



**Darrang College
(Autonomous),
Tezpur-784001**

**Syllabus
M.Sc. (CBCS)
Subject: Zoology**

Approved by :

**Board of Studies meeting held on 19-12-2025
&
Academic Council vide Resolution no. 2, dated 29-12-2025**



**Darrang College
(Autonomous),
Tezpur-784001**

**Syllabus
M.Sc. 1st Semester
(CBCS)
Subject: Zoology**

Approved by :

**Board of Studies meeting held on 19-12-2025
&
Academic Council vide Resolution no. 2, dated 29-12-2025**

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)

UNIT1: 2Credits

1. Concept of species: Species, Polytypic species, Importance of recognition of Polytypic species taxa.
2. Intraspecific categories, subspecies, temporal subspecies, race and cline
3. Population taxonomy, the new systematic and super species.
4. Speciation: Sympatric, Parapatric and allopatric speciation, Speciation in time, sibling species.
5. Taxonomic characters: Molecular, Behavioral, 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: 2Credits

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, poisson 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

Referred Books:-

1. Introduction to Biostatics. Dr. Pranab Kumar Banerjee, S. Chand & Company.
2. Systematics and the Origin of Species by Ernst Mayr

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

(BIOINFORMATICS AND INSTRUMENTATION)

UNIT1: 2Credits

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 phylogenetic 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 likelihood.
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 initio 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

UNIT2: 2 Credits

1. Microscopy: Principles and applications of phase contrast, Fluorescence, confocal and electron Microscopy.
2. Principles and application of tracer techniques- autoradiography and radio immunoassay.
3. Immunological techniques: Immunodiffusion, Immuno-electrophoresis, 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) 4Credits

(EVOLUTION AND CHRONOBIOLOGY)

UNIT1: 2 Credits

1. Theories of organic evolution, prebiotic molecules (Amino acid and Nucleic acid bases).
2. Evolution of Prokaryotes and Eukaryotes
3. Human Evolution –History of Human evolution
4. Modern theories of Origin of life
5. Notion of selectively neutral mutations, evolutionary gene duplication, the founder principle, bottleneck effect of genetic drift.
6. Factors and forces of evolution: Mutation, Genetic variation, Isolation mechanisms and their role in speciation.
7. Theory of Neo-Darwinism and Neo-Lamarckism
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

UNIT2: 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- Supra chiasmatic 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:-

1. Nelson, R.J.(2000). An introduction to behavioral Endocrinology, 2nd edition.
2. Binkley, S.(1990). The clock work sparrow: time, clocks and calendars in biological organisms.
3. Chadrashakaran, M.K.(1985). Biological rhythms. Madras science foundation, Chennai.
4. **Evolution** – Monroe W. Strickberger, Jones & Bartlett / Tata McGraw-Hill

PAPER: ZOO-1044

(Total Marks 40):4Credits

(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 malignancy (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}, P⁵³, P^{APC}, genetic pathways to cancer.
7. 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. Methods of gene mapping: 3 point test cross in *Drosophila*, gene mapping in human by Linkage analyses in pedigrees.
10. 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 mammals, Hypoactivation of X-linked genes in *Caenorhabditis elegans*.
4. Human genetics: Karyotype and nomenclature of metaphase chromosome bands.

Referred Books:-

1. **Genetics: A Conceptual Approach** – Benjamin A. Pierce, W.H. Freeman (Macmillan Learning)
2. Alberts B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P.(2014)Molecular Biology of the Cell .
3. Rooney, D.E.,& Czepulkowski, B.H. (2013). Human Cytogenetics: Constitutional Analysis (4th ed.), Oxford University Press

PAPER: ZOO-1054 (Total Marks 40):4Credits

(ECOLOGY AND ENVIRONMENTAL BIOLOGY)

UNIT1: 2Credits

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.
Community development: Types of community changes, causes and examples of ecological succession, Climax community and stability
4. The Niche concept, ecological niche, niche overlap and separation
5. Population ecology- growth pattern, life tables & survivorship curve and density dependent & independent factors.
6. Life history strategies: K-or r-selection, Age and sex ratio.
7. Trophic structure, 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: 2Credits

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.

Referred Books:-

1. Concept of Ecology, Kormondy Edward J.4th Edition
2. Erach Bharucha — Textbook of Environmental Studies for Undergraduate Courses Universities Press (India). 2nd / later editions. ISBN examples: 9788173718625 (2nd ed.), 9789393330901 (4th ed., 2025). (universitiespress.com)
3. R. Rajagopalan — Environmental Studies: From Crisis to Cure Oxford University Press (India). Recent editions (e.g., 3rd ed./latest). ISBN example: 9780199459754 / ISBN-13 9789354978944

4. Anubha Kaushik & C. P. Kaushik — Perspectives in Environmental Studies
New Age International (multiple editions). ISBN example: 9789386418630
5. Martha J. Groom, Gary K. Meffe & C. Ronald Carroll — Principles of Conservation
Biology (3rd ed.) Sinauer Associates (now an imprint of Oxford University Press).
ISBN: 9780878935970 (3rd ed., 2006).
6. W. H. Schlesinger & Emily S. Bernhardt — Biogeochemistry: An Analysis of Global
Change (3rd/4th eds.) Academic Press / Elsevier. ISBN (4th ed.): 9780128146088
/ (3rd ed.) 9780123858740 (2013).
7. Janick F. Artiola, Ian L. Pepper & Mark L. Brusseau — Environmental Monitoring
and Characterization Elsevier / Academic Press, 2004. ISBN: 9780120644773 (1st ed.).
8. Peter Morris & Riki Therivel — Methods of Environmental Impact Assessment
Routledge / Distributed editions; classic reference on EIA methodologies.
9. Daniel B. Botkin & Edward A. Keller — Environmental Science: From Theory to
Practice Wiley

PAPER: ZOO-1064 (THEORY)
(BIOCHEMISTRY)

(Total Marks40):4Credits

UNIT1: 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, Glycolysis and Gluconeogenesis, Glycogenesis and Glycogenolysis; Krebs cycle.

UNIT 2: 2Credits

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. Transamination, 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. 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.

Referred Books:-

1. **Principles and Techniques of Biochemistry and Molecular Biology** – Keith Wilson & John Walker, Cambridge University Press

PAPERZOO-1072 (PRACTICAL)

(Total Marks20):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. Calculation of Standard deviation, standard error, analysis of variation, Coefficient of variation, t-test, chi-square test and two way ANOVA.
4. Extraction of biomolecules (carbohydrates, proteins, lipids) from fish liver.
5. Estimation of protein extracted from fish liver by Biuret/Lowry/Bradford method.
6. Estimation of glycogen extracted from fish liver by Anthrone reagent method.
7. Estimation of blood glucose by Folin-Wu method.
8. Effect of substrate concentration on enzyme activity and determination of K_m and V_{max} by plotting Michaelis-Menten and LB plot.
9. Estimation of DNA
10. Estimation of RNA
11. Determination of molecular mass of proteins by SDS-PAGE.

PAPERZOO-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 data bases
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)



**Darrang College
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Tezpur-784001**

**Syllabus
M.Sc. 2nd Semester
(CBCS)
Subject: Zoology**

Approved by :

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&
Academic Council vide Resolution no. 2, dated 29-12-2025**

M.Sc. Zoology Syllabus (CBCS)

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 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 (Ex situ, In situ, 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, paracrine and autocrine 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. Biosynthesis 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 insects 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, Allatostatin, 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
9. Brooks and Marshall: Essentials of Endocrinology, Blackwell Science. 1995
10. 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 *Caenorhabditis 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 proliferation assays: MTT, Trypan Blue exclusion test.

UNIT-2

5. Automated sequencing methods; Sanger's dideoxynucleotide method; Shotgun DNA sequencing method; Polymerase chain reaction and its advantages.
6. DNA polymorphism: Types of DNA Polymorphism (SNP, RFLP, VNTR, STR, SNPs), Basis of DNA typing/fingerprinting.
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, Sun-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; Altruism: 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. Halliday 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, Hemolymph: Chemical compositions and Functions
2. Cardiac Cycle, Specialized conducting system of heart, generation and conduction of cardiac impulse, neurohormonal 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. 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. Demonstration of 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.



**Darrang College
(Autonomous),
Tezpur-784001**

**Syllabus
M.Sc. 3rd Semester
(CBCS)**

Subject: Zoology

Approved by :

**Board of Studies meeting held on 19-12-2025
&
Academic Council vide Resolution no. 2, dated 29-12-2025**

M.SC. Semester-3 Syllabus

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 (OpenI)	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.3rdSEMESTER
Paper-ZOO-3014 (CELLBIOLOGY)
(Marks40+10)Theory credit: 4 Credits

UNIT I

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 dynamics
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 hemophilic 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.

UNIT II

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

Book recommended

1. Alberts et al.: *Molecular Biology of the Cell* (4th Ed.), Garland, 2002
2. Lodish et al.: *Molecular Cell Biology* (5th Ed.), Freeman, 2004
3. DeRobertis & DeRobertis: *Cell & Molecular Biology*, Lea & Febriger, 1987
4. Berg et al.: *Biochemistry* (5th Ed.), Freeman, 2002
5. Karp: *Cell and Molecular Biology* (John Wiley & Sons, 2002)
6. Lewin: *Genes VIII* (Wiley, 2004)
7. Lodish et al.: *Molecular Cell Biology* (Freeman, 2000)

M.Sc. 3rd SEMESTER
Paper-ZOO-3024 (IMMUNOLGY, MICROBIOLOGY AND PARASITOLOGY)
(Marks40+10) Theory credit: 4 Credits

UNIT-1

1. Innate and acquired immunity – components and characteristic features, primary and secondary responses
2. 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
3. Lymphoid organs – primary and secondary lymphoid organs and their functions, their micro and macro structures, vascular and lymphatic connections.
4. Immunoglobulins : Structure and domain of Ig molecule, Ig classes, subclasses and types; Myeloma protein, monoclonal antibody, Ig superfamily
5. Antigen-antibody reaction: antibody affinity and avidity cross reactivity, agglutination reaction, precipitation reaction.

UNIT-2

- a. Microbial diversity: Prokaryotic microbes-Bacterial and archaea; Eukaryotic microbes- Anaerobic and aerobic Protozoa.
- b. Microbial pathogenesis: Invasiveness and Toxigenicity; pure culture techniques of microbes.
- c. Applied microbiology: Microbial products; Food microbiology; Biocontrol; Biological weapons; Wastewater treatment.
- d. Parasitism: General consideration, Types of parasites, Types of Hosts, symbiosis and Commensalism
- e. 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*

BOOKS RECOMMENDED

1. Michael, J. R. (1993). *Microbiology*. Tata McGraw-Hill.
2. Chatterjee, K. D. (1981). *Parasitology*. Chatterjee Medical Publishers.
3. Chandler, A. C., & Read, C. P. (1970). *Introduction to parasitology*. Wiley.
4. Noble, E. R., & Noble, G. A. (1973). *Parasitology*. Lea & Febiger.
5. Smith, J. E. (1996). *Animal parasitology*. Cambridge University Press.
6. Prescott, L. M., Harley, J. P., & Klein, D. A. (latest ed.). *Microbiology*. McGraw-Hill.
(If you want a specific edition, I can update.)
7. Roitt, I. M., Brostoff, J., & Male, D. (2000). *Immunology*. Mosby.
8. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2003). *Kuby immunology* (5th ed.). W. H. Freeman.

9. Abbas, A. K., Lichtman, A. H., & Pillai, S. (latest ed.). *Cellular and molecular immunology*. Elsevier. (Specify edition if needed.)
10. Roberts, L. S., & Janovy, J. (latest ed.). *Foundations of parasitology*. McGraw-Hill.
11. Cox, F. E. G. (1993/modern ed.). *Modern parasitology: A textbook of parasitology*. Wiley-Blackwell.

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. Puberty and adolescence, role of hormones
4. Reproductive cycles in animals and human: Estrous and menstrual cycle
5. Ovarian Follicular development: Folliculogenesis, mechanism of ovulation in mammals
6. Testicular organization, seminiferous epithelium cycle, Spermatogenesis

UNIT II

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

RECOMMENDED BOOKS

1. *The Physiology of Reproduction*, Vol. 1 and 2, Ernst Knobil and Jimmy D. Neil, (ed.), Raven Press.
2. *Male Reproductive Function*, Christina Wang, (ed.), Kluwer Academic Publishers.
3. *The Ovary*, (ed), Solly Zuckerman Zuckerman, Barbara J. Weir, T. G. Baker. Academic Press.
4. *The Ovary*, Peter C. K. Leung and Eli Y. Adashi, (ed.), Elsevier (Academic Press), 2004.
5. *Cell and Molecular Biology of Testis*, (ed.), Claude Desjardins and Larry L. Ewing, Oxford University Press, USA.

M.Sc.3rd SEMESTER
Paper-ZOO-3044
Entomology and Aquatic Biology

(Marks40+10) Theory credit: 4Credits

UNIT I

1. Classification of class of Insects upto 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 as pests, vectors of diseases.
4. Role of insects in ecosystem and nutrient cycling.
5. Insects as environmental indicator.
6. Concept of Pest management: IPM concept, Biological Pest Control, Organic pesticides

UNIT II

7. Limnology: Introduction, Definition of limnology, Essential nature of limnology.
8. Aquatic Resources: Characteristic features of freshwater, brackishwater 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.

RECOMMENDED BOOKS

1. **Atwal:** *Agricultural pests of India and South East Asia*, Kalyani Publishers, 1986
2. **Chapman:** *The Insects: Structure and Function*, 4th Ed., ELBS, 1998
3. **Klowden:** *Physiological Systems in Insects*, Academic Press 2002
4. **McGavin:** *Essentials of Entomology*, Oxford Univ. Press 2001 New Delhi
5. **Srivastava:** *A text book of applied entomology*. Vol. I & II, Kalyani Publishers, New Delhi, 1998. 1993
6. **Wigglesworth:** *Principles of Insect Physiology*, ELBS, 1972
7. **Tembhare, D.B.:** *Modern Entomology*, Himalaya Publishing House, 1995
8. **Wetzel, R.G.** *Limnology: Lake and River Ecosystems*, 3rd Ed., 2001

9. **Welch, P.S.:** *Limnology*, 1951

10. **Jhingran, V.G.:** *Fish and Fisheries of India*, Hindustan Publishing Corporation, New Delhi, 1985

M.Sc 3rd SEMESTER

PAPER Z-3056 (OPEN II): 6credits INTEGRATIVE BIOLOGY

UNIT I

1. Molecules and their interactions: Structures of atoms, molecules and chemical bonds, Stabilizing interactions (van der waal's, Electrostatic, Hydrogen bonding, Hydrophobic interactions, etc)
2. Growth, yield and Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.
3. Conformation of Nucleic acids (A-,B-,Z-DNA), t-RNA and microRNA.
4. Microbial Physiology: Growth, yield and characteristic, strategies of cell division, Stress response.
5. 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.

UNIT II

6. Cellular communication: Regulation of haematopoeisis, neurotransmission and its regulation
7. Gene mapping methods: Linkage maps, tetrad analysis, Mapping by using somatic somatic cell hybrids
8. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.
9. Quantitative genetics: Polygenic inheritance, heritability and its measurements. QTL mapping.
10. Recombination: Homologous and non-homologous recombination including transposition, site specific recombination.
11. 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)
PRACTICAL (3Credits) (Marks 20+5)

1. Observation of mitochondria using vital stain.
2. Dissection and histological study of lymphoid organs in rat/mouse.
3. Differential WBC count in mammalian blood.
4. Metachromatic staining of pituitary
5. Detection of DNA, glycogen, and protein using cytochemical techniques.
6. Preparation of histological slides from testis and ovary.
7. Preparation and study of phagocytosis by splenic/peritoneal macrophages.
8. Study of the estrous cycle.

M.Sc.3rdSEMESTER
Paper-ZOO-3073 (AQUATIC BIOLOGY & FISHERIES, ENTOMOLOGY AND
PARASITOLOGY)
(Marks20+5) Credit: PRACTICAL

1. Estimation of soil parameters: pH, organic carbon, and phosphate.
 2. Estimation of primary productivity by the Light and Dark Bottle (L–D–B) method.
 3. Collection and identification of plankton, aquatic insects, and aquatic macrophytes.
 4. Estimation of turbidity using the 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 mouthparts, antennae, and legs.
 8. Dissection and temporary mounting of the salivary gland of honeybee/cockroach.
 9. Dissection of the sting apparatus in honeybee/wasp.
 10. Study of prepared slides and museum specimens of selected parasites representing protozoans, helminths, and arthropods.
 11. Preparation and identification of permanent slides of rectal ciliates in frog.
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Darrang College (Autonomous), Tezpur-784001

Syllabus M.Sc. 4th Semester (CBCS) Elective 1: Cell and Molecular Biology Subject: Zoology

Approved by :

Board of Studies meeting held on 19-12-2025

&

Academic Council vide Resolution no. 2, dated 29-12-2025

Elective 1: Cell and Molecular Biology

Code	Course	Credit	Contact hour	Total marks	Type
ZOO-4014	Molecular Cell Biology	4	60	40+10	Elective (Theory)
ZOO-4024	Membrane Biology	4	60	40+10	Elective (Theory)
ZOO-4034	Molecular Biology	4	60	40+10	Elective (Theory)
ZOO-4044	Genomics and Proteomics	4	60	40+10	Elective (Theory)
ZOO-4054	Immunology	4	60	40+10	Elective (Theory)
ZOO-4062	Practical 1 (Molecular Cell Biology)	2	60	20+5	Practical
ZOO-4076	Dissertation	6	90	60+15	Dissertation (Elective)

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 organization 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 cells; 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, and 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 mRNA stability.
5. Translation: Genetic code, Wobble hypothesis, Prokaryotic and Eukaryotic translation, including the 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.
2. Genome organization: The complexity of the 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; CDNA libraries.
5. Genome information reserves and DNA sequence analysis using software.
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 the membrane attack complex
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.
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. Hypersensitive reactions
5. Autoimmunity
6. Immunology of Cancer
7. Immunoprophylaxis (Vaccines) & Immunotherapy, Transplantation immunology, Modern Antibody therapy

M.Sc. 4th semester

Paper ZOO-4062

(Molecular Cell Biology) PRACTICAL

(Marks 20+5) Theory Credit: 2 Credits

1. Supravital staining of living cells, blood cells, and living protozoa
2. Staining of certain organelles in situ using specific stains (mitochondria, Golgi, etc)
3. Study of micronuclei in mice/fish
4. Preparation and study of polytene chromosomes
5. Study of Euchromatin and Heterochromatin C banding
6. Preparation of the mitotic chromosome in onion root tip cells
7. Meiotic chromosome preparation from rats or mice
8. Isolation of genomic DNA from Mammalian Tissue
9. Separation of DNA by Agarose Gel Electrophoresis
10. Demonstration of amplification of DNA by PCR
11. Viva-voce

M.Sc. 4th semester

Paper ZOO-4076

(Dissertation/Field report)

(Marks 60+15), Credit: 6

1. Dissertation – 60 marks
2. Field report - 15 marks



**Darrang College
(Autonomous),
Tezpur-784001**

**Syllabus
M.Sc. 4th Semester
(CBCS)**

**Elective 2: Animal Ecology and Wildlife
Biology**

Subject: Zoology

Approved by :

**Board of Studies meeting held on 19-12-2025
&
Academic Council vide Resolution no. 2, dated 29-12-2025**

SEMESTER-4

ELECTIVE 2: Animal Ecology and Wildlife Biology

Code	Course	Credits	Contact hours	Total Marks	Types
ZOO-4014	Ecosystem Functions and Stability	4	54	40+10=50	Elective(Theory)
ZOO-4024	Wildlife and Wildlife Habitat Relations	4	54	40+10=50	Elective(Theory)
ZOO-4034	Wildlife Population Ecology and Methods	4	54	40+10=50	Elective(Theory)
ZOO-4044	Wildlife Conservation	4	54	40+10=50	Elective(Theory)
ZOO-4054	Wildlife Management	4	54	40+10=50	Elective(Theory)
ZOO-4062	Practical	2	54	20+5=25	Practical
ZOO-4076	Dissertation	6	81	60+15=75	Dissertation

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

PAPER- ZOO-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.

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

PAPER- PAPER- ZOO-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, 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- ZOO-4034
WILDLIFE POPULATION ECOLOGY AND METHODS**

**Total Credits: 4
=50**

Total Contact Hours: 54

Total marks: (40+10)

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- ZOO-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; 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- ZOO-4054
WILDLIFE MANAGEMENT & MANAGEMENT PRACTICES**

Total Credit: 4 Total Contact Hours: 60 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- ZOO-4062 PRACTICAL

Total Credit: 2 Total Contact Hours: 60 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 transect techniques for wildlife and wildlife habitat data collection.

2. Wildlife Census Techniques

(A) Direct method (i) Line transect (ii) point transect (iii) Quadrature 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.

**M. Sc. FOURTH SEMESTER
SPECIAL PAPER: ANIMAL ECOLOGY AND WILD LIFE BIOLOGY
PAPER- ZOO-4076 (DISSERTATION)**

Total Credits: 6 Total Contact Hours: 90 Total Marks: (60+15) =75

The students will take up a project/survey/review/experimental work based on topics of relevance to the subject specialization and in consultation with their respective supervisor/guide to be completed within the period of the course. The work shall be based on proper methodology and protocols, and submitted in appropriate format to the department within stipulated time. The guidelines for the dissertation work may be notified by the department from time to time. The final submission of hard bound thesis, presentation and viva voce shall carry 60% marks, and 40% marks are to be evaluated internally by the supervisor which may consist of (but not necessarily restricted to) the following: rationality, scientific validity, methodology punctuality, timely progress, internal test/examinations etc.

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Darrang College (Autonomous), Tezpur-784001

Syllabus M.Sc. 4th Semester (CBCS)

Elective:3 Fish biology & Fishery Science

Subject: Zoology

Approved by :

**Board of Studies meeting held on 19-12-2025
&
Academic Council vide Resolution no. 2, dated 29-12-2025**

Elective:3 Fish biology & Fishery Science

Specialization: Fish Biology & Fishery Science

Code	Course	Credit	Contact hour	Total marks	Type
ZOO-4014	Fish Taxonomy & Study of Fish Growth & Population	4	54	40+10	Core (Theory)
ZOO-4024	Fish Physiology & Fish Genetics	4	54	40+10	Core (Theory)
ZOO-4034	Capture Fisheries & Ecosystem management	4	54	40+10	Core (Theory)
ZOO-4044	Aquaculture & Fish Biotechnology	4	54	40+10	Core (Theory)
ZOO-4054	Fish Pathology & Post harvest technology	4	54	40+10	Core (Theory)
ZOO-4062	Practical paper-I (Taxonomy, Fish Biology & Aquaculture)	2	54	20+5	Practical
ZOO-4076	Dissertation	6	54	60+15	Dissertation

**M. Sc. FOURTH SEMESTER
FISH BIOLOGY & FISHERY SCIENCE
PAPER-ZOO -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 freshwater 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 freshwater fishes.
5. 5. Types of scales and fins in fish and their modifications

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, Gastrosomatic Index — their estimation.
3. Growth rate and ageing.
4. Study of Species Diversity Indices, Fish Species Richness, Relative abundance.
5. Stock assessment and management — Stock composition analysis, fecundity analysis.
6. Natural markers — morphological analysis, environmental signals, genetic analysis.
7. Applied Markers — marking and tagging.

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-ZOO -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-ZOO -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-ZOO -4054 (Total Marks 40) 4 Credits
(Fish Pathology, Ecosystem management and Fish Biotechnology) Unit: -1 FISH PATHOLOGY: 2
credits (20 marks)**

Unit:-1 FISH PATHOLOGY & ECOSYSTEM MANAGEMENT: 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.
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. Study of Algal blooms; Biological indicators and Microbial toxins.

Unit:-2 BIOTECHNOLOGY: 2 Credit (20 Marks)

10. Food biotechnology: Probiotics, single cell proteins, Nutraceuticals.
11. Cell lines and cell culture; DNA markers and MAS.

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.

**Impact of exotic fish species and GMOs on aquatic biodiversity
Biotechnology in fish conservation.**

M. Sc. FOURTH SEMESTER
FISH BIOLOGY & FISHERY SCIENCE
PAPER - ZOO-4062 (Total Marks 20) 2 Credit
(Fish Taxonomy, Fish Biology & Aquaculture — Practical)

1. Identification of commercially important freshwater 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. Age determination of fishes using scales.
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. Identification and study of various types of fishing gears.
6. Determination of gonadosomatic index (GSI), hepatosomatic index (HSI), condition factor (CF), and Gastrosomatic Index.
7. Water chemistry — Estimation of DO, TA, TH, Ca and Mg in pond/river water.
8. Study of different Types of scales in fish.
9. Haematological studies in *Monopterus albus*/*Clarias magur* — DLC
10. Demonstration of Induced breeding of Indian major carps/catfishes.
11. Viva-Voce

**M. Sc. FOURTH SEMESTER
FISH BIOLOGY & FISHERY SCIENCE
PAPER - ZOO-4076 (Total Marks 60+15) 6 Credit
(DISSERTATION)**

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