproduction: Male and female hormones and their functions, bio-synthesis, structure of steroid receptor, mechanism of action, endocrine pathophysiology.
9. Pineal gland and its bio-regulators: Anatomy and photo-responsive character of pineal gland, evolution of the pineal organ in vertebrates, melatonin hormone, biosynthesis, environmental regulation, function of melatonin.

CORE COURSE PRACTICAL

CC-302: Animal Physiology and Endocrinology

Marks: 50
Course credit: 02

1. Determination of haemoglobin percent, C.T. and B.T. in human blood
2. Estimation of blood Sugar.
3. Biochemical estimation of blood Cholesterol.
4. Measurement of pulse rate and blood pressure in human
5. Total count of RBC and WBC in human blood;
6. Differential count of human blood
7. Estimation of Amino-N by Sorenson's Formol Titration method
8. Quantitative estimation of Ascorbic acid
9. *In situ* studies of endocrine organs in mice or rat
10. Histological studies of endocrine glands in rat/mice

CC-303 Seminar Presentation

Marks: 50
Course credit: 02

CC-304 Institutional Visit/Field Studies

Marks: 50
Course credit: 02

Discipline Specific Elective (DSE)

Students shall have to choose any one pair (A+B) course among **DSE-301 - DSE-305**

DSE-301A: Cellular Immunology

Course credit: 03

Unit-I: Cellular arsenals of Innate and Adaptive Immunity

Marks: 30

1. Innate Immunity: Innate Lymphoid Cells, Cellular Innate Response Receptors and Signalling, Recognition of microbes of and damaged self by the innate immune system.
2. Differentiation and maturation of B cells, Lineage Commitment, Generation of antibody diversity. Activation and Regulation.
3. Differentiation and maturation of T cells, Lineage Commitment, positive and negative selection, Generation of receptor diversity. Activation and Regulation.

Unit-II: Functional regulation of Cellular Immunity

Marks 30

1. Tolerance & Autoimmunity. Establishment and Maintenance of Tolerance, What Causes Autoimmunity? Examples of some Autoimmune Diseases.

2. Hypersensitivity Disorders, Types of hypersensitivity reactions, mechanism of hypersensitivity development, selected immunologic hypersensitivity diseases, therapeutic approaches.
3. Neuro-Immunology: Glial cells, Hypothalamic-Pituitary-Adreno cortical Axis (HPA) immune system interaction.

DSE-301B: Molecular Immunology

Course credit: 03

Unit-I: Molecular components of immune system

Marks 30

1. Antigen: Physical and chemical nature, structure, antigenic determinants, Structural and Chemical Basis of Antigen Binding.
2. Antibody: Three-dimensional structure, subclasses, binding forces of antigen and antibody, diversity.
3. Complement system, Major Pathways of Complement Activation, Function and Regulation of Complement Activity, Complement Deficiencies. Microbial Complement Evasion Strategies, Evolutionary Origins of the Complement System.
4. Cytokines: Receptors and Signaling, Cytokine Antagonists.

Unit-II: Molecular Organization of MHC and Transplantation Immunology

Marks: 30

1. Organization of MHC in mouse and human, Polymorphism, Antigen presentation and MHC restriction.
2. Transplantation Immunology, general principles; activation of alloreactive B Cells and production and functions of alloantibodies. Methods to Reduce the Immunogenicity of Allografts.
3. Elements of barrier immunity, Immunology of Mucosa and Skin.

DSE-302A: Environment and Chemical Ecology

Course credit: 03

Unit-I: Environmental Geology and Earth's Processes

Marks 30

1. Environmental Geology: Scope and necessity, origin of the earth, earth systems and its interaction with - lithosphere, atmosphere, hydrosphere and biosphere, earth's materials - minerals and their distribution and abundance in the Earth's crust, formation and classification of rocks, soil - characteristics, formation of soil, erosion and conservation.
2. Earth's Processes: Endogenic and exogenic processes: earthquakes, tsunami and volcanism. Geological agents: river, Wind, Glaciers and Ocean action. Floods, landslides, cyclone and avalanche, classification of trace elements, mobility of trace elements, geochemical cycles. Human use of trace elements and health.

Unit-II: Natural Resources and Chemical Ecology

Marks 30

1. Mineral resources and environment: Resources and reserves, depletion trends of natural resources, environmental impact of exploitation, land use planning- environmental aspects of terrain evolution, geological features of India.
2. Chemical Ecology: Pheromones, allelochemicals and environment, semiochemicals, biochemical basis of food and water selection by animals, feeding attractants and stimulants, endocrine disruptors - hypothesis, mechanism of action, environmental consequences.

DSE-302B: Environmental Toxicology and Environmental Risk Assessment

Course credit: 03

Unit-I: Environmental Toxicology

Marks 30

1. Basic concepts of environmental toxicology: Introduction to environmental toxicology, scope of environmental toxicology, description and terminology of toxic effects, factors influencing toxicity, dose response relationship-graded response time action curves, LC₅₀ LD₅₀, threshold limit value, physico-chemical analysis of soil and water bodies.
2. Toxicant uptake and mode of action of toxicants: Route of toxicant uptake (skin, lungs, gills, digestive system), uptake at the tissue and cellular level, single and double-compartment models, toxicity at the molecular level (carcinogenesis, genotoxicity assays, chromosome studies), acute and chronic toxicity, toxicity due to heavy metals, hydrocarbons, pesticides, food additives, drugs and radiation, bioconcentration, bioaccumulation and biomagnification of toxic materials in food chain, eutrophication, effect on biota, dissolved oxygen, BOD, COD, oxygen sag curve, bioassay techniques.

Unit-II: Defense Responses and mitigation

Marks 30

1. Defence responses to toxicants: Role of cytochrome P450 and its multiple forms, xenobiotics – biotransformation and degradation, biological and biochemical markers, tolerance and resistance to potentially toxic substances.
2. Environmental risk assessment and mitigation strategies: Basic components of a risk assessment, use and importance of ecological risk assessment, frameworks for ecological risk assessment, case studies of environmental risk assessment and sustainable development, green chemistry.

DSE-303A: Insect Physiology and Communication & Coordination

Course credit: 03

Unit I: Insect Physiology

Marks 30

1. Insect midgut biology; Fat body
2. Insect Circulation: Haemolymph, Haemocytes and Haemoglobin
3. Insect integument and development system, Diapause,
4. Excretion, homeostasis and detoxification
5. Insect Immunity

Unit II: Insect Communication and Coordination:

Marks 30

1. Insect signaling; Insect hormones: Sources, biosynthesis, transport, mode of action and regulation of their titers
2. Perception of the environment
3. Intra-specific and inter-specific chemical and mechanical communications in insects
4. Insect symbiosis
5. Insect flight and migration

DSE 303B: Industrial Entomology

Course credit: 03

Unit I: Culture of Insects

Marks 30

1. Sericulture: Tasar, Eri and Muga Culture; voltinism and moultinism.
2. Breeding strategies of Mulberry silkworms & its diseases and enemies
3. Honey bee: Role in Pollination and production of honey, propolis and bee-wax; Extraction and preservation of honey
4. Beekeeping in India; Disease and enemies of honey bee
5. Lac culture: Insect, host plant; lac harvesting and processing

Unit II: Uses of Insects**Marks 30**

1. Insect as Food and Feed for man, fish, poultry
2. Entomoceticals and insect based dye
3. Decomposition by insect and Insect aesthetics
4. Entomophily, Insect & mites as natural enemies of Weeds and Plant pests
5. Mass production of insect biocontrol agents

DSE 304A: Fish Biology and Applied Ichthyology**Course credit: 03****Unit I: Fish Biology****Marks 30**

1. Principles of fish classification with distinctive characters of major fish orders.
2. Epidermis and exoskeleton; integuments, cells, scale, colouration, fins, bioluminescent organ, electric organs and electroreception and electrolocation, poison gland
3. Internal structures; swim bladder, sound production, auditory function, Weberian ossicles, Eye and photoreception, olfactory organ, and chemoreception, acoustico-lateralis system (membranous labyrinth and lateral line), special sense organs (Ampullae of Lorenzini, Pit Organs).
4. Fish Endocrinology: Hypothalamo-hypophyseal system, pituitary, thyroid, Adrenal gland, Corpuscles of Stannius, Ultimobranchials, Caudal neurosecretory system, gastrointestinal hormones, pineal organ.
5. Fish Reproduction: Structure and functions of reproductive organs, gametogenesis, types and modes of reproduction, role of melatonin in oocyte growth, MIH-induced oocyte maturation, and action of synthetic hormones in induced breeding.
6. Biology of some commercially importance freshwater and marine water fish and shellfish.

Unit II: Applied Ichthyology**Marks 30**

1. Somatic growth of fish: Measurement, patterns, role of nutrition in fish growth, food conversion and efficiencies, factors affecting the growth and methods of determination of growth and age.
2. Food and feeding habit: Alimentary canal, its modifications and digestion
3. Fish nutrition: Supplementary feeding; different kinds of processed feeds; feed ingredients and feed formulation; different types of fish feeds; food energy; probiotics, prebiotics, feeding schedules, feed dispensing methods.
4. Fish diseases and their control: Fungal, bacterial, parasitic (protozoan, helminths, crustaceans, annelid, molluscan, endoparasitic), viral diseases, ideas on non-parasitic (asphyxiation / gas disease / Air embolism, Dysentery or nutritional disorder, swim bladder problem) and epizootic ulcerative syndrome (EUS).
5. Fish migration: Purpose and types of migration in fish, diadromous migration, physiological factors controlling iono- and osmoregulation, energetics, environmental, factors, anthropogenic impacts.
6. Aquaponics and hydroponics: Definition and scope.

DSE 304B: Fisheries and Hydrobiology**Course credit: 03****Unit-1: Fisheries****Marks 30**

1. Inland fisheries resource: Riverine fisheries, The Ganga river system, The Brahmaputra river system, The east coast river system, The west coast river system, The Indus river system, reservoir fisheries, cold water fisheries of lakes.
2. Estuarine Fisheries: Open estuaries, Embanked estuaries, principal fisheries of brackish water.
3. Marine fisheries: resource, coastal fisheries, factor influencing fish production along the west and east coast, exclusive economic zone.
4. Fish toxicants

Unit 2: Hydrobiology**Marks 30**

1. Limnological factors associated with aquaculture
2. Spawning pond/pool, hatching pits/hapa, nursery pond; rearing pond; growing pond or stocking pond; kinds of fish culture.
3. Detailed knowledge of different systems of aquaculture of fishes and shellfishes.
4. Waste water management through aquaculture

DSE-305A: Molecular Cell Biology**Course credit: 03****Unit I: Molecular Cell Biology-I****Marks: 30**

1. Cell/Tissue culture techniques: i) Culture media, Properties, and preparation, ii) Primary cell culture, cell lines, Lymphocyte culture, Fibroblast culture, iii) Isolation of clones & Genetic variants, iv) Transformation of cell, v) Cell separation by FACS, Application of Cell culture, Spectral Karyotyping, cell imaging.
2. Heterochromatin: organization and function, giant chromosomes (polytene chromosomes), position effect variegation
3. DNA Replication; Chromosome end replication problem; Telomere shortening and its replication
4. Transcription: i) Regulatory elements, DNA binding motifs of transcription factors, ii) Activators and Repressors of transcription, RRM iii) degradation of mRNAs and regulation
5. Translation: Regulation, chaperone and chaperonin, Protein degradation and regulation

Unit II: Molecular Cell Biology-II**Marks: 30**

1. Cell-cell signalling: i) Cell surface receptors, ii) G-protein coupled receptors, Signal amplification, iii) Signalling pathways that control gene expression - Cytokine receptor and JAK-STAT pathway, MAP kinase pathway, RTK and RAS Pathways, Phosphoinositide Signaling: PLC γ iv) Signaling pathways controlled by ubiquitylation, peptide degradation, protein cleavage (Notch/Delta, SERBP) v) Integration of Cellular Responses to Multiple Signaling Pathways: Insulin Response
2. Stem Cell: Biology, Dynamic function of stem cell, Genetic regulation of stem cell and its application (stem cell therapy)
3. Differentiation of muscles and regulation, Duchenne muscular dystrophy, Becker's muscular dystrophy.
4. Biology of aging: cellular and molecular basis of aging and its genetic control

DSE-305B: Molecular Genetics**Course credit: 03****Unit I: Molecular Genetics-I****Marks: 30**

1. Patterns of Inheritance: Mendelian inheritance, Family studies, Multiple alleles and Complex traits, triallelic disorder, Anticipation, Uniparental disomy.
2. Multifactorial and polygenetic inheritance, Susceptibility genes, Transmission disequilibrium traits, heritability.
3. Epigenetics and diseases
4. Molecular Pathology: Concept, Pathogenic mutation, Loss of function mutations, Gain of function mutation, Gene to disease approach, Disease to gene approach, Chromosomal approach
5. Genetic analysis of genotoxicity: cellular and molecular approaches.
6. Extra chromosomal inheritance

Unit II: Molecular Genetics-II**Marks: 30**

1. Gene regulation in Eukaryotes: i) Alternative splicing, (ii) Post transcriptional gene silencing, (iii) Chromatin remodelling in gene regulation
2. Cell death and its regulation

3. Mitochondrial DNA: Organization, replication and diseases
4. Prion: History, cause, features, TSE, PrP^c and PrP^{Sc} biology and replication
5. Molecular Virology: i) Biology, entry and replication strategy of DNA & RNA human viruses, ii) Gene expression and Regulation: SV40, HBV, Polyomaviruses, Influenza & HIV, iii) Antiviral strategies

GE-301: Molecular Biology, Biochemical and Biophysical methods

Course credit: 04

Unit-I: Techniques in Molecular Biology

Marks 37.5

1. Recombinant DNA technology: Restriction Endonucleases, Vectors, Cloning strategies, selection of recombinant DNA, DNA sequencing, PCR (basic knowledge), Genomic and cDNA libraries: constructions and screening.
2. Expression Vectors and expression of fusion proteins; purification of fused proteins.
3. Site directed mutagenesis strategies and prospects.
4. Transgenic Animals: production, prospects.
5. Applications of recombinant DNA technology in human gene therapy, vaccine development, environmental bioremediation and protein engineering.
6. Sangers sequencing and NGS methods.
7. Gene and Genome editing techniques.

Unit-II: Biochemical and Biophysical methods

Marks 37.5

1. Methods of pH measurement in the laboratory.
2. Tools and Techniques for analysis of biological samples for estimation of sugar, protein and fat.
3. Principle and application of Spectrophotometry.
4. Principle and application of Chromatography.
5. Principle and application of Centrifugation.

GE-302: Biophysics and Biostatistics

Course credit: 04

Unit-I: Biophysics

Marks 37.5

1. Principles and uses of analytical instruments: Spectrophotometer, Spectrofluorometer, Mass Spectrometry
2. Microscopy: Fluorescence and Confocal Microscopy, Principle of TIRF Microscopy, GFP, FISH, FRET
3. Chromatography: Principles, Column chromatography, GLC, HPLC, Ion-exchange chromatography, Gel exclusion chromatography, Affinity chromatography
4. Electrophoresis: Basic principles, PAGE, Agarose gel electrophoresis, 2-Dgel electrophoresis
5. Centrifugation: Basic principles of Sedimentation, Differential and Density gradient centrifugation
6. Basic principle of Crystallography and X-ray diffraction, Basic idea of NMR
7. Radioisotope techniques: Radioactivity and half-life, radioisotopes, units of radioactivity, G-M counter, solid and liquid scintillation counter, Metabolic labeling, Applications of radioisotopes in Biology.

Unit II: Biostatistics

Marks 37.5

1. Biostatistics/Biometry: Definition and utilization in biological studies
2. Basic concepts of terminologies used in biostatistics: Data, Variable, Population, Sample, Estimate.
3. Measures of Central Tendency
4. Measures of Variation
5. Graphical representation of data

6. Probability Distribution – Concept of Probability, Binomial Distribution and Poisson Distribution
7. Simple Linear Regression and Correlation
8. Chi-Square Test
9. Hypothesis Testing and Students' 't' distribution
10. Analysis of Variance
11. Models: Definition, Classification, Usefulness.

CONTINUING EVALUATION

CC-301, DSE-[(301-305) (A and B)], GE-301, GE-302 (Class Tests)

Marks (8 x 1) + (15 x 2) + (25 x 1) =63

ABILITY ENHANCEMENT COURSE

AEC-301: University prescribed

**Marks: 50
Course credit: 02**

FOURTH SEMESTER

CORE COURSE THEORY

CC-401: Gamete Biology and Developmental Biology

Course credit: 02

Unit I: Gamete Biology

Marks 21

1. Hormonal regulation of ovulation, pregnancy, parturition and lactation.
2. Assisted Reproductive Technologies (ARTs) in male and females.
3. Semen composition and formation, assessment of serum function.
4. Development of gonads
5. Biology of sex determination and sex differentiation in human and *Drosophila*—a comparative account.
6. Cryopreservation: Methods and application.
7. Teratological effects of xenobiotic on gametes.
8. Embryonic stem cells, renewal by stem cells.

Unit II: Developmental Biology

Marks 21

1. Differential Gene Expression:
 - (i) Genomic Equivalence.
 - (ii) Differential gene transcription,
 - (iii) Differential RNA Processing.
 - (iv) Transcriptional regulation of an entire chromosome: dosage compensation.
2. Cell-cell communication in development: General concept of potency, commitment, specification, induction, competence and determination
3. Early development in amphibians.
4. Vulva formation in *C. elegans*
5. The genetics of axis specification in *Drosophila*.
6. Metamorphosis, regeneration, and aging

CC- 402: Evolution and Population genetics

Course credit: 02

Unit I: Evolution

Marks: 21

1. Speciation: Biological and Phylogenetic species concept, Patterns and Mechanisms of reproductive isolation; genetic basis of reproductive isolation. Models of Speciation: allopatric, dichopatric, peripatric, parapatric, sympatric
2. Molecular Evolution: (i) Protein & Gene evolution, Evolution of Multigene Family, (ii) Acquisition of new genes: Mechanisms and Exon Theory,
3. Concerted Evolution and Molecular Drive,
4. Emergence of Non-Darwinism: Neutral Hypothesis, Molecular clock, Concept of Evolutionary Developmental Biology, Evolution of Novel Character,
5. Molecular Evolution: RNA World
6. Origin and Evolution of man, Origin of speech and language

Unit II: Population Genetics

Marks 21

1. Population Genetics: Origin of Genetic variation in the natural population, Hardy-Weinberg law—Assumption, Derivation & application in population genetics, Equilibrium at two or more loci and X-linked loci, Measures of Genetic variation
2. Destabilizing forces influencing allele frequencies: Mutation, Natural Selection: Selection against recessive and recessive lethal, Selection against dominant, Heterozygote advantage, Migration & metapopulation and Genetic drift, Mutation-Selection Balance, Mutation–drift balance,
3. Genetic structure of population

4. Inbreeding: Measure of inbreeding, inbreeding depression, Heterosis
5. Quantitative traits: Genotype-environment interaction, phenotypic variance, Heritability & its estimation, polygenic traits, Quantitative trait loci and mapping.

CORE COURSE PRACTICAL

CC 403: Gamete Biology and Developmental Biology

Course credit: 02

1. Preparation of window on the incubating chick egg.
2. Study of normal developmental (WM) stages of various organisms (slide based)
3. Fixation, staining and identification of chick embryo after incubation the eggs for different hours.
4. Preparation cross section of chick embryo after incubation the eggs for different hours.
5. Identification of stages of estrous cycle by vaginal smear preparation in rat
6. Surgical techniques such as adrenalectomy, castration, etc. on rats or mice.
7. Histology of gonads.

CC-404 Comprehensive Viva Voce

Marks 25

Course credit: 01

CC-405 Dissertation/Review

Marks 50

Course credit: 02

Discipline Specific Elective (DSE)

Student will have to choose any one course among **DSE-401 - DSE-405**

DSE-401: Clinical Immunology and Immunotechnology

Course credit: 03

Unit-I: Clinical Immunology

Marks 30

1. Immunity to microbial infectious diseases, Viral, Bacterial and Protozoan diseases, Evasion strategies of some pathogens.
2. Tumor immunology. Terminology and the Formation of Cancer, Tumor Antigens, Immune Response to Cancer, Immuno-editing, Anticancer Immunotherapies.
1. HLA and disease association, HLA typing.
3. Immunodeficiency diseases including AIDS, Primary and secondary Immunodeficiency Diseases.
4. Reproductive Immunology, HLA-G, KIR gene.

Unit- II: Immunotechnology

Marks 30

1. Hybridoma technology, Monoclonal antibody, and usage.
2. Vaccines, Basic Research and Rational Design, Advance Vaccine Development.
3. Techniques and technologies for quantitation of immunologically relevant molecules, substances and the cells and their uses for diagnostic purposes. Agglutination reaction, Precipitation reaction, immune-diffusion, immune-electrophoresis, Radioimmunoassay, ELISA, FACS, MACS, CRISPR-Cas9 Technology.

DSE-402: Chronobiology, Behavioral Ecology and Environmental Biotechnology

Course credit: 03

Unit-I: Chronobiology and Behavioural Ecology

Marks 30

1. Chronobiology: Periodicity in the environment and in the organisms; biological rhythm – basic components, types, centers (suprachiasmatic nuclei, pineal gland, optic lobes), factors influencing biological rhythms (environmental, photoperiod, temperature, other Zeitgebers), molecular bases of circadian rhythms: clock genes: *Drosophila* and mouse.
2. Applied Chronobiology: Human circadian rhythms, application of circadian rhythms and principles; jet-lag/shift work; depression and sleep disorders; chronopharmacology and chronotherapy.
3. Behavioural Ecology: Introduction to behavioural ecology, proximate and ultimate reasoning, development of behaviour, social communication and dominance, altruism and evolution - group selection, kin selection, reciprocal altruism; use of space and territoriality, mating systems, parental investment and reproductive success, parental care, aggressive behaviour, habitat selection and optimality in foraging, migration, orientation and navigation; animal communication - types and functions.

Unit-II: Environmental Biotechnology: Techniques and applications

Marks 30

1. Approaches and methods in study of chronobiology and behavioural ecology: Basic concepts and methods pertaining to classical and modern study models, methods of measurement: entrainment, re-entrainment, phase angle difference, free-run, phase shift, arrhythmia.
2. Environmental Biotechnology: Genetic modified organisms, quorum sensing and quenching, environmental biotechnology for management of resources (reclamation, bioprospecting, biomining, biodiversity conservation, DNA barcoding and alternative fuel), use of microbes in solid waste management, vermitechnology, anthropocentrism, biocentrism and ecocentrism.

DSE-403: Insect Pests & Vectors and their Management (C)

Course credit: 03

Unit I: Insect Pests & Vectors:

Marks 30

1. Introduction to the important pests of Tea, Citrus, Stored grains: symptoms of their attack, crop damage and management
2. Insect Pests of Tropical Forests and their Management
3. Polyphagous insect pests: locust, aphid and termite
4. Vector biology: Mode of transmission of pathogens by insect vectors to major crop, man and livestock and their Control strategies
5. Insect and arthropods causing harm to livestock
6. Insects and Plants: Coevolution and Herbivory

Unit II: Insect Pests Management

Marks 30

1. Concept of Economic levels: Determination of EIL & Calculation of economic decision level
2. Pest surveillance, sampling methods, Use of remote sensing and Pest forecasting
3. Case histories of successfully implemented IPM
4. Insecticide Resistance Management (IRM) in Pest and Vectors
5. Insect Control Strategies: Conventional and Non-conventional
6. Biological control of pests: Challenges and success
7. Host plant resistance to insects and Molecular biology of insect Biotypes

DSE 404: Fish Technology**Course credit: 03****Unit I: Fish Technology-I****Marks 30**

1. Fish spoilage: cause, rigor mortis, types of fish spoilage
2. Preservation and processing of fish: different methods of preservation, relative rate of spoilage, chilling, refrigerated freezing, deep freezing/quick freezing, freeze drying, sun drying, solar dryers, salting, smoking, canning, use of chemicals and radiation etc.
3. Fish by-products and their economic importance: different types of fish by-products, fish oil, polyunsaturated fatty acid, fish oil (composition, extraction and purification) and production of ω -3 rich fatty acid concentrates, Supercritical fluid extraction (SFE) and fractionation of fish oils and fatty acid/esters, fish meal, fish flour, fish glue, isinglass, fish protein, fish protein concentrate (FPC), fish leather, fish sausage and soup, fish manure, fish guano, fish silage, lecithin, chitin and chitosan, squalene etc.

Unit II: Fish Technology-II**Marks 30**

1. Genome and fish biotechnology: Sex Determination, Selective breeding and Hybridization. Androgenesis and Gynogenesis, Polyploidy, Sex reversal, transgenesis, Molecular markers, DNA barcoding.
2. Fish detection methods – Basic principles of acoustic fish detection; echosounder and sonar.
3. Crafts: Principal types of fishing crafts operated in Inland and Marine Waters of India
4. Gears: Classification of fishing gears; Selection of fishing gears; Types of fishing gears used in Inland and Marine Waters of India; Electro fishing

DSE-405: Molecular Cell Biology and Genetics**Course credit: 03****UNIT I: Molecular Cell Biology and Genetics-I****Marks 30**

1. Cancer genetics: i) Cancer as a genetic disease, cell cycle and cancer, ii) Mutation – a predisposition to cancer, iii) Oncogenes, tumour suppressor genes, Oncogenic mutations iv) Two-Hit theory of cancer, Multistep theory of Cancer v) Chromosome instability and environmental factors in cancer vi) Colorectal, Breast Cancer, Li Fraumeni syndrome vii) Cancer Therapy.
2. Elementary Idea of Pharmacogenetics and Pharmacogenomics, ecogenetics, personalized Medicine.
3. Asymmetric cell division, regulation of mating type switch in Yeast, neuroblast formation in *Drosophila*.
4. Genetic mosaic, regulation of body plan development in *Drosophila*, *Hox* genes and vertebrate limb pattern
5. Molecular genetics of Diseases: i) Trinucleotide expansion – HD, Fragile-X Syndrome ii) neurodegenerative diseases- Alzheimer, Parkinson, iii) Multifactorial – Schizophrenia: Molecular basis
6. Catalytic and Regulatory RNAs.

Unit II: Molecular Cell Biology and Genetics-II**Marks 30**

1. Genomics and Proteomics: i) Concept of transcriptome and proteome, ii) Global study of Genome activity (Functional Genomics): Analysis of transcriptome by SAGE and DNA Microarray technique, Analysis of proteomes by 2D Gel Electrophoresis, Mass Spectrometry, Yeast two hybrid system, Phage Display, Expression Profiling, Protein-Protein Interaction.
2. Recombinant DNA Techniques and Gene function analysis: i) Recombinant DNA Techniques: PCR, Real Time/Quantitative PCR, Droplet PCR, DNA sequencing, New generation DNA sequencing (NGS), Shotgun sequencing of whole genome, Foot printing, DNA mobility shift assay, Western and southwestern blotting, ii) Gene function analysis: Random mutagenesis, site specific mutagenesis, targeted mutagenesis: gene knockout and knock-in method, CRISPER-Cas9 system, RNAi and specific gene silencing.
3. Application of Genetic techniques: i) Mapping genome: Linkage analysis in pedigrees in human using DNA markers- RFLP, Microsatellites, SNPs and STS; ii) Detection & Estimation of genetic

linkage, iii) Mapping of disease gene: Positional candidate cloning & Functional candidate gene cloning strategy, iv) Mutation detection assays: SSCP, DGGE, HA, CMC, PTT, v) Non-candidate driven approach (GWAS).

DSE-406 (A/B/C/D/E): Discipline Specific Elective Course Practical

Marks: 50

Course credit: 02

Student will have to choose any one course among DSE-406 A-E corresponding to their earlier choice of Discipline Specific Elective Course

DSE-406A: Immunology

Marks: 50

Course credit: 02

1. Collection of complement and anti-serum.
2. Differentiate the primary and secondary antibody response in haemagglutination test by using mercaptoethanol.
3. Characterization of purified immunoglobulin preparation by SDS-PAGE.
4. Preparation of cell suspension from lymphoid organs and solid tumours, staining and identification of cell types. Collection and purification of ascetic tumour cells.
5. Separation of cells in Hypaque Ficoll gradient and count of percentage of blasts.
6. Raising of antiserum (ALS) and test of specificity of the serum in lysis of target; Ouchterlony Plate Test, Immuno-diffusion and Immuno-electrophoresis.
7. Plaque forming cell (PFC) Assay.
8. Rosette forming cell (RFC) Assay.
9. Test for cell mediated immune response: Measurement of Arthur's rx/CML/GVH/MI response.
10. PCR

DSE-406B: Environmental Biology

Marks: 50

Course credit: 02

1. Frequency, density, abundance in terrestrial and aquatic systems.
2. Important value index
3. Species identification with special reference to North Bengal.
4. Functional responses in planktons.
5. Water quality analysis: dissolved oxygen, BOD, chloride, total hardness, E_c , TDS, salinity, etc.
6. Soil quality analysis: organic carbon, calcium carbonate, pH, E_c .
7. Microbiology: bacteria culture techniques, *E. coli* (EMB media), coliform test, Gram staining of bacteria.

DSE-406C: Insect Biology and Pest Management

Marks: 50

Course credit: 02

1. Studies in internal morphology:
Cockroach/Grass hopper: Nervous and reproductive systems
2. Mounting of insect:
Wings, mouth parts, antennae, legs, tracheal trunk, spiracle, agriculturally/medically important insects
3. Preparation of keys:
Order and Family level for major orders
4. Quantification of water-soluble protein in insect egg
5. Electrophoretic study of Haemolymph/ovarian/egg protein / salivary / gut enzymes
6. Host plant/seed preference study:
Quantitative assay of damage of host leaf/seed caused by pests
7. Estimation of biochemical changes in host plant/seed due to pest attack

8. Determination of LD50/LC50 values of pesticides using a pest/vector species
9. Study in species RTU/family level diversity of insect community from crop/forest/grassland/soil habitats.
10. Submission of insects from representative orders (at least from different 10 insect orders) preferably pests

DSE 406D: Fish Biology, Fisheries and Aquaculture

Marks: 50
Course credit: 02

1. Collection of water samples from different sources to analyse the following;
 - a) Limnological parameters.
 - b) Primary productivity
 - c) Qualitative and quantitative estimation of phyto-and zooplanktons
2. Determination of Age in fish using scale.
3. Study of bucco-pharyngeal region, gill-rakers, and the alimentary canal of local fishes to determine their food and feeding habits.
4. Techniques of induced breeding (collection and preservation of carp pituitary gland, preparation of gland extract).
5. Urinogenital, swim bladder and Weberian ossicles in teleosts.
6. Histological preparation of fish tissues.
7. TC of RBC and DC of WBC, estimation of Hemoglobin of fish blood.
8. Diet formulation and preparation of artificial fish feed
9. Quantitative detection of digestive enzymes.
10. Identification of different fishes

DSE-406E: Molecular Cell Biology and Genetics

Marks: 50
Course credit: 02

1. Preparation of mitotic chromosomes from the bone marrow of Mice/ Rat by Air dry/Flame dry method
2. Preparation of meiotic chromosome from the testes of Mice by Air/Flame dry method
3. Preparation of Synaptonemal Complex by surface spread method from the testes of mice/rat
4. Chromosome Banding: C, G banding, NOR
5. Micronuclei test
6. Drosophila food preparation, Handling of flies and Setting of crosses
7. Setting crosses to study sex-linked inheritance, linkage and crossing over in Drosophila
8. Three-point test cross for gene mapping in Drosophila
9. Preparation of polytene chromosomes and Heat shock puffs
10. Lymphocyte culture and preparation of mitotic chromosome (Human).
11. Genomic DNA isolation from Blood (Human), tissues (Mice), quantitation, and restriction digestion
12. Transformation of host bacteria with given plasmid DNA
13. Isolation of Plasmid DNA
14. Restriction Digestion of Lambda-DNA/Plasmid/Genomic/Mitochondrial DNA and Electrophoresis
15. Restriction mapping in plasmid by double digestion
16. Molecular cloning using small vector
17. Study of Serum protein, Hb, LDH, by PAGE
18. PCR Amplification of known DNA/RAPD

GE-401: Environment and Public Health

Course credit: 04

Unit-I: Basics and determinants of public health

Marks 37.5

1. Development of the discipline: Introduction, scope and concerns, history and development in developed and developing countries.

2. Determinants of environment related health problems: Overview, impact of environment and climate change, genomics and public health, behavioural determinants, socio-economic inequalities.
3. Communicable disease epidemiology: Incubation periods, Epidemic patterns, Modes of transmission, Transmission dynamics, Measures of infectiousness, Secondary/tertiary attack rates and Health Programmes (governmental/non-governmental)

Unit-II: Insight into public health problems, assessment and mitigation strategies Marks 37.5

1. Major environment related health problems: Radiation induced disorders, neurological diseases, mental diseases, cardiovascular diseases, renal and hepatic diseases, cancer, diabetes mellitus, microbial diseases, indoor and outdoor environment health problems.
2. Assessment of environment related health problems: Basic concept of epidemiology, environmental exposure assessment, modes of transmission.
3. Prevention and control strategies: Population screening, environmental impact studies, strategies and structures for intervention, strategies for health services, food safety principles.

GE-402: Wildlife Conservation, Biodiversity & Taxonomy

Course credit: 04

Unit-I: Wildlife Conservation

Marks 37.5

1. Definition of wildlife, rationale for wildlife conservation and classification of wildlife according to severity of threats
2. Wildlife population estimation and capturing-handling techniques.
3. Radio telemetry: Radio collars, antenna and receivers
4. Role of CITES, WWF, BLI, IUCN, BNHS, Wildlife Protection Act conservation with special emphasis on Eastern Himalayan and Terai Wildlife
5. *In situ* and *ex situ* conservation: prospects and limitations, role of captive breeding in conservation
6. Socio-economic perspective of wildlife conservation.
7. Use of Biotechnology in Conservation.

Unit II: Biodiversity & Taxonomy

Marks 37.5

1. Definition and indices of biodiversity
2. Levels of biodiversity: genetic, species and ecosystem
3. Values and uses of Biodiversity
4. Megadiversity and hotspots of Biodiversity
5. Threats to biodiversity
6. Zoological nomenclature; rules
7. Zoological classification, rules of classification, criteria of zoological classification
Identification, functions of classification.
8. Taxidermy and preparation of specimens for taxonomic purpose
9. Identification and keys
10. Molecular systematics: Chromosome, allozymes, DNA

CONTINUING EVALUATION (INTERNAL)

CC-401, CC-402

Marks (8 x 2)

DSE-(401-405)

Marks (15X1)

GE-401/ GE-402 (Class Test)

Marks (25 x 1)

SEC-401: University prescribed

**Marks: 50
Course credit: 02**

SUGGESTED READINGS

Nonchordates & Chordates:

1. Barnes, R.D. 1993 Invertebrate Zoology, W.B. Saunders Co.
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