M. SC. ZOOLOGY SYLLABUS
(CBCS)

DEPARTMENT OF ZOOLOGY
GAUHATI UNIVERSITY
Gopinath Bardoloi Nagar
Guwahati -781 014
Assam, India

M.Sc. Zoology Syllabus (CBCS)
Semester-1

Code	Course	Credit	Contact hour	Total marks	Type
ZOO-1014	**Biosystematics and Biostatistics**	4	54	40+10	Core (Theory)
ZOO-1024	**Bioinformatics and Instrumentation**	4	54	40+10	Core (Theory)
ZOO-1034	**Evolution and Chronobiology**	4	54	40+10	Core (theory)
ZOO-1044	**Genetics and Cytogenetics**	4	54	40+10	Core (Theory)
ZOO-1054	**Ecology and Environmental biology**	4	54	40+10	Core (Theory)
ZOO-1064	**Biochemistry**	4	54	40+10	Core (Theory)
ZOO-1072	**Biosystematics, Biostatistics and Bioinformatics**	2	54	20+5	Practical
ZOO-1082	**Genetics, Cytogenetics, Evolution and Chronobiology**	2	54	20+5	Practical

M.Sc. FIRST SEMESTER

PAPER ZOO-1014 (Total Marks 40): 4 Credits
(BIOSYSTEMATICS and BIOSTATISTICS)

UNIT 1: 2 Credits

1. Concept of species: Species, Polytypic species, Importance of recognition of Polytypic species taxa.
2. Infraspecific categories, subspecies, temporal subspecies, race and cline
3. Population taxonomy, the new systematics and superspecies.
4. Speciation: Sympatric, Parapatric and allopatric speciation, Speciation in time, sibling species.
5. Taxonomic characters: Molecular, Behavioural, Ecological and geographical characters, weighing of characters, characters with low and high taxonomic weight.
6. Intrapopulation variations: Non-genetic and Genetic variations.
7. Interpretation and application of important rules.

UNIT 2: 2 Credits

1. Applications of Biostatistics, Sampling methods: Random sampling, Stratified sampling and Sub-sampling
2. Measurement of variations: Standard error, standard deviation and co-efficient of variation, Quartile and percentiles, probability and distribution, Binomial, poison and normal distributions.
3. Correlation and regression: Linear regression equation and line of best fit, Coefficient of correlation, Coefficient of regression
4. Chi-square test value of statistics, Confidence limit, t-test, Introduction to one way and two ways Anova and F-test.
5. Kruskal-Wallis test, Man-Whitney U test

PAPER ZOO-1024 (Total Marks 40): 4 Credits

(BIOINFORMATICS AND INSTRUMENTATION)

UNIT 1: 2 Credits

1. Theoretical aspects of sequence analysis. Needleman-Wunsch and Smith-Waterman methods of global and local alignments for a pair of sequences.
2. Molecular phylogeny and evolution: Properties and types of phylogenic trees; Tree building methods- Distance based: UPGMA (Unweighted pair group method using arithmetic mean), Neighbor-joining, minimum evolution and least square methods; Character-based: Maximum parsimony, maximum likehood.
3. Levels of protein structures and visualization: Protein secondary and tertiary structures prediction methods (Description of machine learning methods for secondary structures, homology/comparative modeling, fold recognition or threading and ab infitio methods for tertiary structure prediction)
4. Overview of protein-protein and protein-ligand interactions (use of Cluspro and Autodock)

   Referred books:

   1. Bioinformatics, Sequence and Genome analysis. Second Ed. By David W. Mount
   2. Bioinformatics and Functional genomics. Third Ed. By Jonathan Pevsner

UNIT 2: 2 Credits

1. Microscopy: Principles and applications of phase contrast, Fluorescence and confocal Microscopy.
2. Principles and application of tracer techniques- autoradiography and radio immunoassay.
3. Immunological techniques: Immunodiffusion, Immunoelectrophoresis, Enzyme linked Immuno-absorbant assay (ELISA)
4. Centrifugation: Density gradient and unit gravity centrifugation, tissue processing and separation of various sub-cellular organelles by centrifugation
5. Molecular separation Techniques: Ion-Exchange, Absorption, partition, gel filtration, and affinity chromatography, and HPLC.
   Electrophoresis- Principle and applications, Agarose, SDS, SDS-PAGE, Pulsed gel and Disc electrophoresis, determination of molecular weight by SDS-gel electrophoresis
6. Cryopreservation: Methods and applications
7. Southern, Northern and Western Blotting
8. Principle and application of Nick-translation, in situ-hybridization
9. Chromosome banding, FISH-chromosome painting technique

PAPER ZOO-1034 (Total Marks 40): 4 Credits

(**EVOLUTION AND CHRONOBIOLOGY**)

UNIT 1: 2 Credits

1. Theories of organic evolution, Prebiotic molecules (Amino acid and Nucleic acid bases).
2. Evolution of Prokaryotes and Eukaryotes.
3. Origin of life: Modern theories, Changes in hereditary instructions in relation to evolution.
4. Notion of selectively neutral mutations, evolutionary gene duplication, the founder principle, bottleneck effect of genetic drift.
5. Evolutionary history of natural integration, evolution of man.
6. Factors and forces of evolution: Mutation, Genetic variation, Isolation mechanisms and their role in speciation.
7. Emergence of the theory of Neo-Darwinism.
8. Molecular evolution : Concept of neutral evolution (Kimura), molecular divergence and molecular clock, molecular tools in phylogeny, classification and identification, Origin of new genes and proteins, gene duplication and divergence

UNIT 2: 2 Credits

1. Biological clocks
2. Significance of Biological time keeping
3. Biological rhythms: Types of rhythms- Circadian, Circatidal, Circalunar, Circannual; Centres of biological rhythms- Suprachiasmatic nuclei, Pineal gland, Optic lobes; Factors influencing biological rhythms- Environmental, Photoperiod, Temperature, Other Zeitgebers.
4. Methods of measurement: Entrainment, Re-entrainment, Phase angle difference, Free-run, Phase shift, Phase response curve, Arrhythmia.
5. Molecular bases of circadian rhythms: Clock genes: *Drosophila* and Mouse.
6. Applied Chronobiology: Human circadian rhythms, Application of circadian rhythms and principles; Jet-lag/shift work; Depression and sleep disorders; Chronopharmacology and Chronotherapy.

Referred Books:-

Nelson, R.J. (2000). An introduction to behavioural Endocrinology, 2nd edition.

Binkley, S. (1990). The clockwork sparrow: time, clocks and calendars in biological organisms.

Chadrashekaran, M.K. (1985). Biological rhythms. Madras science foundation, Chennai.

PAPER ZOO-1044 (Total Marks 40): 4 Credits

(GENETICS AND CYTOGENETICS)

UNIT 1: 3 Credits

1. Eukaryotic chromatin structure and chromosome organization: Classes of DNA Chromosomal proteins: histones and their modifications, non-histone proteins, scaffold/ matrix proteins, levels of chromatin condensation at interphase and metaphase stage.
2. Organization and functions of mitochondrial DNA
3. Microbial genetics: bacterial chromosomes, transformation, transduction, conjugation
4. Bacteriophage: Type, structure and morphology
5. Chromosome anomalies and diseases: chromosomal anomalies in maligancy(chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilm's tumor)
6. Genetics and cancer: oncogenes-tumour inducing retroviruses and viral oncogenes, chromosome rearrangements and cancer, tumour suppressor genes, cellular roles of tumour suppressor genes, P^{RB}, P^{53}, P^{APC}, genetic pathways to cancer.
7. History of organization, goals and values of human genome project, organization and distribution of human genes.
8. Gene action: from genotype to phenotypes- penetrance and expressivity, gene interaction, epistasis, pleiotropy.
9. Nature of gene and its function, fine structure of gene (r11 locus)
10. Methods of gene mapping: 3 point test cross in *Drosophila*, gene mapping in human by Linkage analyses in pedigrees.
11. Basic concept of molecular disorders and gene therapy.

UNIT 2:-1 Credit

1. Giant chromosome: models for studies on chromosome organization and gene expression.
2. Sex determination: Role of Y chromosome, sex mosaics, sex chromosome anomalies, sex influenced alleles, sex limited genes and hormonal influence.
3. Sex determination and dosage compensation gap of X-linked genes, hyperactivation of X linked genes in Drosophila, Inactivation of X-linked gene in female mammas, Hypoactivation of X-linked genes in *Caenorhabditis elegans*.
4. Human genetics: Karyotype and nomenclature of metaphase chromosome bands.

PAPER ZOO-1054 (Total Marks 40): 4 Credits
(ECOLOGY AND ENVIRONMENTAL BIOLOGY)

UNIT 1: 2 Credits

1. Structure of ecosystem-variations in physical environment and adaptations, Homeostasis, stability concept
2. Biodiversity of ecosystem – Salient features of aquatic and terrestrial ecosystem and their biotic communities
3. Biotic community concept and community analysis – organization, population density, relative abundance, frequency, dominance, carrying capacity, species richness and species diversity

4. Community development: Types of community changes, causes and examples of ecological succession, Climax community and stability
5. The Niche concept, ecological niche, niche overlap and separation
6. Population ecology- growth pattern, life tables & survivorship curve and density dependent & independent factors.
7. Life history strategies: K- or r-selection, Age and sex ratio.
8. Trophic structure, food chain and food webs, energy flow and Lindeman's trophic dynamics concept, Food web pattern and measurement in ecosystem energy flow model, concept of productivity and measurement of primary productivity.

UNIT 2: 2 Credits

1. Environmental issues, environmental regulations and biodiversity management approaches.
2. Environmental concerns–green house effect, global warming and environmental pollution.
3. Biogeochemical cycles- carbon, nitrogen and sulphur cycles; impact of human activity on nutrient cycles.
4. Human and Environment: Anthropogenic Impact on Environment, Environmental Impact assessment.
5. Environmental monitoring and documentation.
6. Major drivers of biodiversity changes in environment and principles of biodiversity Conservation.

PAPER ZOO-1064 (THEORY) (Total Marks 40): 4 Credits
(BIOCHEMISTRY)

UNIT 1: 2 Credits

1. Energy rich compound, role of ATP/ADP cycle in transfer of high energy phosphate
2. Important respiratory complex of ATP synthesis and oxidative phosphorylation, chemiosmotic hypothesis
3. Secondary structure: α-helix, β-pleated sheet & bends, Prediction of secondary structure, Ramachandran plot
4. Tertiary structure: Forces stabilizing tertiary structure, Domains and motifs, Quaternary Structure of proteins.
5. Enzyme kinetics, lowering of activation energy, Derivation of Michaelis-Menten equation and determination of K_m and V_{max} using MM & LB plots, Concepts of regulation of enzyme activity.
6. Concept of metabolic pathways, Glyolysis and Gluconeogenesis, Glycogenesis and Glycogenolysis; Kreb cycle.

UNIT 2: 2 Credits

1. Hexose monophosphate shunt pathway and its significance; β-oxidation of fats and synthesis of fatty acids.
2. Intermediary metabolism: inter-conversion between lipids, carbohydrate and proteins.
3. Amino acid: Structure and chemistry of amino acid, Amino acid catabolism:
4. Trasnsamination, Transdeamination and oxidative deamination, Urea cycle
5. Nucleic acids **:** Structure, folding motifs, conformational flexibility and supercoiling,
6. DNA replication, DNA polymerases, Origin of replication and formation of primosome,
7. Replication fork and replisome, Termination of replication, Transcription unit, split genes
8. 5. Mechanism of transcription: RNA polymerases , Formation of pre-initiation complex at
9. RNA pol II promoter, Capping , Poly (A) tailing ,Splicing Mechanism of translation: Role of ribosomes and tRNA, Formation of initiation complex.
10. Elongation and termination.

PAPER ZOO -1072 (PRACTICAL)
(Total Marks 20): 2 Credits
(BIOSYSTEMATICS, BIOSTATISTICS AND BIOCHEMISTRY)

1. Identification of invertebrates, larval forms of invertebrates, protista, and vertebrates.
2. Determination of biodiversity indices: Shannon-Weiner Index, Similarity and Dissimilarity index and association index.
3. Graphical representation of data.
4. Calculation of Standard error, standard deviation, analysis of variation, Coefficient of variation, t-test, chi-square test and two way ANOVA.
5. Extraction of biomolecules (carbohydrates, proteins, lipids) from fish liver.
6. Estimation of protein extracted from fish liver by Biuret/Lowry/Bradford method.
7. Estimation of glycogen extracted from fish liver by Anthrone reagent method.
8. Estimation of blood glucose by Folin-Wu method.
9. Effect of substrate concentration on enzyme activity and determination of K_m and V_{max} by plotting Michaelis-Menten and LB plot.
10. Estimation of DNA
11. Estimation of RNA
12. Determination of P_{ka} & P_I value of glycine using Titration method.
13. Determination of molecular mass of proteins by SDS-PAGE.

PAPER ZOO-1082 (PRACTICAL)
(Total Marks 20): 2 Credits
(GENETICS, CYTOGENETICS, EVOLUTION, CHRONOBIOLOGY AND BIOINFORMATICS)

1. Study of mutant phenotypes of Drosophila.
2. Study of sex chromatin in buccal smear and hair bud cells (Human).
3. Preparation and study of metaphase chromosomes from mouse bone marrow.
4. Chromosome banding (C- and G-banding).
5. Study the difference in number, shape and size of chromosomes in normal vs. tumor cells and normal vs. irradiated cells.
6. Preparation of human karyotype and study of chromosomal aberrations with respect to number, translocation, deletion etc from the pictures provided.
7. Study of Hardy-Weinberg equilibrium in human population by taking the example of blood group system (ABO).
8. Use of search engines like Scopus, Science Direct for reference material collection management.
9. Nucleic acid and protein sequence databases
10. Data mining for sequence analysis
11. Web based tools for sequence searches and homology screening
12. Construction for phylogenetic trees for proteins using UPGMA or Neighbor joining method(no software to be used)
13. Reproduction of the same phylogeny using MEGA software for the given set of sequences
14. Finding possible genes in a given nucleotide sequence(ORF finder)
15. Prediction and validation of protein structure using homology modeling (use of Swiss model)
16. Determination of binding modes of a given ligand in the active site of a protein(use of Autodock)

Semester-2

Code	Course	Credit	Contact hour	Total marks	Type
ZOO-2014	**Biodiversity**	4	54	40+10	Core (Theory)
ZOO-2024	**Endocrinology**	4	54	40+10	Core (Theory)
ZOO-2034	**Developmental Biology**	4	54	40+10	Core (Theory)
ZOO-2044	**Animal cell Culture And Genetic Engineering**	4	54	40+10	Core (Theory)
ZOO-2054	**Animal behavior**	4	54	40+10	Core (Theory)
ZOO-2064	**Animal Physiology**	4	54	40+10	Core (Theory)
ZOO-2072	**Biodiversity, Animal behavior, Developmental Biology**	2	54	20+5	Practical
ZOO-2082	**Endocrinology, Animal Physiology, Animal cell Culture And Genetic Engineering**	2	54	20+5	Practical

M.Sc. 2nd SEMESTER

Paper-ZOO-2014 (BIODIVERSITY)
(Marks 40+10) Theory credit: 4 Credits
Unit-I

1. Major elements of global diversity, Evolution and distribution
2. Biodiversity in different levels (Country, Global, Regional)
3. Components of Biodiversity (Genetic, Organismal and Ecological)
4. Magnitude and pattern of Biodiversity
5. Carrying capacity, land use and population pressure on Biodiversity
6. Impact of climate Change, Global health and diseases on Biodiversity

Unit-II

7. Value of Biodiversity (Species and Ecosystems), Utilization of Biodiversity
8. Methods and tools for biodiversity conservation (exsitu, insitu, Restoration and Rehabilitation, land use)
9. Priority setting: Criteria for conservation
10. Women, gender and biodiversity conservation
11. Legal instruments for Biological diversity conservation
12. Sustainability, Harnessing and benefit sharing

Suggested Books:

1. M.Kato (Ed) ; The Biology of Biodiversity: Springer-Verlag, 2000
2. Anne E. Magurran; Measuring Biological Diversity; Blackwell Publishing, 2004
3. K. C. Agrawal: Global Biodiversity, Nidhi Publishers(India), 2002
4. Kelvin J. Gaston & John I Spicer: Biodiversity An Introduction; 2nd Edn. Blackwell Publishing; 2004

M.Sc. 2nd SEMESTER
Paper-ZOO-2024 (ENDOCRINOLOGY)

(Marks 40+10) Theory credit: 4 Credits

UNIT I:

1. Hormone and target organs: hormone receptors and their characteristics. neurocrine endocrine and paracrine secretion of hormones, Hormonal signal transduction ,
2. Hypothalamus: Hypothalamic neurosecretory centres, Hypothalamic hormones, hormonal feedback.
3. Pituitary: Pituitary hormones and their functions.
4. Thyroid: Thyroid hormones biosynthesis and their functions
5. Comparative anatomy of adrenal glands in vertebrates, Biosysnthesis of adrenal hormones and their functions, Adrenal Medulla: Catecholamine biosynthesis, release and its physiological functions.
6. Parathyroid: Calcitonin and vitamin D in calcium Homeostasis
7. Endocrine Pancreas: Glucose homeostasis and physiological functions of Insulin and Glucagon

UNIT II:

8. Neurosecretory hormones in insets and crustaceans and their functions
9. Neuroendocrine system of Insect : Neurosecretory cells of brain and ventral nerve cord, synthesis and assemblage of neurohormones, neurohemal organs, release and transport of neurohormones to targets, long distance axonal transport, Hormones produced by Neurosecretory cells and their function
10. Prothoracicotropic hormone, Allatotropin, Allatostanin, Diapause hormone, Bursicon, Eclosion hormone, Proctolin, Diuretic hormone and Heart beat accelerating factor
11. Corpus cardiacum : Structure , Hormones produced by Corpus Cardiacum and their functions, Corpus allatum : structure and functions of JH, JH as a gonadotropin
12. Prothoracic gland and ring gland, ecdysone and its functions; Ovarian ecdysones-structure and function, synthesis of ecdysone. Role of Juvenile hormone analogues and ecdysteroids in pest control

Suggested Books:

1. Comparative Vertebrate Endocrinology, Bentley, P. J., Cambridge University Press, UK

2. Vertebrate Endocrinology, Norris D. O., Elsevier Academic Press,

3. Hand Book of Physiology, American Physiological Society, Oxford University Press, Section 7: Multiple volumes set.

4. The Insects: Structure and Function, Chapman, F.R., The English Language Book Society (ELBS) and The English Universities Press Ltd.

5. The Principles of Insect Physiology Wigglesworth, V. B., ELBS and Chapman and Hall.

6. Endocrinology (3 volumes set), *DeGroot* L. J. and Jameson J.L., Editors, (5th Ed., 2006), Saunders Elsevier Press, USA.

7. Molecular Biology of Steroid and Nuclear Hormone receptors, ed. Freedman L. P., (1998), Birkhauser, Boston, USA

8. Biochemical actions of hormones, ed. Litwack, G. (1985), Academic press, New York, USA
Brooks and Marshall: Essentials of Endocrinology, Blackwell Science. 1995

9. Turner and Bagnara: General Endocrinology, W. B. Saunders Company Philadelphia. 1984

10. Larson: Williams Text Book of Endocrinology, 10th edition. W. B. Saunders Company, Philadelphia. 2002.

M.Sc. 2nd SEMESTER
Paper-ZOO-2034 (DEVELOPMENT BIOLOGY)
(Marks 40+10) Theory credit: 4 Credits

Unit-I

1. Principles of experimental embryology: the developmental dynamics of cell specification stem cells and developmental commitment, totipotency and pluripotency.

2. Morphogenesis and cell adhesion-the thermodynamic model of cell interactions, concept of morphogen gradients and morphogenetic fields, cell adhesion molecules
3. Fertilization-pre and post fertilization events, activation of eggs, Gamete fusion and prevention of phylogeny
4. Nucleo cytoplasmic interaction in development of unicellular organisms and in early development and differentiations of multi cellular organisms, Importance and role of cytoplasm, hybridization experiments, nature of changes in nuclei, cell hybridization and nuclear transplantation experiments.
5. Cell to cell communications in development: Induction and competence, Reciprocal and sequential inductive events, Instructive and permissive interactions, Epithelial and mesenchymal interactions, Genetic specificity of induction, Paracrine Factors; the inducer molecules.

Unit-II

6. Role of maternal contribution in early embryogenic development in Drosophila: Maternal effect genes, gap genes, pair rule genes, segment polarity genes, homeotic genes and hox genes in development.
7. Organogenesis: vulva formation in *Caenorhapditis elegans*.
8. Regeneration: Epimorphic regeneration of Salamander limbs, Morphallactic regeneration in hydra, Compensatory regeneration in Mammalian liver.
9. Different types of stem cells and their applications ,,Regeneration therapy.
10. Role of environment in animal Development: Gravity and pressure, Developmental symbiosis ,Larval settlement. Diapause: suspended development.

Suggested Books:

1. Developmental Biology, Gilbert, (8th Ed., 2006) Sinauer Associates Inc., Massachusetts, USA.
2. Principles of Development, Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, (3rd Ed., 2006), Oxford University Press, New Delhi, INDIA.
3. Analysis of Biological Development, Kalthoff, (2nd Ed., 2000), McGraw-Hill Science, New Delhi, INDIA.

M.Sc. 2nd SEMESTER

Paper-ZOO-2044 (ANIMAL CELL CULTURE, AND GENETIC ENGINEERING)
(Marks 40+10) Theory credit: 4 Credits
UNIT 1:

1. Cell culture: Basic techniques of cell culture. Development of primary cell cultures; cell separation, harvesting and maintenance of cell lines; Transformation and differentiation of cell cultures, types of cell culture: monolayer, suspension, clonal and stem cell culture, cryopreservation cell lines.
2. Cell culture Media: Primary and established cell line cultures; Media supplements- their metabolic functions; Serum and protein-free defined media and their applications.
3. Measurement of viability and parameters of growth. Cell cycle analysis and synchronization of cultures; Assessment of cell culture contaminants, safety parameters.
4. Cell culture Bioassays: Cell proliferation assays

UNIT-2

5. Automated sequencing methods; Sanger's dideoxynucleotide method; Shotgun DNA DNA sequencing method; Polymerase chain reaction and its advantages.
6. DNA polymorphism: Basis of DNA typing/fingerprinting; Expressed sequence tags and their use for developing STSs, SSRs and SNPs
7. Basic biology of cloning vectors: plasmids, phages, single stranded DNA vectors, high capacity vectors, retroviral vectors, expression vectors, and other advanced vectors in use; genomic library and cDNA library
8. RNA interference: History, molecular mechanisms and applications of antisense RNA, microRNA, siRNA, and ribozymes.
9. Gene and somatic cloning techniques
10. Transgenic technology-animals as bioreactors

Suggested Books

1. Principle of Genome Analysis and Genomics, Primrose, S. B. and Twyman R. M., (7th Ed., 2006), Blackwell Publishing Company, Malden, USA
2. Genomes 3, Brown, T. A., Garland Science Publishing, London, UK
3. Cultures of animal cell. R. Freshny
4. Basic cell culture protocol. Cheryl D. Helgason
5. Animal cell culture essential methods. John M. Davis

M.Sc. 2nd SEMESTER
Paper-ZOO-2054 (Animal Behaviour)
(Marks 40+10) Theory credit: 4 Credits

Unit-I

1. Patterns of animal behavior
   a. Objectives and mechanism of behaviours.
   b. Types of reflexes, characteristics of reflexes and complex behaviour.
   c. Orientation: Primary and Secondary Orientation, Sum-Compass Orientation.
   d. Kinesis: Orthokinesis and Klinokinesis.
   e. Taxis: Different kind of taxis.
2. Development of behaviour: Genetic basis of behaviour, Hormone brain relationship
3. Neural basis of behaviour: Key stimuli, Stimulus filtering, Supernormal stimuli, Open and closed IRM, Biological rhythms.
4. Learning Definition, Types of learning, Neural mechanism of learning
5. Communication : Types of communications-Auditory communication ; Infrasound communication among Elephants and Whales; Sonar,Navigation,and communications;Vocalization in nonhuman primates;Ecolocation in Bats; Visual communication; Chemical signals;Functions of scent in vertebrates; Tactile communications.

Unit-II

6. Motivational system: Physiological basis of motivation, control of hunger drive and thirst drive in animals. Motivational conflict and decision making, displacement activity, models of motivation, measuring motivation, hormones and pheromones influencing behaviour of animals.
7. Sociobiology:Units of Sociobiology; major social behaviours; Alturism: Reciprocal altruism, group selection, kin selection and concept of inclusive fitness, cooperation , /reciprocation; Selfishness; Eusociality.
8. Reproductive strategies: Sexual selection, intrasexual selection (male rivalry), intersexual selection (female choice), infanticide, mate guarding.
9. Parental Behaviour:Care before birth;Care after birth; Early parental care;Types of parental care ;Factors affecting parental care; Care and attachment; Parent offspring conflict..

Suggested Books:

1. Mechanism of Animal Behaviour, Peter Marler and J. Hamilton; John Wiley & Sons, USA

2 Animal Behaviour, David McFarland, Pitman Publishing Limited, London, UK

3 Animal Behaviour, John Alcock, Sinauer Associate Inc., USA

4 Perspective on Animal Behaviour, Goodenough, McGuire and Wallace, John Wiley & Sons, USA

5 Exploring Animal Behaviour, Paul W. Sherman & John Alcock, Sinauer Associate Inc. ,Massachusetts, USA

6 An Introduction to Animal Behaviour, A. Manning and M.S Dawkins, Cambridge University Press, UK

7. Alcock : Animal Behaviour- An Evolutionary Approach. (7th ed.) Sinaur Associates, Inc. 2001.

8. Drickamer & Vessey: Animal Behaviour –Concepts, Processes and Methods (2nd ed.), Wadsworth, 1986.

9. Gadagkar: Survival Strategies-Cooperation and Conflict in Animal Societies. Universities Press,1998.

10. Grier : Biology of Animal Behaviour, Mosby, 1984.
11. Hallidy and Slater : Animal Behaviour(vols. I-3) Blackwell Scientific Publ., 1983.
12 Krebs & Davis : Behavioural Ecology. (3rd ed.) Blackwell, 1993.
13. Lehner : Hand Book of Ethological Methods.(2nd ed.) Garland, 1996.
14. Slater & Halliday : Behaviour and Evolution,(1st ed.) Cambridge Univ. Press, 1994.

M.Sc. 2nd SEMESTER
Paper-ZOO-2064 (ANIMAL PHYSIOLOGY)
(Marks 40+10) Theory credit: 4 Credits

UNIT I:

1. Body Fluid: Blood, Lymph, Hydrolymph, Hemolymph: Chemical compositions and Functions
2. Cardiac Cycle, Specialized conducting system of heart, generation and conduction of cardiac impulse, neurohomonal regulation of cardiac amplitude and frequency.
3. Respiratory system in vertebrate: Pulmonary ventilation, alveolar ventilation, diffusion and transport of gases, Basal metabolic rate. Respiratory centers: organization and function
4. Counter current mechanism of urine formation, RAS and hormonal regulation of urine formation. Acid-base balance and homeostasis
5. Nutrition: Gastro intestinal hormones and digestive enzymes: chemical nature and functions.

UNIT II:

6. **Nervous system:** Neurons and types of neurons, Types of synapses and synaptic knobs, Axonal transmission.
7. Membrane potential and generation of action potential. Sodium-potassium pump, Synaptic transmission, neuromuscular junction Excitatory and inhibitory post-synaptic potential, Chemical transmission, neurotransmitters (acetylcholine, or catecholamines, serotonin and GABA), Autonomic nervous system (Sympathetic and parasympathetic)
8. Special sensory system: Eye: Anatomical Organisation of retina, Photoreceptors: Processing of visual impulses Ear: Cochlea, basilar membrane, and organ of Corti. Generation of endochochlear potential. Processing of auditory impulses.
9. Muscle: Contractile proteins, Ultrastructure of skeletal muscles, Properties of muscle: muscle twist, summation, tetanus and fatigue, Sliding filament theory of muscle contraction and regulation.

SUGGESTED BOOKS:

1. Ganong: Review of Medical Physiology (21st Ed.), Lang Medical Publications, 2003
2. 2. Guyton and Hall: Text Book of Medical Physiology (10th Ed.), W.B. Saunders, 2001

3. Keel et al: Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989
4. Murray et al: Harper's Illustrated Biochemistry (26th Ed.), Appleton & Lange, 2003
5. West: Best and Taylor's Physiological Basis of Medical Practice (11th Ed.), Williams and Wilkins,1981.

M.Sc. 2nd SEMESTER
Paper-ZOO-2072 (BIODIVERSITY, ANIMAL BEHAVIOUR & DEVELOPMENTAL BIOLOGY) (PRACTICAL)
(Marks 20+5) Theory credit: 2 Credits

1. Collection and identification of egg (at least six different types)
2. Study of life cycle of *Drosophila melanogaster*.
3. Dissection and study of larval pre pupal wing, leg, eye, and antennal imaginal disc in *D. melanogaster*.
4. Preparation and study of frog/mice sperm smear.
5. Detection of SH proteins during various stages in the early development of amphibian embryo.
6. Study of developmental stages of fish from egg to hatchling.
7. In vitro culture of chick embryo.
8. Study of chick embryo using vital staining.
9. Study of cell death during development.
10. Activity budgeting of bird/mammal
11. Effect of toxicant on opercular movement and surfacing in fish.
12. Effect of toxicant on movement of fish.

Paper-ZOO-2082 (ENDOCRINOLOGY, ANIMAL PHYSIOLOGY, BIOTECHNOLOGY AND TISSUE CULTURE)
(Marks 20+5) Theory credit: 2 Credits

1. Neuroendocrine system of cockroach – Dissection and display
2. Prothoracic gland of cockroach – Dissection, display and mounting
3. Mounting of prothoracic gland
4. Thyroid and parathyroid gland of mouse/chicken – dissection and display and slide preparation
5. Pituitary gland of mouse /fish – Dissection, display and permanent slide preparation using metachromatic stains.
6. Steroid and thyroid hormone assay by ELISA
7. Histological study of endocrine glands of vertebrates
8. Detection of uric acid in malpighian tubules
9. Hemocyte count and estimation of protein in hemolymph.
10. Total RBC and WBC count in human blood.
11. Isolation of genomic DNA from mammalian tissue.
12. Restriction-digestion of DNA sample and separation of fragments by performing agarose gel electrophoresis. Interpretation of the results by comparing with the standard digests.
13. MTT cell proliferation assay, cell viability assay.

Semester-3

Code	Course	Credit	Contact hour	Total marks	Type

ZOO-3014	**Cell Biology**	4	54	40+10	Core (Theory)
ZOO-3024	**Immunology, Microbiology and Parasitology**	4	54	40+10	Core (Theory)
ZOO-3034	**Reproductive Biology**	4	54	40+10	Core (Theory)
ZOO-3044	**Entomology and Aquatic Biology**	4	54	40+10	Core (Theory)
ZOO-3056 (Open I)	**Integrative Biology**	6	81	60+10	Open
ZOO-3063	**Cell Biology, Histology, Histochemistry, Immunology and Reproductive Biology**	3	54	30+7.5	Practical
ZOO-3073	**Aquatic Biology, Fishery, Entomology, Parasitology**	3	54	30+7.5	Practical

Total-28 credits

M.Sc. 3rd SEMESTER
Paper-ZOO-3014 (CELL BIOLOGY)
(Marks 40+10) Theory credit: 4 Credits

1ST HALF

1. Chemical complexity and organization : distinctive structural and molecular features of prokaryotic and eukaryotic cells
2. Models of plasma membrane structure , membrane lipids, proteins and carbohydrates, organizational and functional features of plasma membrane
3. Cytoskeleton, microfilament, microtubules and intermediate filaments – structure and dyanamics
4. Cell movement, intracellular transport, role of kinesin and dyenin, cilia and flagella-structure and function
5. Cell to cell adhesion : Ca++ dependent and CA++ independent homophilic cell-cell adhesion, Gap junctions and connexins, cell matrix adhesion – intrigrins, collagen
6. Cell cycle : cyclins and cyclin dependent kinases; regulation of cdk-cyclin activity,cell cycle checkpoints.

2nd HALF

1. Biogenesis of membrane bound organelle: Mitochondria and nucleus.
2. Protein import and mitochondrial assembly.
3. Peroxisomes,functions of peroxisomes. Peroxisome assembly.
4. Regulation of gene expression in prokaryotes and Eukaryotes, and RNA editing
5. Intracellular protein traffic: Protein synthesis on bound and free polysomes, membrane proteins, golgi sorting uptake into ER; Post-transcriptional modifications and trafficking mechanism.
6. Apoptosis: definition, mechanism and significance

M.Sc. 3rd SEMESTER under revision
Paper-ZOO-3024 (IMMUNOLGY, MICROBIOLOGY AND PARASITOLOGY)
(Marks 40+10) Theory credit: 4 Credits

UNIT-1

Innate and acquired immunity – components and characteristic features, primary and secondary responses

Cells of the immune system : Types of cells and their subsets responsible for immune response- WBC, macrophages, dendritic cells, B,T and NK cells; Basic concept of B and T cell antigen receptors and CD markers, Cell cooperation in immune response

Lymphoid organs – primary and secondary lymphoid organs and their functions, their micro and macro structures, vascular and lymphatic connections.

Immunoglobulins : Structure and domain of Ig molecule, Ig classes, subclasses and types; Myelema protein, monoclonal antibody, Ig superfamily

Antigen-antibody reaction: antibody affinity and avidity cross reactivity, agglutination reaction, precipitation reaction.

UNIT-2

Microbial diversity:Prokaryotic microbes-Bacterial and archea; Eukaryotic microbes-Anaerobic and aerobic Protozoa.

Microbial pathogenesis: Invasiveness and Toxigenicity; pure culture techniques of microbes.

Applied microbiology: Microbial products; Food microbiology; Biocontrol; Biological weapons; Wastewater treatment.

Parasitism: General consideration, Types of parasites, Types of Hosts, symbiosis and Commensalism

Distribution, habit and habitat, structure and life cycle of economically important helminth parasites of man and domesticated animals: *Echinococcus granulosus, Hymenolepis nana,, Scistosoma haematobium, Trichinella spiralis* and *Wuchereria bancrofti*

M.Sc. 3rd SEMESTER
Paper-ZOO-3034 (REPRODUCTIVE BIOLOGY)
(Marks 40+10) Theory credit: 4 Credits

UNIT I

1. Development of gonads and Disorder of gonadal development
2. Sexual differentiation within the gonads
   Anatomical organization of male and female reproductive system
3. Reproductive life cycle
4. Puberty and adolocence, role of hormones
5. Reproductive cycles in animals and human: Estrous and menstrual cycle
6. Ovarian Follicular development: Folliculogenesis, mechanism of ovulation
   In mammals
7. Testicular organization, seminiferous epithelium cycle, Spermatogenesis

UNIT II

8. Role of hormones in fertilization,
9. Placenta and Placental hormones
10. Implantation and role of hormones
11. Pregnancy and hormones of pregnancy.
12. Development of breast, Lactation and hormonal regulation
13. Parturition in mammals
14. Assisted reproductive Techniques: IVF-ET
    Environmental endocrine issue: environmental estrogens, endocrine disruptors

M.Sc. 3rd SEMESTER
Paper-ZOO-3044 (AQUATIC BIOLOGY AND FISHERIES)
(Marks 40+10) Theory credit: 4 Credits

UNIT 1

1. Classification of class of Insect up to Orders with salient features and common example.
2. Useful insects: Insects and Insect products, Pollinating insects, insect used as food and medicine.
3. Harmful insects: Insect pests, vectors of diseases.
4. Insect's role in ecosystem and nutrient cycle.
5. Insects as environmental indicator.
6. Concept of Pest management

UNIT II

7. Limnology: Introduction, Definition of limnology, Essential nature of limnology.
8. Aquatic Resources: Characteristic features of fresh water, brackish water and marine water environment.
9. Freshwater Environment: Extent and distribution of freshwater. Lotic environments, ideological classification of fresh water biota. Freshwater communities.
10. Rivers: Origin and characteristics of Rivers, Function and Biological productivity
11. Major threats to freshwater ecosystem including pollution and sand mining, impact of large dams.
12. Fish germplasm diversity of North East India — their prospects, problems & conservation strategy.
13. Ornamental fishes of North-East India and exotic ornamental fishes: their culture & breeding techniques.

M.Sc 3rd SEMESTER
PAPER Z-3056 (OPEN I): 6 credits
INTEGRATIVE BIOLOGY

Molecules and their interactions: Structures of atoms, molecules and chemical bonds, Stabilizing interactions (van der waal's, Electrostatic, Hydrogen bonding, Hydrophobic interactions, etc)

Growth, yield and Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.

Conformation of Nucleic acids (A-, B-, Z- DNA), t-RNA and micro RNA.

Microbial Physiology: Growth, yield and characteristic, strategies of cell division, Stress response.

Cell signaling: Hormones and their receptors, signaling through G protein coupled receptors, signal transduction pathways, second messengers, and regulation of signaling pathways, bacterial chemotaxis and quorum sensing.

Cellular communication: Regulation of haematopoeisis, neurotransmission and its regulation

Gene mapping methods: Linkage maps, tetrad analysis, Mapping by using somatic somatic cell hybrids

Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

Quantitative genetics: Polygenic inheritance, heritability and its measurements.QTL mapping.

Recombination: Homologous and non-homologous recombination including transposition, site specific recombination.

Population genetics- population, gene pool, gene frequency; concepts and rate of change in gene frequency through natural selection.

M.Sc. 3rd SEMESTER
Paper-ZOO-3063(CELL BIOLOGY, HISTOLOGY, HISTOCHEMISTRY, IMMUNOLOGY AND REPRODUCTIVE BIOLOGY)

(Marks 20+5) Theory credit: 3 Credits
PRACTICAL

1. Isolation of mitochondria from mouse liver by differential centrifugation and staining.
2. Microtubules in vesicle transport in fish chromatophore.
3. Observation of DNA fragmentation in apoptotic cell
4. Dissection and histology of lymphoid organs in rat/mouse.
5. Differential WBC count in mammalian blood.
6. Isolation of B lymphocytes.
7. Cell viability and count using trypan blue stain from bone marrow and spleenocytes.
8. Detection of DNA, glycogen and protein using cytochemical technique.
9. Preparation of histological slides from testis and ovary.
10. Study of estrous cycle.

M.Sc. 3rd SEMESTER

Paper-ZOO-3073 (AQUATIC BIOLOGY & FISHERIES, ENTOMOLOGY AND PARASITOLOGY)

(Marks 20+5) Theory credit: 3 Credits
PRACTICAL

1. Estimation of soil parameters: pH, Organic Carbon, phosphate.
2. Estimation of primary productivity by LB-DB Method.
3. Collection and Identification of Plankton, Aquatic Insects, Aquatic Macrophytes.
4. Estimation of turbidity using Secchi-Disc method.
5. Identification of indigenous and exotic ornamental fishes under different families.
6. Identification of insects belonging to different orders.
7. Identification of different types of insect mouth parts, antennae and legs.
8. Salivary gland of honey bee — dissection and temporary mounting.
9. Dissection of sting apparatus in honey bee.
10. Study of prepared slides and museum specimens of selected parasites of representative groups of protozoans, parasites, helminthes and arthropods.
11. Preparation and identification of permanent slide of rectal ciliates in frog.
12. Culture and study of insect parasitoid on an insect host.

Fourth Semester

Elective 1: Animal physiology and Biochemistry

Code	Course	Credit	Contact hour	Total marks	Type
Zoo-4014	**Biochemistry and Proteomics**	4	54	40+10	Elective (Theory)
Zoo-4024	**Enzymology and Recombinant Technology**	4	54	40+10	Elective (Theory)
Zoo-4034	**Physiology and Adaptational Biology**	4	54	40+10	Elective (Theory)
Zoo-4044	**Molecular Endocrinology and Reproductive Biology**	4	54	40+10	Elective (Theory)
Zoo-4054	**Immunology**	4	54	40+10	Core (Theory)
Zoo-4064 *	**Dissertation**	6	81	60+15	Dissertation (Elective)
Zoo-4072	**Practical 1 (Biochemistry and Enzymology)**	2	54	20+5	Practical

M.SC 4th SEMESTER (ANIMAL PHYSIOLOGY AND BIOHEMISTRY)
BIOCHEMISTRY AND PROTEOMICS
CODE: Zoo-4014
CREDIT: 04
UNIT I:BIOCHEMISTRY

1. Biological standard state and free energy change in coupled reaction.Biological oxidation reduction reaction, redox potentials, relation between standard reduction potential and standard free energy change. High energy phosphate compound –introduction, phosphate group transfer, free energy of hydrolysis of ATP
2. Carbohydrates: Regulation of TCA cycle , Cori cycle, futile cycle and anapleortic reaction
3. Lipids :
   Cholesterol: Biosynthesis and degradation. Lipid transport and storage. Biosynthesis of eicosanoids: Prostaglandins, leucotrienes and thromboxanes. Biosynthesis and degradation of porphyrin and heme
4. Nucleotides : Biosynthesis and regulation of purine and pyrimidine nucleotides
   Catabolism of purines and pyrimidines
5. Eukaryotic Transcription :

   General introduction, characteristics of promoters and enhancer elements. Activators and repressors of transcription. Different DNA binding domains like zinc finger, helix-turn-helix, leucine zipper, helix-loop-helix. Properties of eukaryotic RNA polymerases and their mode of action, assembly of basal transcription apparatus at the promoter, initiation, elongation and termination of transcription.

6. Post-transcritional processing
   RNA binding proteins and RNA motifs. Transcription attenuation .Processing of pro- and eukaryotic rRNA and tRNAs . RNA targeting and mRNA stability

UNIT II: PROTEOMICS:

1. Protein chemistry

Levels of protein structure:
Secondary structure: H-bonding scheme, Diversity in alpha-helices, Helix capping, Beta-Stand and sheet, Turns and loops, Importance of loops. *Supersecondary structure*: Domains
and motifs.
Tertiary structure: General properties and characteristics, Protein Data Bank (PDB). *Quaternary structure*: Concept of subunits and protomers and their association, Importance of quaternary structure, Various examples.

2. Protein Folding

   Anfinsen's classical experiment; Folding curves and transitions;Types of protein folding and intermediates; Models of protein folding; Assisted protein folding (Chaperones).

3.Post-translational processing, targeting and turnover
4. Techniques to investigate protein structure and folding

Spectroscopic methods : Absorbance, Fluorescence, Circular dichroism;
Structural methods : NMR; X-ray crystallography.

5. Microarrary,2D-electrophoresis,protein sequencing,mass spectrometry.

M.SC 4th SEMESTER (ANIMAL PHYSIOLOGY AND BIOHEMISTRY)
ENZYMOLOGY AND RECOMIBNANT TECHNOLOGY
CODE: Zoo-4024
CREDIT: 04

UNIT I: ENZYMOLOGY

1. Kinetics:
   Single substrate reactions: Steady state and equilibrium kinetics, Michaelis-Menten equation and plot.Linear kinetic plots: Lineweaver Burk, Hanes Wolf, Edie Hofstee, Eadie Scatchard plot .Importance of Kcat/km, Kinetics of Zero and first order reaction, Calculations on enzyme kinetics,
2. Multi-substrate reactions:
   Random sequential, Ordered, Ping-pong (double reciprocal) mechanism
3. Allosteric enzyme
   Qualitative description of concerted and sequential model for allosteric enzyme
4. Enzyme Inhibition: Reversible inhibition and Irreversible inhibition
   Competitive; Non-competitive; Un-competitive and mixed, Determination of nature of inhibition and Ki by LB
5. Regulation: Allosterism, covalent modifications and regulation by proteolytic clevage

6. Protein ligand binding measurement, Hill and Satchard plot

UNIT II: Recombinant Technology

1. Restriction and Modification systems in *E. coli* and their use in recombinant library constructions.
2. Biology of filamentous phages, development of phage and phagemid vectors.
3. Biology of Bacteriophage lambda, Promoters and control circuits, phage assembly and *in vitro* packaging and development of vectors for different types of Libraries.

4. Vectors for cloning large fragments of DNA, (Cosmid, PAC, YAC and BAC) and strategies for cloning large DNA fragments. Strategies for constructing cDNA libraries and screening using Nucleic acid and antibody probes.

5. Introduction to next generation sequencing (NGS). Polymerase chain reaction and its application in research including cloning of PCR amplified fragments, mutagenesis and construction of Libraries. Real time/quantitative PCR.

6. Subtractive Libraries, Expression based strategies for cloning of functional genes.

PHYSIOLOGY AND ADAPTATIONAL BIOLOGY
CODE: Zoo-4034
UNIT I : PHYSIOLOGY

1. Gastrointestinal Hormones and digestive Enzymes,Regulation of Gastrointestinal secretions and functions, The enteric nervous system, Glucose homeostasis.

2. Mechanism of blood coagulation and hemostatis
3. Cardiac cycle events, regulation of cardiac amplitude and frequency
4. Counter current mechanism of urine formation
5. Physiology of movement and locomotion, Biochemistry of contractile proteins,Sources
   of energy for muscle contraction, Sliding filament theory Excitation of contraction and mechanism of regulation of contraction by calcium Mechanism of relaxation
6. Auditory and visual motion processing

UNIT II:

1. Physiology of neuronal system: Excitable membrane: a)Membranes potential b)Ions as current carriers-Protons,calcium,potassium,structure of cation-permeable channels and chloride channels Synaptic transmission: Electral transmission,chemical transmitters-Neuropeptide,FMRF-amide family
2. Respiration: Regulation of respiration, Respiratory functions of blood: Respiratory pigments, respiratory acidosis and alkalosis, Alkali reserve. Control and co-ordination of respiration, Respiratory adjustments , Hypoxia and oxygen therapy, Dyspnea, Periodic breathing, Respiratory buffering. High altitude: decreased pressure of gas, hypoxic effects, mountain sickness and acclimatization
3. **Adaptations to Stress**
   Environmental stress, acclimation, acclimatization, avoidance and tolerance, stress and hormones. Sensing the Environment- holoreception, chemoreception, mechanoreception, echolocation, Endogenous and exogenous biological rhythms,
4. Osmoregulation in aquatic and terrestrial environments.Thermoregulation - Heat balance in animals, Adaptations to temperature extremes, torpor, Aestivation and hibernation, Counter current heat exchangers.
5. Space Physiology: Physiological requirement of space travel

MOLECULAR ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY
CODE: Zoo-4044
CREDIT: 04

UNIT I : MOLECULAR ENDOCRINOLOGY

1. Hypothalmic releasing hormones: Regulation of hypothalamic hormone secretion.
2 Pituitary hormones and regulation of pituitary hormone secretion

3. Hormonal feedback
4. Hormone receptors and Hormonal signal transduction.

5. Neorosecretory hormones in insects and crustaceans and their function

6. Principle and procedure of RIA and radio receptor assays, ELISA,Cell culture bioassays: Ishikawa estrogen assay and recombinant yeast assay.

UNIT II : Reproductive Biology

1. Reproductive cycles:Regulation of reproductive cycle in female: menstrual cycle in human, estrous cycle in rat.

2. Early embryogenesis and biology implantation: Pre-implantation embryo development. Functional markers of embryo. Molecular basis of uterine-blastocyst interaction. Cellular and endocrine aspects of implantation. Types of implantation
3. Control of fertility and sterility: Male: Origin, cause and treatment of male sterility, Azoospermia, Oligozoospermia Asthenozoospermia and Varicocoele
4. Female: Origin, cause and treatment of female sterility
5. Mechanism of action of oral contraceptives, Surgical sterilization, with reference to tubectomy
6. Hormone Replacement Therapy (HRT), Ovulation Induction and Enhancement: Treatment of infertility,ZIFT,GIST,ICSI,Environmental estrogens,Endocrine disruptors.

IMMUNOLOGY
CODE: Zoo-4054
CREDIT: 04
UNIT I

1. Complement system: classical and alternate pathways of complement activation
2. Complement and inflammation, formation of membrane attack complex
2. Cytokine structure and function, cytokine receptor, Cytokine and immune response.
3. Genetic Basis of Ab Structure
4. Genetic organization of MHC, role of MHC in activation of T lymphocyte, Association of diseases with MHC haplotypes
5. The T Cell Receptor: Structure and Genetic Basis , Antibody-Mediated Reactions , Cell-
   Mediated Reactions

UNIT II

1 Immunology of HIV Infection
2 Infection and Immunity
3. Immune Regulation & Tolerance
4. Autoimmunity
5. Immunology of Cancer
6. Immunoprophylaxis (Vaccines) & Immunotherapy, Transplantation immunology,Modern
   Antibody therapy

Paper-Zoo-4064
Dissertation
Credit=6, Contact Hour=81, Total Marks=60+15=75

M.SC 4th SEMESTER (ANIMAL PHYSIOLOGY AND BIOHEMISTRY)
(BIOCHEMISTRY, PROTEOMICS AND ENZYMOLOGY)
PRACTICAL CODE: Zoo-4072
CREDIT: 02

1. Estimation of tissue protein by Bradford method.
2. Estimation of total free amino acid by using Ninhydrin reagent.
3. Determination of amylase activity and calculation of amylase number.
4. Study of effect of time on arginase activity by calorimetric method and assay of arginase enzyme by spectrophotometric method
5. To study the effect of temperature on arginase activity
6. To study the effect of P^H on Arginase activity
7. To analyse the expression of beta actin mRNA by qPCR
8. Determination of inhibitor constant (ki) for L-Orinithine against Arginase enzyme by LB plot
9. Study of estrous cycle in rat/mice
10. Histological detection of a glucose-6phosphate
11. To study sperms count and motility in mice
12. Histologiccal study of testis, ovary,pancrease,pituitary,adrenal,thyroid and para-thyroid in mammals.
13. SDS-PAGE analysis of placental proteins.
14. Purification of IgG from plasma using Protein A Sepharose affinity chromatography.

SEMESTER-4
ELECTIVE 1: Animal Ecology and Wildlife Biology

Code	Course	Credits	Contact hours	Total Marks	Types
Z-4014	**Ecosystem Functions and**	**4**	**54**	**40+10=50**	**Elective(Theory)**

	Stability				
Z-4024	**Wildlife and Wildlife Habitat Relations**	**4**	**54**	**40+10=50**	**Elective(Theory)**
Z-4034	**Wildlife Population Ecology and Methods**	**4**	**54**	**40+10=50**	**Elective(Theory)**
Z-4044	**Wildlife Conservation**	**4**	**54**	**40+10=50**	**Elective(Theory)**
Z-4054	**Wildlife Management**	**4**	**54**	**40+10=50**	**Elective(Theory)**
Z-4066	**Dissertation**	**6**	**81**	**60+15=75**	**Dissertation**
Z-4072	**Practical**	**2**	**54**	**20+5=25**	**Practical**

M. Sc. FOURTH SEMESTER
SPECIAL PAPER: ANIMAL ECOLOGY & WILDLIFE BIOLOGY

PAPER- Z-4014

ECOSYSTEM FUNCTIONS AND STABILITY

Total credits: 4 Total Contact hours: 54 Total Marks: 40+10

Unit-I: Ecosystem Function (Credits 2) Total Contact hours: 27

Ecosystem Productivity, Measurements of Primary and secondary productivity, food chain and trophic level, Functional rules and guilds, Keystone species, Nutrient cycling, Nutrient Pools and exchange, Phosphorous cycle, Energy flow Models, Nutrient cycles in forests, Ecosystem developments, Restoration ecology and its relevance to present context, Bioenergetics of ecosystem development, relevance of Ecosystem development theory to human ecology. Ecological efficiencies, Ecological Niche, Niche overlap, Niche separation, Niche Relationship and community structures, Ecological equivalents, Parallel niche, Competitive Displacement, Principles of co-existence.

Unit-II: 2 Ecosystem Stability (Credits 2) Total contact hours: 27

Meaning of Stability and Stability concept, Types of Stability; Resistance and resilience stability, Relationship of Species Diversity and Stability, Stability of Isolated Population, Stability of their steady state and Influence of random perturbations on population Stability, Ecosystem maturity and role of Natural selection, Natural and Artificial ecosystems, Theory of ecosystem succession, Climax concept and Significance of ecological succession, two views of community organizations. Ecological Principles of Management, Role of Ecologist in the management of Natural Ecosystem, Management Techniques, Significance of Planning of Ecosystem Management, Ecological Risk Assessment, Analytical methods for ecological risk assessment in terrestrial and Aquatic ecosystem and planning and strategies.

SPECIAL PAPER: ANIMAL ECOLOGY & WILDLIFE BIOLOGY

PAPER- PAPER- Z-4024
WILDLIFE AND WILDLIFE HABITAT RELATIONS
Credits: 4 Total Contact Hours: 54 Total marks: (40+10) =50

UNIT-I: Wildlife Habitat (2 Credits) Total Contact hours: 27

Characteristics, Compositions and distribution of Grassland Ecosystem in India and NE India; Wetland definition, Ramsar Convention and criteria for inclusion, wetland formation and types; Types of forest in NE Region, Dominance species composition in different Forest types (Tropical, Temperate and Alpine forest), Canopy openness, closed Canopy and Open canopy forests,. High altitudes habitat of wildlife and wildlife species compositions; Wildlife Habitat Assessment by Community Dominance Index (CDI), Canopy Area Coverage, Foliage Height Diversity (FHD), Similarity and Dissimilarity index and Association index, Changing patterns of environmental gradients of light, temperature and humidity in degraded forest and its impact on wildlife.

Unit II: Wildlife Habitat Relations (2 Credits) Total Contact hours: 27

Succession of Wildlife Habitat within the Wildlife Sanctuaries and National parks of Assam (KNP, ONP, NNP, MNP & PWLS), Implication of habitat Succession in wildlife, Forest fragmentation & wildlife Habitat loss, Gap formation and their impact on wildlife, Gap dynamics, impact of climate changes on wildlife species, Island Factor and its relationship with present day wildlife conservation networks, Habitat utilization pattern of Rhino, Elephant, Greater Adjutant Stork, Golden Langur and Tiger. Habitat selections, Evolution of habitat preferences, theory of habitat selections, Loss of wetland habitat and its relation to wildlife species. Ecological Role of Wetlands as a Wildlife Habitat, role of wetland ecosystem in Biodiversity conservation.

M. Sc. FOURTH SEMESTER
SPECIAL PAPER: ANIMAL ECOLOGY & WILDLIFE BIOLOGY

PAPER- Z-4034
WILDLIFE POPULATION ECOLOGY AND METHODS

Total Credits: 4 **Total Contact Hours: 54** **Total marks: (40+10) =50**

Unit-I: Wildlife Population Ecology (Credit 2) **Total Contact Hours: 27**

Wildlife Population Characteristics, Carrying capacity of wildlife, Characteristics and types of Carrying capacity; Carrying capacity of wildlife habitat and wildlife population sizes, Sign of wildlife habitat carrying capacity and population health, Competition and its types, Competition for resources, Dispersal, three mode of dispersal; concepts of ecological density and crude density; Evolutionary advantages of dispersal, vital statistics: life table and life table preparations, reproductive value; Causes of Migration, Migratory routes of birds associated with NE India, study of bird migration and local movement pattern using mist nets and colour banding pattern and metallic rings; Home range: Importance of Home range in species conservation, Territoriality among Mammals and Birds.

Unit-II: Wildlife Study Methods (Credit 2) **Total Contract hours: 27**

Methods of Samplings & Sampling Design; Studies of terrestrial vegetation for Wildlife habitat, Why Sampling design has been prior to any study and its importance, differences between Random and stratified random sampling and systematic random sampling in wildlife habitat, Statistical analysis of wildlife data using computer software and circular statistics, Occupational survey methods and its necessity for the study of large vertebrates, research designed and statistical approach for hypothesis testing; Methods for Wildlife Population Survey, differences between population survey and census, Importance of Wildlife Census, Direct and Indirect methods of wildlife census, Mist netting techniques, Radio telemetry techniques, Modern Census Techniques of Rhino, Tiger, Elephant**,** Migratory and residential birds, terrestrial birds, Herpetofauna, butterflies, spiders & other invertebrates. Study of wildlife home range using modern and individual ID techniques.

M. Sc. FOURTH SEMESTER
SPECIAL PAPER: ANIMAL ECOLOGY AND WILD LIFE BIOLOGY

PAPER- Z-4044:
WILDLIE CONSERVATION
Total Credit: 4 Total Contact Hours: 54 Total Marks: (40+10) =50

Unit-I: Wildlife Conservation (2 Credits) Total contact hours: 27

Umbrella, Flagship species and edge species, Importance of Umbrella and flagship species and its species conservation; Contribution of Wildlife in GNP, Distribution of Large Cats, Elephant, Rhino, Swamp Deer, Asiatic Wild Buffalos, Hoolock Gibbon and Globally endangered birds of NE Region, Endemic animals and Restricted Ranges species, Conservation needs, Economics and Ecological issues, Ecological Basis of Wildlife management, Identifying land for Nature Reserve, SLOSS debate, Wildlife Corridors, conservation prospects of urban wildlife and strategies. Metapopulation and metapopulation dynamics, concept of Island biogeography, Mammalian biogeography of Assam and India.

Unit-II: Conservation Practices (2 Credit) Total Contact hours: 27

Wildlife Conservation Evaluation: Attributes, Criteria and Values; IUCN Criteria of Threatened Wildlife, Conservation and Preservation, Biodiversity and types of diversity, importance of biodiversity Conservation, prospects of biodiversity in economic development, biodiversity & human livelihood, Global biodiversity hot spots, DNA Finger Printing, Genetic Depression, Conservation Practices in NE Region, Reintroduction and Translocation, In- situ and Ex- situ conservation, Modern conservation tool: Camera trapping, Micro Chips, Radio Collar, PTT/ NTT, Scat/ Dung analysis.

M. Sc. FOURTH SEMESTER
SPECIAL PAPER: ANIMAL ECOLOGY AND WILD LIFE BIOLOGY

PAPER- Z-4054
WILDLIFE MANAGEMENT & MANAGEMENT PRACTICES

Total Credit: 4 Total Contact Hours: 54 Total Marks: (40+10) =50

Unit I: Wildlife Management (Credits 2) Total contract hours: 27

Wildlife Protection (Act) 1972, Wetland (Act) 2016, Biodiversity (Act) 2002, CITES, Wildlife Crime, Conservation Breeding and Economics, Breeding species in Captivity, Effective Population size, Genetic Management in Captivity, Cryopreservation, Importance of DNA bar coding, Molecular aspects of wildlife management, wildlife forensic, Role of Zoo in species Conservation, Wildlife conservation model and management objectives, management of wildlife based on habitat and species carrying capacity. The impact of human wildlife conflict on natural systems. Non-lethal techniques for reducing depredation. The impact of human-wildlife conflict on human lives and livelihoods. Techniques to reduce crop loss: human and technical dimensions in Africa. Bearing the cost of human-wildlife conflict: the challenges of compensation scheme. Increasing the values of wildlife through non-consumptive use? Deconstructing the myths of ecotourism and community-based tourism in the tropics.

Unit II: Ecological Association & Wildlife Management (2 Credit) Contact ours: 27

Reasons of wildlife Taxonomic Diversity in NE Region, Historical, Evidence of species colonization in NE India, Utilitarian Values of Wildlife and species management, Pivotal linkages, in ecosystems, Wild mammals group, Linkage of Primates in Tropical ecosystem functioning, Importance of Wetland and Forests of NE region as complementary Habitat for Birds and Mammals, Important wildlife species composition in Kaziranga and Manas, Dehang-Debang, Nokrek and Namdapha NP.
Extinction and Estimating the risk of extinction, Quantifying risk of extinction, colonization and species extinction.

M. Sc. FOURTH SEMESTER
SPECIAL PAPER: ANIMAL ECOLOGY AND WILD LIFE BIOLOGY
PAPER- Z-4066
DISSERTATION
Total Credits: 6 Total Contact Hours: 81 Total Marks: (60+15) =75

1.	Preparation of dissertation (**4 credits**)	40	marks
	2. Presentations and Viva voce (**1 credits**)		10 Marks
	3. Field visits (**1 credits**)	10 Marks	

M. Sc. FOURTH SEMESTER
SPECIAL PAPER: ANIMAL ECOLOGY AND WILD LIFE BIOLOGY

PAPER- Z-4072
PRACTICAL
Total Credit: 2 Total Contact Hours: 54 Total Marks: (20+5) =25

1. Community Analysis
Measurements of species diversity and use of software; **(a)** Shannon Winner Index (H´), **(b)** Evenness Index, **(c)** Equitability Index **(E), (d)** Community Dominance Index (CDI), **(e)** Canopy area coverage, **(f)** Foliage Height Diversity (FHD).Association Index, Similarity & Dissimilarity index, Habitat classification, Point and Line transact techniques for wildlife and wildlife habitat data collection.

2. **Wildlife Census Techniques**
(**A**) Direct method (i) Line transact (ii) point transact (iii) Quadrate method (iv) Stratified & Random Sampling (**B**) Indirect Methods (i) Pellet Group counting methods/rate of defecation, scat/dung analysis (ii) Camera Trapping Method (iii) Pugmark Census and Analysis. Field base/ laboratory base studies of Bird, butterfly and herpetofauna; census techniques and species identification of birds & Butterfly.
3. Wildlife Behavior
(**A**) **Mammal's** (i) Scan animal sampling (**B**) **Bird's** (i) Time and Activity budgeting (ii) Foraging efficiency (iii) Habitat use pattern of wildlife species using Radio Telemetry, GPS, Compass bearing & GIS techniques, Identification of important food plant species of birds and mammals. Study of Edge index.

4. Statistical Analysis of Wildlife Data
ANOVA, t- test using equal variance assuming, Paired sample t- test; Principal, Component analysis (PCA) and Circular distribution of wildlife data (Circular Statistics),

5. **Viva voce** & Practical note book.

Elective:3 Fish biology & Fishery Science

Specialization: Fish Biology & Fishery Science

Code	Course	Credit	Contact hour	Total marks	Type
Z-4014	Fish Taxonomy & Study of Fish Growth & Population	4	54	40+10	Core (Theory)
Z-4024	Fish Physiology & Fish Genetics	4	54	40+10	Core (Theory)
Z-4034	Capture Fisheries & Ecosystem management	4	54	40+10	Core (Theory)
Z-4044	Aquaculture & Fish Biotechnology	4	54	40+10	Core (Theory)
Z-4054	Fish Pathology & Post harvest technology	4	54	40+10	Core (Theory)
Z-4066	Dissertation	6	54	60+15	Dissertation
Z-4072	Practical paper-I (Taxonomy, Fish Biology & Aquaculture)	2	54	20+5	Practical

M. Sc. FOURTH SEMESTER
FISH BIOLOGY & FISHERY SCIENCE
PAPER-Z -4014 (Total Marks 40) 4 Credit
(Fish Taxonomy and Study of Fish Growth & Population)

Unit-1: FISH TAXONOMY: 2 Credits (20 Marks)

1. Taxonomic characterization: taxonomic keys; Taxonomic methods for identification of fresh water fishes.
2. Methods employed for phylogenetic studies and fish identification.
3. Modern Trends in Fish Taxonomy; Fish Barcoding.
4. Fish skeleton as a tool for identification of fresh water fishes.
5. Biogeographic units of Freshwater Biodiversity: Status and distribution of freshwater fish diversity in North East India.

Unit-2: STUDY OF FISH GROWTH AND POPULATION: 2 Credits (20 Marks)

1. Study of Growth curve: Absolute and relative Growth, Length-weight relationships, Condition factor, Relative condition factor — their significance.
2. Hepatosomatic index, Gonadosomatic index, Index of fullness, Ponderal index, Index of propagation — their estimation.
3. Growth rate and ageing.
4. Study of Species Diversity Indices, Fish Species Richness, Relative abundance.
5. Concept of Index of Biotic Integrity (IBI); Jaccard index.
6. Stock assessment and management — Stock composition analysis, fecundity analysis.
7. Natural markers — morphological analysis, environmental signals, genetic analysis.
8. Applied Markers — marking and tagging.

M. Sc. FOURTH SEMESTER
FISH BIOLOGY & FISHERY SCIENCE
PAPER-Z -4024 (Total Marks 40) 4 Credit
(Fish Physiology and Fish Genetics)

Unit-1: FISH PHYSIOLOGY: 3 credits (30 marks)

1. Physiology of digestion in teleost — Digestive system: anatomical differentiation and modifications. Feeding behavior and feeding adaptation in fishes.
2. Respiratory system in Fishes — Gill structure, Mechanism of respiration, Counter-current principle, Exchange of gases. Accessory respiratory organs and respiratory epithelium, Physiological adaptation in air breathing fishes.
3. Forms and Functions of swim bladder and Weberian ossicles in teleosts.

4. Excretion in fishes — Excretion of nitrogenous wastes, Urea cycle.
5. Principles of osmoregulation in Freshwater and Marine Teleosts — Processes and functional aspects.
6. Endocrine system in Fish — Hypothalamo-hypophysial system; Neurosecretory system and Neuro-hypophysial hormones; Functional morphology of Pituitary gland; structure and function of Thyroid and Pancreas.

Unit-2: FISH GENETICS: 1 credit (10 marks)

1. Population Genetics: Individual *vs.* population; genetic structure of random mating populations.
2. Hardy-Weinberg principle: Test of equilibrium, application and properties of equilibrium populations.
3. Selection: Scope, application, role of genetics in fish selection and breeding; National and International scenario of selective breeding programmes in fish.
4. Stock improvement: sex-reversal, Hybridization, Gynogenesis, Polyploidy, hybrid vigour, introgression.

M. Sc. FOURTH SEMESTER
FISH BIOLOGY & FISHERY SCIENCE
PAPER-Z -4034 (Total Marks 40) 4 Credit
(**Capture Fisheries & Post-harvest Technology**)

Unit:-1 CAPTURE FISHERIES: 3 credits (30 marks)

1. Types of capture fisheries resources.
2. Fishery resources of the major river systems of India; Fish and Fisheries of River Brahmaputra.
3. Coldwater Fish & fisheries of India; Hill stream fisheries of North East India; Mahseer fisheries: prospects and problems with special reference to NE India.
4. Floodplain wetland (*beel*) fisheries: Fish resources, problems and management approaches.
5. Coastal fisheries of India (Sardine & Mackerel fisheries).

6. Fishing crafts and gears used in inland capture fisheries. Destructive fishing—its impact on fish diversity.

7. Estuarine fisheries (estuarine fisheries resources, problems confronting brackish water capture fisheries).

Unit-2:- POST-HARVEST TECHNOLOGY: 1 credits (10 marks)

1. Principles of preservation, handling and packaging of fish for marketing.
2. Importance and methods of Fish preservation (Refrigeration and freezing, Drying, Salting, Smoking, Canning, Pickling, pasting and spicing, Fermentation).
3. Fishery bi-products, their production and utilization (liver oils, Body oils, Fish meal, Fish flour, Fish Silage, Fish protein, Fish guano, Bone meal).

M. Sc. FOURTH SEMESTER
FISH BIOLOGY & FISHERY SCIENCE
PAPER-Z -4044 (Total Marks 40) 4 Credits
(**Aquaculture**)
Unit:-1 AQUACULTURE TECHNOLOGY: 2 Credits (20 marks)

1. Aquaculture systems — Extensive, semi-intensive, intensive and super intensive culture of fish; Pen and Cage culture in lentic and lotic water bodies; Monoculture vs. Composite fish culture.

2. Fish Breeding Technology — Brood stock management, nutritional requirements, captive rearing, and maturation; induced breeding techniques: physical and chemical inducing agents.

3. Breeding and Culture of Air breathing fishes.

4. Non-conventional methods of fish farming — sewage fed fisheries, integrated fish farming.

5. Aquarium keeping — Design and construction of tanks; species-wise tank size requirement; heating, lighting, aeration and filtration arrangements; decorations used; common aquarium plants and their propagation.

Unit:-2 AQUACULTURE NUTRITION: 2 credits (20 marks)

6. Nutritional requirements in aquaculture — Protein, carbohydrate, fats, vitamins and minerals.
7. Feed formulation — General principles, different steps of feed formulation, classification of feed ingredients.
8. Maintenance of Natural Color of fishes in Aquarium.
9. Larval nutrition — Importance of live feed and artificial feed, Different types of feed available for larvae.
10. Aquaculture Management — Feed, health and water quality management; prophylaxes; quarantine measures.

M. Sc. FOURTH SEMESTER
FISH BIOLOGY & FISHERY SCIENCE
PAPER-Z -4054 (Total Marks 40) 4 Credits
(Fish Pathology, Ecosystem management and Fish Biotechnology)
Unit: -1 FISH PATHOLOGY: 2 credits (20 marks)

1. Fish disease — Types; symptoms; and prophylaxes.
2. Disease diagnostics tools: Histopathological methods; Immunoassay; Biochemical assay; Serological techniques.
3. Techniques for isolation and identification of fungi; Basics of mycological and virological techniques.
4. Isolation and culture of different types of bacteria.

Unit:-2 ECOSYSTEM MANAGEMENT: 1 credits (10 marks)

5. Impact of environment on aquaculture: Raw water source, physical and chemical characteristics, contaminants and pollutants (algae, pathogens, heavy metals, pesticides) and their effect on productivity.
6. Biological indicators and indices of water quality.
7. Sanitation in aquaculture systems
8. Algal blooms and environmental microflora.

9. Microbial toxins.

Unit:-3 BIOTECHNOLOGY: 1Credit (10 Marks)

10. Food biotechnology: Probiotics, single cell proteins, Nutraceuticals.
11. Cell lines and cell culture; DNA markers and MAS.
12. Application of biotechnological tools: Recombinant DNA, Development of hybridoma and production of monoclonal antibodies; Collection, handling and observation of gametes of finfish and shellfish.
13. Cryopreservation technology; Transfer of gene and transgenic species formation.

M. Sc. FOURTH SEMESTER
FISH BIOLOGY & FISHERY SCIENCE
PAPER - Z-4072 (Total Marks 20) 2 Credit
(Fish Taxonomy, Fish Biology & Aquaculture — Practical)

1. Identification of commercially important fresh water fish species — Indigenous and exotic food and ornamental fishes.
2. Comparative biometric assessment (Morphometry and Meristics) of representative freshwater fish species (carp/catfish/murrel/perch/loach) following proper Taxonomic Keys and tools for their identification.
3. Fish osteology — Alizarin preparation of fish skeleton.
4. Dissection — Comparative digestive system in herbivorous, carnivorous and omnivorous fish; nervous system (brain and cranial nerves - V, VII, IX, X); Urino-genital system (male/female); Weberian ossicle.
5. Gut-content analysis in locally available freshwater fish species.
6. Determination of gonadosomatic index (GSI), hepatosomatic index (HSI), condition factor (CF), and fecundity.
7. Water chemistry — Estimation of DO, TA, TH, Ca and Mg in pond/river water.
8. Histopathological examination; Bacterial colony count.
9. Haematological studies — DLC
10. Induced breeding and larval rearing of IMC.
11. Viva-Voce

Elective 4: Cell and Molecular Biology

Code	Course	Credit	Contact hour	Total marks	Type
Zoo-4014	Molecular cell Biology	4	54	40+10	Elective (Theory)
Zoo-4024	Membrane Biology	4	54	40+10	Elective (Theory)
Zoo-4034	Molecular Biology	4	54	40+10	Elective (Theory)
Zoo-4044	Genomics and Proteomics	4	54	40+10	Elective (Theory)
Zoo-4054	Immunology	4	54	40+10	Elective (Theory)
Zoo-4064	Dissertation	6	81	60+15	Dissertation (Elective)
Zoo-4072	Practical 1 (Molecular cell Biology)	2	54	20+5	Practical

M.Sc 4th semester
Paper Zoo -4014
(Molecular cell biology)
(Marks 40+10) Theory credit: 4 Credits

1. Nuclear structure and transport between the nucleus and cytoplasm.

2. Molecular structures of genes and chromosomes: molecular definition of a gene; chromosomal organisation of genes and non coding DNA; mobile DNA; organizing cellular DNA into chromosomes.

3. Chromatins and chromosomes; centromere and telomere

4. Genetics of cell cycle: genetic regulation of cell division in yeasts and eukaryotes; molecular basis of cellular checkpoints.

5. Somatic cell genetics: cell fusion and hybrids- agents and mechanisms of fusions: heterokaryons and selective hybrids.

6. Cancer : monoclonal origin; differences between normal and cancer cell; cell transformation and factors for cell proliferation; concepts of oncogenes and their role in cancer, tumour suppressor and apoptotic genes; chromosomal basis of cancer.

7. Ageing : cellular basis of aging ; causes of aging; oxidative damage; genetic instability ; mitochondrial genome damage; genetic aging programme.

M.Sc 4th semester
Paper Zoo -4024
(Membrane Biology)

(Marks 40+10) Theory credit: 4 Credits

1. Biomembranes: structural organisation and basic concepts.
2. Transport across cell membranes: diffusion of small molecules across phospholipid bilayer; facilitated diffusion; Active transport by ATP powered pumps; co-transport;coupling active transport to existing ion gradients; uniports, symports and antiports; co-transport by symporters and uniporters; transport across epithelia, osmosis , water channels and the regulation of cell volume.
3. Membrane potential and nerve impulses.
4. Role of cyto-membrane in health and diseases with special reference to lipid peroxidation
5. Membrane associated receptor proteins: cell surface receptors, endocytosis and ligand formation.
6. An overview of the endomembrane system.

M.Sc 4th semester
Paper Zoo -4034
(Molecular biology)
(Marks 40+10) Theory credit: 4 Credits

1. DNA replication: Basic idea of prokaryotic and eukaryotic DNA replication- mechanics of DNA replication, enzymes and accessory proteins involved in DNA replication.
2. DNA repair system: Excision repair, Mismatch repair, DNA breaks repair, Bypassing of DNA damage. Homologous recombination and Site specific recombination.
3. Gene expression: From Transcription to Translation. An overview of transcription in prokaryotic and eukaryotic cells. Synthesis and processing of ribosomal RNA, transfer RNA and messenger RNA. Transcriptional and post-transcriptional gene silencing.
4. Post –transcriptional modification in RNA : 5' cap formation and 3' end processing and polyadenylation, Splicing-editing, Nucleus export of m-RNA stability.
5. Translation: Genetic code, Wobble hypothesis, Prokaryotic and Eukaryotic translation including mechanism of initiation, Elongation and Termination. Co and post transcriptional modification of proteins.
6. Transcriptional and post transcriptional control of Gene expression.

M.Sc 4th semester
Paper Zoo -4044
(Genomics and Proteomics)
(Marks 40+10) Theory credit: 4 Credits

1. Proteins and proteome: protein structure; the four levels of protein structure; 3D structure of proteins; Transcriptome: the link between the transcriptome and the proteome; protein interaction network; convergent and divergent evolution of protein structure and functions.
2. Genome organisation: The complexity of genome; Nuclear genomes; genetic features of nuclear genomes.
3. Sequencing of genomes: methodology of DNA sequencing; Contiguous DNA sequence; Strategies of sequencing; recognition of coding and non coding regions and annotation of genes; quality of genome sequence database calling and sequence accuracy.
4. DNA libraries: Genomic library; C DNA libraries.
5. Genome information reserves and DNA sequence analysis using softwares.
6. Metagenomics: Introduction- from genomics to metagenomics; next generation of DNA sequencing technologies and potential challenges.

IMMUNOLOGY
CODE: Zoo-4054
CREDIT: 04
UNIT I

1. Complement system: classical and alternate pathways of complement

activation

2. Complement and inflammation, formation of membrane attack comple
3. Cytokine structure and function, cytokine receptor, Cytokine and immune response.
4. Genetic Basis of Ab Structure
5. Genetic organization of MHC, role of MHC in activation of T lymphocyte, Association of diseases with MHC haplotypes
6. The T Cell Receptor: Structure and Genetic Basis , Antibody-Mediated Reactions , Cell- Mediated Reactions

UNIT II

1 Immunology of HIV Infection

2 Infection and Immunity

3. Immune Regulation & Tolerance
4. Autoimmunity
5. Immunology of Cancer
6. Immunoprophylaxis (Vaccines) & Immunotherapy, Transplantation immunology,Modern Antibody therapy

M.Sc 4th semester
Paper Zoo -4064
(Dissertation/Field report)
(Marks 60+15) , credit: 6 Credits

1. **Dissertation**
2. **Field repor**

M.Sc 4th semester
Paper Z -4074
(Molecular cell biology)
(Marks 20+5) Theory credit: 2 Credits

1. Supravital staining of living cells, blood cells, living protozoa.
2. Staining of certain organelles in situ using specific stains (mitochondria, golgi etc).
3. Cell viability and count using trypan blue stain from splenocytes.
4. Study of heat shock puffing activity in polytene chromosomes.
5. Study of Euchromatin and Heterochromatin C banding.
6. Mitotic chromosome preparation and chromosome banding from lymphocyte culture.

7. Meiotic chromosome preparation from rat or mice.
8. Isolation of genomic DNA from Mammalian Tissue.
9. Separation of DNA by Agarose Gel Electrophoresis.
10. Amplification of DNA by PCR.
11. Viva-voce.

Semester-4
Elective 5: Entomology

Code	Course	Credit	Contact hour	Total marks	Type
Zoo-4014	Insect structure and function	4	54	40+10	Elective (Theory)
Zoo-4024	Insect Ecology	4	54	40+10	Elective (Theory)
Zoo-4034	Insect Physiology	4	54	40+10	Elective (Theory)
Zoo-4044	Agricuture and Forest entomology	4	54	40+10	Elective (Theory)
Zoo-4054	Pest and pest control, Medical and Forensic entomology	4	54	40+10	Elective (Theory)
Zoo-4066	Dissertation	6	81	60+15	Dissertation
Zoo-4072	Practical (Insect Ecology, Insect physiology)	2	54	20+5	Practical

Paper-Zoo-4014: Insect Structure & Function
Credit=4, Contact Hour=54, Total Marks=40+10=50

1. Structure of insect head, thorax and abdomen, insect integument
2. Type of mouthparts, antennae, legs and their modifications & function
3. Wings, wing structure, venations and wing coupling.
4. Insect eye:-structure & function.
5. Receptor organs in insects (Chemo receptors, mechanoreceptors and Photoreceptors)

6. Sound and light producing organs in insects.
7. Insect –plant interactions, plant resistance to insects,

Paper-Zoo-4024: Insect Ecology
Credit=4, Contact Hour=54, Total Marks=40+10=50

1. **Dynamics of insect life system-determinants of insect abundance, population change, birth rate, Death rate, Movements,**
2. **Effect of environment on insect development-- effect of light, temperature & humidity, Regulation of insect populations,**
3. **Basic concept of surveillance and sampling of insect**
4. Adaptation of insects- Aquatic, Terrestrial, soil,
5. **Insect biodiversity, threats to insect biodiversity, impact of climate change on insect communities**
6. **Insect behavior: chemotropism, thigmotropism, hydrotropism, rheotropism, anemotropism, phototropism, thermotropism, geotropism, instinct. Protective behavior: mimicry. Crypsis, warning coloration. Behavioural defence, chemical defence. Breeding behavior.**
7. **Insect associations: Passive insect association, active associations, estivating aggregation, protective aggregation, swarming aggregation, sleeping aggregation, dissociation, social aggregations**

Paper-Zoo-4034: Insect Physiology
Credit=4, Contact Hour=54, Total Marks=40+10=50

1. **Digestive System** : Different parts of alimentary canal their origin and histology, salivary glands, physiology of digestion and absorption
2. **Respiratory system** : General organization of respiratory system, classification of respiratory system, Respiration in terrestrial insects - different types of spiracles and their structure, opening and closing mechanism of spiracles, trachea and tracheoles, air sacs, ventilation of tracheal system, mechanism of gaseous exchange, Respiration in aquatic insects, physiology of gill and plastron respiration,, respiration in parasitic insects
3. **Circulatory system** : Diaphragms and sinuses, doral vessel, accessory pulsatory organs, blood circulation, chemical composition of haemolymph, different type of haemocytes and their functions
4. **Nervous system** : Structure and type of neurons, Central nervous system-basic plan, gross anatomy and microanatomy of brain and ganglion, sympathetic nervous system, nerve impulse transmission
5. **Reproductive system**: male and female reproductive system, spermatogenesis, oogenesis. Hormonal control of reproduction in male and female insects, types of reproduction
6. **Excretory system** : basic and cryptonephredial system, Malpighian tubules-anatomy and histology, accessory organs of excretion, metabolic pathways of formnation of uric acid and ammonia, elimination of uric acid by malpighian tubules.
7. **Diapause, Growth and metamorphosis of insects**.

Paper-Zoo-4044: Agricultural and Forest Entomology and Pest Control
Credit=4, Contact Hour=54, Total Marks=40+10=50

Unit I : Credits-II

1. Major pests of rice, vegetables, tea, jute and pulses – classification upto family, life history, nature and damage and control (two each)
2. **Stored grain pests** : Sitophilus oryzae, Tribolium castaneum, Trogoderma granarium, Sitotroga cerellela, Callobruchus chinensis, life history and control
3. **Forest insects**: defoliators, borers and suckers of Teak, Sal, Gamari, classification upto family, life history and control (two each), Insect damage and Sign categories of forest insects

4. **Primary control measures**: Physical, Mechanical, Cultural and Legislative measures. Chemical control: Classification and mode of action of important insecticides, **insecticide toxicity to humans**, drawbacks of chemical control, Insect resistance to pesticides, Fumigants-application and operational precautions, **insecticide laws and regulations** Pheromonal control.
5. **Biological and Genetic control** : use of parasites, parasitoids, predators and pathogenic organisms, sterile insect technique, lethal mutations, inherited sterility, cytoplasmic incompatibility
6. **Pest management: Economic decision levels for pest populations- Concept of economic injury level, Economic threshold, Crop susceptibility to injury, Pre-insecticide era, insecticide era, concept of integrated pest management.**
7. **IPM and a case study.**

Paper-Z-4054: Medical, Veterinary and Forensic Entomology
Credit=4, Contact Hour=54, Total Marks=40+10=50

1. **Hematophagy, Evolution of the blood sucking habit, Host choice, Host location, anti-haemostatic and anti-pain factors in saliva, phagostimulants, gonotrophic concordance**
2. **Mosquito(Aedes, Culex, Anopheles, Toxorynchus) Taxonomy, Biology and Behaviour . Major vector born diseases**

3. **Vector-parasite relationship, Parasite strategies for contacting a vector, Vector immune mechanisms**
4. **Public health importance of Mites, Ticks**
5. **Myiasis and myasis causing flies**
6. **Veterinary pests** : Horsefly, stable fly, screw worm, nose fly, cattle blood sucking louse, life history and control

7. **Forensic entomology**:- Lifecycles of Calliphora and Sarcophaga, determination of date and causes of death

Paper-Zoo-4064

Dissertation

Credit=6, Contact Hour=81, Total Marks=60 +15=75

Paper-Zoo-4072

Practical

Credit=2, Contact Hour=54, Total Marks=20+05=25

1. Male reproductive system of cockroach
2. Alimentary canal of house fly with crop
3. Bacterial chamber of termite
4. Pharyngeal, labial and thoracic salivary glands of Honey bee
5. Detection of chitin in insect cuticle
6. Estimation of protein from haemolymph of insect.
7. Histological study of foregut, midgut and hindgut of insect.
8. Study of insect collection and preservation
9. Study of different types of mouth parts
10. Study of different types of antenna
11. Study of different types of legs
12. Preparation of arolium, empodium and pollen basket
13. Identification of Aquatic, terrestrial and boring insects with specific adaptive characteristics.
14. Collection and identification of economically important insects and various stages of their life history.

15. Practical record
16. Viva Voce : 5
    Marks

Suggested Reading:

i. General Entomology by S.W. Frost. Narendra Publishing House, New Delhi.
ii. General Textbook of Entomologyby Walter Scott Patton and Alwen M. Evans. Akashdeep Publishing House, Delhi.
iii. Entomology & Pest Management by L.P. Pedigo. Pearson Education (Singapore) Pre.Ltd.
iv. Medical and Veterinary Entomology By G. Mullen & L. Durden (Edt.). Academic Press.
v. Insect Biochemistry and Physiology by J.L. Nation. CRC Press.
vi. The Insects Structure and Function by R.F. Chapman. Cambridge University Press. Unted Kingdom.
vii. Modern Entomology by D.B.Tembhare. Himalaya Publishing House. Mumbai.
viii. A handbook for the Identification of Insects of Medical Importance by J. Smart, K. Jordon and R.J. Whittick. Biotech Books, Delhi.
ix. Insect Behaviour by M. Prakash. Discovery Publishing House Pvt. Ltd. New Delhi.
x. IMM'S General Textbook of Entomology by O.W.Richards and R.G. Davies. Vol – I & VOL II
xi. Toxicology of Inseticides by F.Matsumura. Plenum Press, New York and London.
xii. The Biology of Blood-sucking in insects by M.Lehane. Cambridge University Press, UK.
xiii. Insect Ecology, Behaviour, Populations & Communities by P.W. Price; R.F. Denno; M.D. Eubanks; D.L.Finke & I.Kaplan. Cambridge University Press.
xiv. A Textbook of Forest Entomology by T.V.Sathe. Daya Publishing House, Delhi.
xv. The Ecology and Control of the Forest Insects of India and the neighbouring countries by C.F.C. Beeson. Shiva Offset Press, Dehra Dun.
xvi. The Insects An Outline of Entomology by P.J. Gullan & P.S. Cranston. Blackwell Publishing.

Name of the Programme (Programmes Outcomes)
M.Sc. in Zoology

1. Students will be able to identify the major groups of organisms with an emphasis on animals and be able to classify them within a phylogenetic framework also using bioinformatics tools. Students will be able to compare and contrast the characteristics of animals that differentiate them from other forms of life
2. Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth. They will be able to use specific examples to ex plicate how descent with modification has shaped animal morphology, physiology, life history, and behavior.
3. Students will be able to explain how organisms function at the level of the gene, genome, cell, tissue, organ and organ -system. Drawing upon this knowledge, they will be able to give specific examples of the physiological adaptations, development, reproduction and behavior of different forms of life
4. Students will be able to explicate the ecological interconnectedness of life on earth by tracing energy and nutrient flows through the environment. They will be able to relate the physical features of the environment to the structure of populations, communities, and ecosystems
5. Students will be able to demonstrate proficiency in the experimental techniques and methods of analysis appropriate for their area of specialization within biology
6. Students will be able to demonstrate proficiency aquaculture management practices, induced breeding, insect culture etc
7. Students will use current biochemical and molecular techniques to plan and carry out experiments. They will generate and test hypotheses, analyze data using statistical methods where appropriate, and appreciate the limitations of conclusions drawn from experimental data. Trouble-shooting will be stressed in classes and labs

Course Outcomes
ZOO- 1014 (Biosystematics and Biostatistics)

Students have acquired knowledge:

- To identify the major groups of organisms with an emphasis on animals and be able to classify them within a phylogenetic framework also using bioinformatics tools. Students can compare and contrast the characteristics of animals that differentiate them from other forms of life.
- To use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth. They can use specific examples to ex plicate how descent with modification has shaped animal morphology, physiology, life history, and behavior.
- To explain how organisms function at the level of gene, genome, cell, tissue, organs and organ-systems. Drawing upon this knowledge, they can provide specific examples of the physiological adaptations, development, reproduction and behavior of different forms of life
- To explicate the ecological interconnectedness of life on earth by tracing energy and nutrient flows through the environment. They will be able to relate the physical features of the environment to the structure of populations, communities, and ecosystems
- To demonstrate proficiency in the experimental techniques and methods of analysis appropriate for their area of specialization within biology
- To demonstrate proficiency aquaculture management practices, induced breeding, insect culture etc

- To use current biochemical and molecular techniques to plan and carry out experiments. They can generate and test hypotheses, analyze data using statistical methods where appropriate, and appreciate the limitations of conclusions drawn from experimental data.

Z-1024 (Bioinformatics and Instrumentation)

Students have acquired knowledge to:

- Explain which type of data is available from the most common protein sequence and structure databases (UniProt, GenBank, Protein Data Bank, CATH).
- Explain the theories underlying the most common methods for sequence searches and sequence alignments, and in particular knows the principle and main steps for pairwise and multiple sequence alignments;
- Explain and is able to apply the main steps of dynamic programming for simple alignments of short sequences;
- List methods to uncover structure-function relationship in proteins and knows their underlying principles;
- Explain the principles of computational methods for the prediction of secondary structure elements from protein sequence, prediction and modeling of three-dimensional protein structures (homology modeling, threading and ab initio methods).
- Select and apply the most appropriate method for aligning sequences, visualizing and analyzing protein structures, predicting secondary structure elements and modeling protein structures from sequence.
- Understand the principle and uses of the instrument in the analysis of different biological samples
- Implement the knowledge of instrument in analyzing the sample.

Z-10134 (Evolution and chronobiology)

Students have acquired knowledge to:

- Understand the biological evolution of the organisms that inhabit the Earth today are different from those that inhabited it in the past.
- Understand that natural selection is one of the several processes that can bring about evolution, although it can also promote stability rather than change
- Understand that the four propositions underlying Darwin's theory of evolution through natural selection are: (1) more individuals are produced than can survive; (2) there is therefore a struggle for existence; (3) individuals within a species show variation; and (4) offspring tend to inherit their parents' characters.
- Understand that the three necessary and sufficient conditions for natural selection to occur are: (1) a struggle for existence; (2) variation; and (3) inheritance.
- Handle chronobiological terminology.
- Critically study the chronobiological publications.
- Adequately summarize and present chronobiological information.
- Apply chronobiological principles in biological and medical-biological science.

Z-1044 (Genetics and Cytogenetics)

Students have acquired knowledge to

- Get a broad understanding of core molecular genetics concepts including molecular biology, genetics.
- Acquire working knowledge in a defined skill set of molecular biology and biotechnology protocols, including PCR, genetic mapping, gene isolation and cloning, DNA sequencing, and sequence analysis.

- Set key concepts of genome organization and manipulation in depth, such as assembly of physical maps of genomes, sequencing methods and strategies, genome annotation and bioinformatics, comparative genomics, global gene expression profiling.

Z-1054 (Ecology and Environment Biology)

Students have acquired knowledge

- To understand how individuals interact with members of their own species and with organisms of another species
- To explain how populations of a species grow, change and are distributed across the range of their suitable habitats
- To appreciate how communities of species are assembled and how they interact on an ecosystem level, across short and geological time-scales
- To apply the underlying theory and basic principles of ecology learned throughout the course to understand the changes that are occurring as a result of human activity
- To demonstrate that understanding biological and ecological principles can be used to solve real-world problems that we are facing

Z-1064 (Biochemistry)

Students will acquire knowledge

- On the synthesis of proteins, lipids, nucleic acids, and carbohydrates and their role in metabolic pathways along with their regulation at the epigenetic, transcriptional, translational, and post-translational levels including RNA and protein folding, modification, and degradation. Regulation by non-coding RNAs will be tied to the developmental and physiological functioning of the organism.
- To understand the mechanism of Enzyme acrtion and their regulation in biochemical pathway.
- To understand the thermydynamic principle of biological systems and bioenergetics.

Z-1072 (Biosystematics, Biostatistics and Biochemistry)

•Acquire practical knowledge and get the hands on practice in the subject of biosystematics, biostatics and bioinformatics

Z-1082 (Genetics, Cytogenetics, Evolution and Chronobiology)

- Acquire practical knowledge and get the hands on practice in the subject of genetics, cytogenetics, bioinformatics

Z-2014 (Biodiversity)

Students have acquired knowledge to

- Understand the concepts and theory in biodiversity science and management from interdisciplinary perspectives and at an advanced level;
- Assess the modes through which conservation builds and extends power and describe in detail the factors that explain the emergence and performance of different governance modes;
- Appreciate the role of ethics, values and norms in producing culturally attuned and effective conservation interventions;
- Understand new technological forces for the future of biodiversity science and management;
- Link theory, hypothesis, methods, data and field work so as to identify and develop advanced research questions and design dissertation research that is identifiable with a professional research approach

Z-2024 (Endocrinology)

Students have acquired knowledge to

- Understand the role, metabolic function of various endocrines, its specific secretions and also the disorder and pathophysiology.
- Understand the mechanism of hormone action, signal transduction system
- Understand the role and function of neurosecretory hormones of insects and crustacean

Z-2034 (Developmental biology)

Students have acquired knowledge to

- Understand and master basic concepts of developmental biology
- Understand how fertilization and cleavage occur
- Understand the process and consequence of gastrulation
- Understand mesoderm induction and neural induction
- Understand basic concepts of organogenesis
- Understand basic concepts of growth, regeneration and aging
- Understand basic concepts of gene expression and regulation

Z-2044 (Animal cell culture and Genetic engineering)

Students are able to:

- Understand theoretical concept to maintain cultures of animal cells and established cell lines with good viability, minimal contamination and appropriate documentation.
- Understand the episodic tasks relevant to cell culture, including preparation and evaluation of media, cryopreservation and recovery, and assessment of cell growth/health.
- Able to recognize and troubleshoot problems common to routine cell culture.
- Understand the importance of plasmids and viruses to genetic engineering.
- Know the natural function of restriction endonucleases and how a normal bacterial cell protects its DNA from their activity.
- Understand how “sticky ends” are formed and their importance to gene technology.
- Describe how a chimeric genome is constructed.
- Explain the four steps of genetic engineering experiments.
- Distinguish between the techniques of selection and screening of clones.
- Explain how to screen for clones that contain a desired gene fragment.
- Understand the value of and the processes involved with the polymerase chain reaction (PCR).
- Describe techniques used to characterize DNA.
- Discuss the different applications of gene technology.

Z-2054 (Animal Behavior)

- By the completion of this course, students set a comprehensive understanding of the behavior of animals. They will understand the proximate controls of behavior including the role of hormones, the animal’s genotype and the animal’s environment in the development of behavior. Much of our work will take an evolutionary approach, consequently, students will have a comprehensive understanding of the adaptive significance of behavior, emphasizing animal communication, social behavior, territoriality, sexual selection and mating systems.

Z-2064 (Animal Physiology)

Student sets knowledge on:

- Cellular mechanisms of solute and water transport used by animals living in different environments

- The different energy requirements of an animal at rest and during exercise, and how this is reflected in the functioning of the oxygen transporting systems
- How the cardiovascular and respiratory systems are integrated and controlled
- How animals use aerobic and anaerobic forms of metabolism for ATP production.
- How animals move with muscles and navigate their movement by the neural control. The basic control processes of the nervous and endocrine systems
- How animals have adapted to their environment with different ways of urine formation to excrete nitrogen wastes and water
- Carry out physiological studies in the laboratory
- Interpret physiological data and phenomena critically

Z-2072 (Biodiversity, Animal behavior, Developmental Biology)

1. Acquire the practical knowledge and get the hands on practice in the subject of biodiversity, Animal behavior and developmental biology

Z-2082 (Endocrinology, Animal Physiology, Animal Cell Culture and Genetic Engineering)

1. Acquire practical knowledge and get the hands on practice in the subject of endocrinology, animal cell culture and genetic engineering.

Z-3014 (Cell Biology)

- This course help to understand the biology of cells of prokaryote and higher organisms: The structure, function, and biosynthesis of cellular membranes and organelles; cell growth and oncogenic transformation; transport, receptors, and cell signaling; the cytoskeleton, the extracellular matrix, and cell movements; chromatin structure, cell cycle, regulation of cell cycle, apoptosis, regulation of gene expression in prokaryotes and eukaryotes and RNA editing.

Z-3024 (Immunology, microbiology and parasitology)

- Understand the structural features of the components of the immune system as well as their functions, lymphoid organs, monoclonal antibody , structure of antibody, antigen antibody interaction
- Understand the microbial diversity, microbial pathogeneses and applied microbiology
- Understand the concept of parasitism, life cycle of economically important parasites of man and domesticated

Z-3034 (Reproductive biology)

- Understand the comparative structure and function of the male and female reproductive systems
- Understand the physiology of gametogenesis, embryogenesis, pregnancy, parturition and lactation
- Understand the endocrine, neuro-endocrine and environmental factors regulate reproduction
- strategies for the management of reproduction and fertility in animals; including the application of assisted reproductive technologies

Z-3044 (Entomology and Aquatic Biology)

- Understand the economic importance of insects
- Insect vectors, pest
- Role of insects in ecosystem.
- Concept of pest management.
- Understand the limnology, aquatic resources of North East India, major threats of fresh water ecosystem, fish germplasm diversity of North East India.

Z-3056 (Integrative Biology) (Open Programme) (OP)

- Understand the concept NET/SLET and Gate oriented question and approach to tackle the question and their concepts.

Z-3062 (Cell biology, Histology, Histochemistry, Immunology and Reproductive Biology)

- Acquire practical knowledge and get the hands on practice in the subject of aquatic biology, entomology and parasitology.

Z-4014 (Biochemistry and Proteomics) (Optional Course) (OP)

- Students understand the advanced level of Biochemistry, proteomics and their applications deals with a rapidly evolving scientific area that introduces students into genomes, proteomes and databases that store various data about genes, proteins, genomes and proteomes.

Z-4024(Enzymology and Recombinant Technology)

- the major classes of enzyme and their functions in the cell
- role of co enzyme co factor in enzyme catalyzed reaction;
- Differentiate between equilibrium and steady state kinetics and analyzed simple kinetic data and estimate important parameter (Km, Vmax, Kcat etc)
- Define and describe the properties of enzymes in and regulates biochemical pathways (inhibition, Allosteric)
- Understand the basis of current molecular biologic and genomic technologies and be able to contrast the structures of eukaryotic and prokaryotic genes and genomes,
- Understand the complex nature of protein molecules including antibodies and the inherent issues that need to be considered when attempting to produce them in recombinant form, describe the events involved in generating recombinant DNA molecules, to include cDNA generation, expression vectors and the choice of host cell, discuss protein engineering, including protein tagging and mutagenesis-based strategies for generating recombinant proteins with modified properties

Z-4034 (Physiology and Adaptational Biology)

- Understand the advanced level physiology of animals and their system a comparative account.
- Also able to understand the adaptation physiology of human and animal

Z-4044 (Molecular Endocrinology and Reproductive Biology)

- Able to understand the molecular mechanism of endocrinology mechanisms and about the various events and mechanism of reproductive system.

Z-4054 (Immunology)

- Understand advanced knowledge of the underlying principles of immunology and its application in solving problems in biological systems.
- Have an awareness of some current research activities in the field and possible applications of this knowledge.

Z-4066 (Dissertation)

Acquire the practical knowledge and get the hands on practice in the subject of biochemistry, physiology, reproductive biology and immunology.

Z-4014 (CMB)

This course help to understand the molecular structure of chromatin, chromosome, genes and nucleus: Understand the genetic basis of cell cycle, somatic cell hybridization and cancer.

Understand the cellular basis of aging,oxidative damage, genetic stability, mitochondrial genome damage and genetic aging programme.

Z- 4024 (CMB)

This course help to understand the structural organization and basic concepts of Biomembranes.

Transport across cell membranes, facilitated diffusion, active transport by ATP powered pumps, symports, antiports, transport across epithelia, osmosis, water channels and the regulation of cell volume, membrane potential and nerve impulse, role of cyto-membrane in health and diseases, membrane associated receptor proteins and overview of the endomembrane system.

Z-4034 (CMB)

This course help to understand the molecular basis of DNA replication in both prokaryotes and eukaryotes, DNA repair system, gene expression from transcription to translation, post-transcriptional modification in RNA and translation.

Z- 4044 (CMB)

This course help to understand the advanced level of genomics and proteomics: protein structure, 3D structure of proteins, transcriptome, protein interaction network, convergent and divergent evolution of protein structure and functions.

Complexity of genome organization, nuclear genomes and genetic features of nuclear genomes.

Sequencing of genomes, genomic library, cDNA library, metagenomics, NGS and genome information reserves and DNA sequence analysis using softwares.

Z- 4054 (CMB)

Understand advanced knowledge of the underlying principles of immunology and its application in solving problems in biological systems.

Have an awareness of some current research activities in the field and possible applications of this knowledge.

Z-4066 (CMB)

Students will learn how to do research work, Study design, data collection, Sampling design, Statistical design etc. Preparation of Research hypothesis and testing of research hypothesis. Also learn how to write research findings and how discussions are written on what point is important for discussions etc. Students also learn about writings of research conclusions and Reference citing within the text and reference writing at the end of report

Z-4014 (Insect Structure and function)

- Students understand details of insect morphology, origin, locomotion and molecular phylogeny.

Z-4024 (Insect Ecology)

Students set knowledge to

- Apply the basics of insect ecology to the development of the research
- Identify insect specimen up to their order and able to use identification keys for further to more detail levels.

Z-4034 (Insect physiology)

- Able to describe the influence of the exoskeleton on physiological functions of insects.
- Able to describe the hormonal and neuronal regulatory systems.
- Able to describe the communication and sensory system of insects.
- Use the acquired knowledge gained in the course for designing experiments in insects.

Z-4044 (Agriculture and Forest entomology)

- At the end of the course, the student knows the bases of the insect morphology and anatomy and the biology and behaviour of the most harmful insects for different plant species.
- Can understand the agro-forestry environment in the view of the management of the insect populations and plant protection.

Z-4054 (Pest and pest control, Medical and Forensic entomology)

- Students learn to identify and understand the life cycles, morphology, and behavior of mosquitoes, ticks, mites, lice, flea s, and other disease vectors. Students also learn about major arthropod-transmitted disease cycles, including malaria, Lyme disease, leishmaniasis. The interaction between the disease-causing pathogen and the arthropod vector discovered, including biological and mechanical transmission of pathogens as well as the mechanical damage that a parasite inflicts on its host.

Z-4066 (Dissertation)

- Acquire practical knowledge and get the hands on practice in the various aspects of insect biology and entomology as a whole.

Z-4014(Fish Taxonomy & Fish growth & population)

- This paper will develop the students' knowledge on the identification of major groups of freshwater fish species with special reference to NE India; their interrelationships, phylogeny, diversity through morphological, anatomical, ecological and molecular approaches
- This paper will provide an elementary knowledge on fish stock assessments with specific techniques, and knowledge on growth analysis and designing well-being of naturally available fish populations.

Z-4024 (Fish Physiology and Fish Genetics)

- This paper will help a student to understand fish as a physiological and genetic unit; by giving stress on the detailed physiology of a fish and the scope of genetics in fish breeding programmes for stock enhancement in fisheries.

Z-2034 (Capture Fisheries & Post-harvest technology)

- This paper will provide students with an idea on the fisheries resources of India, the scopes these can offer, various fish harvesting techniques, management of sustainable fisheries, and the principle and processes of post-harvest technologies.

Z-2044 (Aquaculture technology & Aquaculture nutrition)

- This paper will present the students with a plan on responsible fish farming, the scientific management of different species in aquaculture, aquarium keeping, and fish nutrition and health management.

Z-2054 (Fish Pathology, Ecosystem management and Biotechnology)

- This paper will help the students to diagnose various fish diseases, their prophylaxes, and probable cure through updated scientific techniques.
- The paper will provide the students with an overview on the impact of environment on aquaculture.
- The paper will also provide an overview on emerging biotechnological tools and techniques to get improved fish varieties and better outputs in aquaculture systems.

Z- 4066 (Dissertation)

- The students will have hands-on-practice in various disciplines of choice under Fish Biology and Fishery Science.

Z-4072 (Practical)

- The students will acquire practical knowledge on various aspects of Fish Biology and Fishery Science.

Z-4014 (Ecosystem Function and Stability)

- Sets general knowledge about ecological sustainability, resilience and human utilization of nature and natural resources to secure well-being and security.
- Knowledge about environmental policy and sustainable development.
- Specific knowledge for applying knowledge on ecological sustainability, planetary biophysical boundaries, ecosystems services and values associated to technology.
- Specific knowledge about national and global environmental status connected to biodiversity, climate, pollution, environmental toxins, land use, resource economy, and distribution of species and organisms.
- Specific knowledge about global initiatives, models and indicator systems for integration of ecological knowledge, driving forces, governance and green production systems.

Z-4024(Wildlife and Wildlife Habitat Relations)

- Acquire knowledge in the characteristics and habitat requirements of wildlife species normally associated with forested ecosystems. Gather information of common forest wildlife species and their associated habitat requirements. Also acquire knowledge in the conservation practices, program guides, and technical guidance tools that aid in the planning for these species.

Z- 4034 (Wildlife population Ecology and Methods)

- Have a thorough understanding of various models of population dynamics

- Become familiar with the application of concepts and models in population ecology to conservation and management of wildlife populations
- Become familiar with concepts and models of species interaction, population regulation and population cycles

Z-4044 (Wildlife Conservation)

Students have acquired knowledge

- To apply knowledge to solve problems related to wildlife conservation and management.
- On how wildlife conservation and management relates to the economy and environment, both currently and in the future.
- To find detailed information on a topic from print as well as online information sources.
- To critically evaluate current events and public information related to wildlife conservation and management as being scientifically-based or opinion-based and contribute to the knowledge base of information.
- To work with others to coordinate activities that achieves group/team objectives.
- To write in a style appropriate for technical or informative publications for various audiences related to wildlife conservation and management.

Z-4066(Dissertation)

The student is able to:

- Find, analyze, evaluate, select and integrate information using various sources, from fields of knowledge and from critical judgments for planning his own studies.
- Formulate research questions and hypotheses, and operate them. Can create a research plan adequate to the research question.
- Present research questions with statistical concepts and translates them to hypotheses, which he then verifies using appropriate methods of statistical inference.
- Advance research skills encompassing construction of research tools and conducting experiments,
- Use computer programs: statistical packages, calculation spreadsheets, text editors, to perform calculations and describe results from empirical studies.
- Determine the ethical value of his own research and scientific pursuits.

Conduct substantive argumentation, utilizing personal views that are based on critical analysis of works from various fields of knowledge, and can create synthetic summaries on their basis.

Z-4072 (Practical)

- Acquire the practical knowledge and get the hands on practice in the various aspect of Wildlife science and its management.

MSc in Wildlife Science WLS-1014 Fundamental Ecology and Functional Ecology

- Students have developed their knowledge on ecosystem concepts, Structure and types of ecosystems, adaptations of the organism in different ecological factors.
- Limiting factors of organisms in the environments, ecological modelling and ecological system analysis.
- Evolution and ecology, adaptations and speciation.
- Functional attributes of ecosystems, Quantitative study of biogeochemical cycles, Fundamental concepts of energy nutrient cycling in different ecosystems, global cycling of CO2 , Cycling of H2O, Trophic dynamic and niche concepts. Energy partitioning and optimizations etc.