Syllabus for M. Sc.

in

ZOOLOGY

Choice Based Credit System (CBCS)

Postgraduate Department of Zoology
Nowgong College (Autonomous)
Nagaon, Assam, Pin-782001

Semester-I

Paper Code	Course Name	Credit	Contact hour	Totalmarks	Type
PG-ZOOL-1014	**BiosystematicsandBiostatistics**	4	54	40+10	Core(Theory)
PG-ZOOL-1024	**BioinformaticsandInstrumentation**	4	54	40+10	Core(Theory)
PG-ZOOL-1034	**Evolution and Chronobiology**	4	54	40+10	Core(theory)
PG-ZOOL-1044	**Genetics and Cytogenetics**	4	54	40+10	Core(Theory)
PG-ZOOL-1054	**Ecology and Environmentalbiology**	4	54	40+10	Core(Theory)
PG-ZOOL-1064	**Biochemistry**	4	54	40+10	Core(Theory)
PG-ZOOL-1072	**Biosystematics, Biostatisticsand Bioinformatics**	2	54	20+5	Practical
PG-ZOOL-1082	**Genetics,Cytogenetics,Evolution and Chronobiology**	2	54	20+5	Practical

M. SC. 1st SEMESTER
PaperCode-PG-ZOOL-1014 (BIOSYSTEMATICS AND BIOSTATISTICS)
(Marks 40+10) Theory credit: 4 Credits

Objectives: To give in-depth knowledge on new systematics,population taxonomy,distribution of organism to investigate their evolutionary histories.To impart knowledge about various tools & techniques used in biological systems and gives them insight about their use in research. Biostatistics teaches them to use the best data analysis methods in their research projects.

Learning outcomes: learn about species concept, subspecies, speciationand taxonomic characters. Students gains knowledge about statistical methods like measures of central tendencies, Probability ,regression, correlation and t-test and F-test and Learns about hypothesis testing and inferential statistics .Learns the problem-solving methods

UNIT 1:Credits: 2

1. Concept of species: Species, Polytypic species, Importance of recognition of Polytypic species taxa.
2. Infra-specific categories, subspecies, temporal subspecies, race and cline
3. Population taxonomy, the new systematics and super species.
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. Intra-population variations: Non-genetic and Genetic variations.
7. Interpretation and application of important rules.

ReferredBook:
1.Principles of systematic Zoology, 2nd Edition, by Ernst Mayr, Peter D Ashlock.

UNIT 2:Credits: 2

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.

ReferredBooks:
1. Introduction to Biostatistics (A textbook of Biometry): Pranab Kumar Banarjee (S. Chand).
2. Principles and practice of Biostatistics (Elsvier): BelavendraAntonisamy, Prasanna S Premkumar, Solomon Christhoper.
3. Elements of Biostatistics 3 Edition, Prasad Satguru.
4. Biostatistical Analysis, Jerrold H. Zar, Pearson Education India, 5th Edition.

M. SC. 1st SEMESTER
Paper-PG-ZOOL-1024 (BIOINFORMATICSANDINSTRUMENTATION)
(Marks 40+10) Theory credit: 4 Credits

Objectives: To impart skill of applying computer technology to get the information that is stored in certain types of biological data and enables them to search and analyze information.
Another objective is to give detail account of different instruments and techniques used in different assays,detection processes and certain diagnostic techniques.

Learning outcomes:1. Students studying this course will be able to perform the data analysis using the statistical tools available on any computer such as excel as well the programs for big and complex data. They will be able to handle high throughput proteomic and genetic data.
2. They will be able to understand the maintenance of computers, server and big data files. This course will make them suitably knowledgeable to undertake the computer jobs in the offices in the hospitals, scientific academies, funding agencies in addition to the teaching institutions.
3. They will also be able to know the principle and use of different instruments in detection processes such as electrophoresis, autoradiography, microscopy, chromatographic techniques.

UNIT1: **Credits: 2**

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 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 abinfitio 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: **Credits: 2**

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

Referred books:

1. Principles and Techniques of Biochemistry and Molecular Biology Seventh edition, Edited by Keith Wilson and John Walker, Cambridge University press
2. Molecular Biomethods Handbook, Second Edition, Edited by John M. Walker and Ralph Rapley, Humana Press

M. SC. 1st SEMESTER
PaperCode-PG-ZOOL-1034 (EVOLUTIONANDCHRONOBIOLOGY)
(Marks 40+10) Theory credit: 4 Credits

Objectives: The primary objective of the course is to impart appreciation for different life forms on earth and their origin, theories describing the basis of evolution.This course provides detail knowledge on how diverse forms of organisms originate.

The anotheraim of this course is to enable students to understand the importance of internal timing in regulation of daily and seasonal processes in organisms.

Learning Outcomes: At the end of the course, the students would be able to

1. After completion of the course students will have knowledge on origin of life, organic evolution, causes of variation and detail account of role of mutation in evolution.
2. Conceptualize how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.
3. Understand the molecular basis in the generation and coordination of internal timing.
3. Develop a critical viewpoint and to interpret observations from experiments on biological rhythms regulating daily and seasonal biology.

UNIT1: **Credits: 2**

1. Organic Evolution: Theoriesoforganicevolution,prebioticmolecules(AminoacidandNucleicacidbases), EvolutionofProkaryotesandEukaryotes.
2. Originoflife: Moderntheories,Changesinhereditaryinstructionsinrelationtoevolution.
3. Notionofselectivelyneutralmutations,evolutionarygeneduplication,thefounderprinciple,bottlene ck effect of geneticdrift.
4. Natural Integration: Evolutionaryhistoryof natural integration, evolution ofman.
5. Factorsandforcesofevolution:Mutation,Geneticvariation,Isolationmechanismsand theirrolein speciation.
6. Neo-Darwinism: Definition, EmergenceofthetheoryofNeo-Darwinism.
7. Molecular evolution : Concept of neutral evolution (Kimura), molecular divergence andmolecular clock, molecular tools in phylogeny, classification and identification, Originofnewgenes and proteins, geneduplication and divergence

Referred books:

1. Hall Brian and Hallgrimsson (2007): Strickberger's Evolution, 4th Edition
2. Douglas J. Futuyma (2017): Evolution, 4th Edition

UNIT2: **Credits: 2**

1.Biologicalclocks: Definition, Significance of Biological time keeping
2.Biological rhythms: Types of rhythms- Circadian, Circatidal, Circalunar, Circannual;Centres of biological rhythms- Suprachiasmatic nuclei, Pineal gland, Optic lobes; Factorsinfluencingbiologicalrhythms-Environmental,Photoperiod,Temperature,OtherZeitgebers.
3.Methods of measurement: Entrainment, Re-entrainment, Phase angle difference, Free-run,Phaseshift, Phaseresponse curve,Arrhythmia.
4.Molecularbasesofcircadianrhythms:Clock genes:*Drosophila*andMouse.
5.Applied Chronobiology: Human circadian rhythms, Application of circadian rhythms andprinciples;

Jet-lag/shift work; Depression and sleep disorders; Chronopharmacology andChronotherapy.

Referred books:

1. Nelson,R. J.(2000).An introductiontobehaviouralEndocrinology, 2nd edition.
2. Binkley,S.(1990).Theclockworksparrow:time,clocksandcalendarsinbiologicalorganisms.
3. Chadrashekaran,M.K.(1985).Biological rhythms.MadrasScienceFoundation,Chennai.

M. SC. 1ST SEMESTER ZOOLOGY
PaperCode-PG-ZOOL-1044 (GENETICS AND CYTOGENETICS)
(Marks 40+10) Theory credit: 4 Credits

Objectives:

Apart from Mendel's laws and basic genetics, at Master's level, this course will provide some of the most incisive analytical approaches that are now being used across the spectrum of the biological disciplines. Cytogenetic will impart knowledge about the human chromosome constitution that would help in applying basic principles of chromosome behavior to disease context. Overall, this course will highlight extension of Mendelian Genetics, dosage compensation, gene interactions, evolution of the concept of gene and its amalgamation with molecular biology and study of genetic diseases. This course also provides genetic basis of some human diseases like Cancer.

Learning Outcomes: 1. Students will learn how genomes are organized and genetic information is passed on in eukaryotes and prokaryotes, how genes work together in a complex manner in biological system and any alteration can lead to major phenotypic change.
2.Students will appreciate the concept of epigenetics as a key mechanism of regulation of gene expression steering development and cell fate that can ultimately be affected in disease condition.
3.Students will learn about sex limited genes, sex linked inheritance, gene interactions
4.They will also learn about microbial genetics.

Credits: 3

UNIT 1:

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, PRB, P53, PAPC, 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: **Credit-1**

1. Giant chromosome: models for studies on chromosome organization and gene expression.
2. 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 *Caenorhabditiselegans*.
4. Human genetics: Karyotype and nomenclature of metaphase chromosome bands.

Referred books:

1. Principles of Genetics. VIII Edition (2008). Gardner, E.J., Simmons, M.J., Snustad, D.P. Wiley India.
2. I Genetics- A Molecular Approach. III Edition (2009).Russell, P. J. Pearson

M. SC. 1st SEMESTER ZOOLOGY
PaperCode-PG-ZOOL-1054 (ECOLOGY AND ENVIRONMENTAL BIOLOGY)
(Marks 40+10) Theory credit: 4 Credits

Objectives: Imparts knowledge to the student regarding ecosystem, its structure, trophic structure, energy flow in an ecosystemand many important aspects on environment and conservation biology. Along with which this course will impart in depth knowledge on environmental issues and interactions between human and environment and consequences.

Learning outcomes: 1. detail account on different ecosystem structures,communities, succession and about mechanism of working of food chain, web and energy flow.

2.become concern about environmental issues such as greenhouse effects, global warming ,environmental monitoring and documentation.

UNIT 1: **Credits: 2**

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.

ReferredBooks:
1. Fundamentals of Ecology, Eugene P. Odum and Gary W. Barret.
2. Concepts of Ecology, N. Arumugam. Saras publication.
3. Elements of ecology, Thomas M. Smith & Robert Leo Smith, Pearson Education.
4. Ecology, The Experimental Analysis of Distribution and Abundance, Pearson Publication.

UNIT 2: **Credits: 2**

1. Environmental issues, environmental regulations and biodiversity management approaches.
2. Environmental concerns–greenhouse 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.

ReferredBooks:

1. Text book of Environmental Biology, A. L Bhatia, Dreamtech Press.
2. Ecology and Environmental Biology, Farah Deeba, Springer.
3. Fundamental of Environmental Biology, Meetu Gupta.

M. SC. 1st SEMESTER ZOOLOGY
PaperCode-PG-ZOOL-1064 (BIOCHEMISTRY)
(Marks 40+10) Theory credit: 4 Credits

Objectives:

- The prime objectives of studying biochemistry is to understand the principles that govern the structures and functions of macromolecules and their participation in molecular recognition.
- To demonstrate the knowledge and understanding of the molecular machinery of living cells like about enzymes and their kinetics and regualtionsand their role in different reaction inside the cells.
- To give detail account of energy generation in biological systems, energy rich compound.
- To impart knowledge on structures of proteins and their associated functions.
- The course also explains the interplay and energetics, catalysis and design of living systems.

Learning outcomes:

On completion of the course, students will be able :

1. comprehend the importance of biochemical reactions(Metabolic reactions) in living organisms.

2. analyze the various types of interactions between the biomolecules and correlate how the large biomolecules such as proteins, nucleic acids made from the simple precursors and interpret the structure-function relationships of the proteins, , lipids, and nucleic acids.

3.learn about energy rich compounds, their synthesis and utilization.

UNIT 1 **Credits: 2**

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 Km and Vmax using MM & LB plots, Concepts of regulation of enzyme activity.
6. Concept of metabolic pathways, Glycolysis and Gluconeogenesis, Glycogenesis and Glycogenolysis; Kreb cycle.

UNIT 2 **Credits: 2**

1. Hexose monophosphate shunt pathway and its significance.
2. β-oxidation of fats and synthesis of fatty acids.
3. Intermediary metabolism: inter-conversion between lipids, carbohydrate and proteins.
4. Amino acid: Structure and chemistry of amino acid, Amino acid catabolism, Trasnsamination, Transdeamination and oxidative deamination, Urea cycle.
5. Nucleic acids **:** Structure, folding motifs, conformational flexibility and supercoiling,

6. DNA replication : DNA polymerases, Molecular mechanism of DNA replication, Origin of replication and formation of primosome and replisome,synthesis of telomeric DNA by telomerase,DNA repair.
7. Gene expression: Transcription unit, split genes, Promoters and enhancers , RNA polymerases , Formation of pre-initiation complex , Mechanism of transcription
8. RNA processing: Ribozymes, Capping , Poly (A) tailing , Mechanism of Splicing of introns.
9. Translation: Wobble hypothesis, Role of ribosomes and tRNA in protein synthesis, Formation of initiation complex, Elongation and termination, Post translational modifications.

Referred books:

1. Lehninger Principles of Biochemistry. David L.Nelson and Michael.M.Cox. W.H.Freeman.
2. Harper's illustrated biochemistry. Rodwell, Bender, Botham, Kennelly and Weil.McGraw-Hill Education/Medical.

M. SC. 1st SEMESTER ZOOLOGY
PaperCode-PG-ZOOL-1072(Practical)
BIOSYSTEMATICS, BIOSTATISTICS AND BIOCHEMISTRY
(Marks 20)
Practicalcredit: 2 Credits

Credits: 2

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.
9. Effect of substrate concentration on enzyme activity and determination of K_m and $V_{max}$by plotting Michaelis-Menten and LB plot.
10. Extraction and 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

M. SC. 1st SEMESTER
PaperCode-PG-ZOOL-1082(Practical)
GENETICS, CYTOGENETICS, EVOLUTION, CHRONOBIOLOGY ANDBIOINFORMATICS
(Marks 20) Practical credit: 2 Credits

Credits: 2

1. Drosophila culture and studyof normal and mutant phenotypes.
2. Studyofsexchromatininbuccal smear(Human).
3. Preparationand studyofmetaphasechromosomes from mousebonemarrow.
4. Studythedifferenceinnumber,shapeandsizeofchromosomesinnormalvs.tumorcellsand normal vs. irradiated cells.
5. Preparationofhumankaryotypeandstudyofchromosomalaberrationswithrespecttonumber, translocation, deletion etc.from thepictures provided.
6. StudyofHardy-Weinbergequilibriuminhumanpopulationbytakingtheexampleofbloodgroupsystem (ABO).
7. Use ofsearchengineslikeScopus,ScienceDirectfor referencematerialcollectionmanagement.
8. Nucleicacidandproteinsequencedatabases
9. Dataminingfor sequenceanalysis
10. Webbased tools forsequencesearches and homologyscreening
11. ConstructionforphylogenetictreesforproteinsusingUPGMAorNeighborjoining method(nosoftwareto be used)
12. ReproductionofthesamephylogenyusingMEGAsoftwareforthegivensetof sequences
13. Findingpossible genesinagivennucleotidesequence(ORFfinder)
14. Predictionandvalidationofproteinstructureusinghomologymodeling(useofSwiss model)
15. Determinationofbindingmodesofagivenligandintheactivesiteofaprotein(useofAutodock)

Semester-II

Paper Code	Course Name	Credit	Contact hour	Totalmarks	Type
PG-ZOOL-2014	**Biodiversity**	4	54	40+10	Core(Theory)
PG-ZOOL -2024	**Endocrinology**	4	54	40+10	Core(Theory)
PG-ZOOL-2034	**Developmental Biology**	4	54	40+10	Core(Theory)
PG-ZOOL-2044	**Cell Cultureand GeneticEngineering**	4	54	40+10	Core(Theory)
PG-ZOOL-2054	**Animalbehavior**	4	54	40+10	Core(Theory)
PG-ZOOL-2064	**AnimalPhysiology**	4	54	40+10	Core(Theory)
PG-ZOOL-2072	**Biodiversity,Animalbehavior,DevelopmentalBiology**	2	54	20+5	Practical
PG-ZOOL-2082	**Endocrinology,Animal Physiology,Cell Cultureand GeneticEngineering**	2	54	20+5	Practical

M. SC. 2ND SEMESTER ZOOLOGY
PaperCode-PG-ZOOL-2014 (BIODIVERSITY)
(Marks 40+10) Theory credit: 4 Credits

Objectives: The main objective of this course is to give detail account of levels, components pattern of biodiversity along with threat factors.It also imparts knowledge on value of protection,preservation and management of biological diversity**.**

Learning outcomes: Students will be able to comprehend the in depth meaning of biodiversity, methods of its conservation, legal instruments in conservation of biodiversity.

UNIT- I **Credits: 2**

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 **Credits: 2**

1. Value of Biodiversity (Species and Ecosystems), Utilization of Biodiversity
2. Methods and tools for biodiversity conservation (ex-situ, in-situ, Restoration and Rehabilitation, land use)
3. Priority setting: Criteria for conservation
4. Women, gender and biodiversity conservation
5. Legal instruments for Biological diversity conservation
6. Sustainability, Harnessing and benefit sharing

ReferredBooks:

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
PaperCode- PG-ZOOL-2024 (Endocrinology)
(Marks 40+10) Theory credit: 4 Credits

Course Objectives: The course is designed to develop deep understanding of endocrine physiology. The aim of this course is to provide a comprehensive understanding of relationship of central nervous system with peripheral endocrine system and controlled functions system in higher vertebrates.

Theanother objective of this Insect endocrinology is the study of the properties, processes, and functions of insect physiological systems mainly the hormonal system. As a component of this course student will study detail account of hormone secreting glands,their synthesis and their physiological actions to examine and understand the structure–function correlates within the various physiological systems functioning in insects.

Learning outcomes: After completion of this course students will acquire detail knowledge on human endocrine system, its gland hormones, their chemical nature and synthesis. Become familiar with the various physiological systems operating in insects • Identify the influence/control (neural and/or hormonal) within each system and how different processes in insect body are regulated through hormones.

UNIT I: **Credits:2**

1.Hormone and target organs: Chemistry of hormones, hormone receptors and their characteristics. Neurocrine endocrine and paracrine secretion of hormones, mechanism of hormonal action and hormone signal transduction.
2. Hypothalamus: Hypothalamic neurosecretorycentres, Hypothalamic hormones, hormonal feedback.
3. Pituitary: Pituitary hormones and their functions, disorders of pituitary gland.
4. Thyroid: Thyroid hormones biosynthesis and their functions, disorders of thyroid gland.
5. Comparative anatomy of adrenal glands in vertebrates, Biosynthesis of adrenal hormones and their functions, Adrenal Medulla: Catecholamine biosynthesis, releaseand its physiological functions.
6. Parathyroid: Functions of Parathormone, Calcitonin and vitamin D in calcium Homeostasis
7. Endocrine Pancreas: Glucose homeostasis and physiological functions of Insulin and Glucagon

UNIT II: **Credits:2**

1. Neurosecretory hormones in insects and crustaceans and their functions
2. 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.
3. Prothoracicotropic hormone, Allatotropin, Allatostatin, Diapause hormone, Bursicon, Eclosion hormone, Proctolin, Diuretic hormone and Heart beat accelerating factor
4. Corpus cardiacum : Structure, Hormones produced by Corpus Cardiacum and their functions, Corpus allatum : structure and functions of JH, JH as a gonadotropin
5. 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.

Referred books:

1.Endocrinology, Mac. E. Hadley and Jone .E. Levine. prentice Hall of India Pvt.Ltd
2.Harrison,s Endocrinology, J.Larry Jameson, McGraw Hill medical.
3.Comparative Vertebrate Endocrinology, Bentley, P. J., Cambridge University Press, UK
4. Vertebrate Endocrinology, Norris D. O., Elsevier Academic Press,
5. Hand Book of Physiology, American Physiological Society, Oxford University Press, Section 7: Multiple volumes set.
6. The Insects: Structure and Function, Chapman, F.R., The English Language Book Society (ELBS) and The English Universities Press Ltd.
7. The Principles of Insect Physiology Wigglesworth, V. B., ELBS and Chapman and Hall.
8. Endocrinology (3 volumes set), DeGroot L. J. and Jameson J.L., Editors, (5th Ed., 2006), Saunders Elsevier Press, USA.
9. Molecular Biology of Steroid and Nuclear Hormone receptors, ed. Freedman L. P., (1998), Birkhauser, Boston, USA
10. Turner and Bagnara: General Endocrinology, W. B. Saunders Company Philadelphia. 1984
11. Larson: Williams Text Book of Endocrinology, 10th edition. W. B. Saunders Company, Philadelphia. 2002.

M.SC. 2nd SEMESTER
PaperCode: PG-ZOOL-2034 (DEVELOPMENTAL BIOLOGY)
(Marks 40+10) Theory credit: 4 Credits

Objectives: To impart knowledge on how an organism develops—how a single cell get differentiated become and organized grouping of cells and get specialized to do aspecific task

Learning Outcomes:

1. Acquire knowledge on gametogenesis, fertilization and morphogenetic movements in the developing embryo
2. To understand organogenesis related to mechanisms of embryo development extra embryonic membrane and placenta in various animals.
3. To learn the metamorphosis and regeneration
4.To understand the embryonic organizer, inductions and differentiation.

Unit-I **Credits: 2**

1. Principlesofexperimentalembryology:thedevelopmentaldynamicsofcellspecificationstem cellsand developmentalcommitment,totipotencyand pluripotency.
2. Morphogenesisandcelladhesion-thethermodynamicmodelofcellinteractions,conceptofmorphogengradientsandmorphogeneticfields,celladhesionmolecules
3. Fertilization-pre and post fertilization events, activation of eggs, Gamete fusion andpreventionofphylogeny
4. Nucleo cytoplasmic interaction in development of unicellular organisms and in earlydevelopment and differentiations of multi cellular organisms, Importance and role ofcytoplasm, hybridization experiments, nature ofchanges in nuclei, cell hybridizationandnuclear transplantation experiments.
5. Cell to cell communications in development: Induction and competence, Reciprocal andsequentialinductiveevents,Instructiveandpermissiveinteractions,Epithelialandmesenchymalinteractions,Geneticspecificityofinduction,ParacrineFactors;theinducermolecules.

Unit-II **Credits: 2**

1. RoleofmaternalcontributioninearlyembryogenicdevelopmentinDrosophila:Maternal effect genes, gap genes, pair rule genes, segment polarity genes, homeoticgenesand hoxgenes in development.
2. Organogenesis:vulvaformationin*Caenorhapditiselegans*.
3. Regeneration:EpimorphicregenerationofSalamanderlimbs,Morphallacticregenerationin hydra, Compensatoryregeneration in Mammalian liver.
4. DifferenttypesofstemcellsandtheirapplicationsRegenerationtherapy.
5. Role of environment in animal Development: Gravity and pressure, Developmentalsymbiosis, larval settlement. Diapause:suspended development.

Referred books:

1. DevelopmentalBiology,Gilbert,(8thEd.,2006)SinauerAssociatesInc.,Massachusetts,USA.
2. PrinciplesofDevelopment,Wolpert,Beddington,Brockes,Jessell,Lawrence,Meyerowitz,(3rdEd., 2006), OxfordUniversityPress,New Delhi,INDIA.

3. AnalysisofBiologicalDevelopment,Kalthoff,(2ndEd.,2000),McGraw-HillScience,NewDelhi,INDIA.

M.SC. 2nd SEMESTER
PaperCode: PG-ZOOL-2044 (CELL CULTURE AND GENETIC ENGINEERING)
(Marks 40+10) Theory credit: 4 Credits

Objectives: To impart knowledge on cell culture techniques,media preparation and about contaminations and safetymeasures**.**Major objective of this core paper is to introduce to the students contemporary molecular techniques for manipulation of genome that could assist them towards advanced understanding of biological processes in broad range of host organisms. The student should be able to understand standard and system-specific gene manipulation approaches ranging from bacteria to mammals. A prior exposure to recombinant DNA technology at undergraduate level is desirable for accelerated learning.To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences. To expose students to application of recombinant DNA technology in biotechnological research
Learning outcomes: 1.after completion of the course students will be able to comprehend the cell culture tools and techniques.
2.after successful completion of the course the candidate should be able to design and comprehend experimental strategies for alteration of genes and gene products in variety of organisms

UNIT 1: Credits-2

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: **Credits-2**

1. Automated sequencing methods; Sanger's dideoxynucleotide method; Shotgun DNA sequencing method; Polymerase chain reaction and its advantages.
2. DNA polymorphism: Basis of DNA typing/fingerprinting; Expressed sequence tags and their use for developing STSs, SSRs and SNPs.
3. 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
4. RNA interference: History, molecular mechanisms and applications of antisense RNA, microRNA, siRNA, and ribozymes.
5. Gene and somatic cloning techniques
6. Transgenic technology-animals as bioreactors

Referred books:

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

M.SC. 2nd SEMESTER
PaperCode: PG-ZOOL-2054 (ANIMAL BEHAVIOUR)
(Marks 40+10) Theory credit: 4 Credits

Objectives: This course exposes students to the broad field of animal behavior. Students will come to understand the historical foundations of the field, as well as current theories and evidence for a broad range of behavioral topics. We will also focus on how the science underlying our theoretical understanding of behavior is conducted, and how behavioral hypotheses at all levels of analysis can be tested experimentally. Behavioral ecology and the evolution of behaviors as adaptations will be recurring themes interwoven through all topics discussed.

Learning Outcomes:1.At the completion of their Animal Behavior course, students will be able to:
2. Exhibit critical and integrative thinking skills
3. Demonstrate ability to communicate information Demonstrate knowledge of key concepts in animal behavior
4.Exhibitneural mechanism of learning, genetic basis of different behavior also learn about reproductive behaviors.

UNIT- I **Credits: 2**

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 **Credits: 2**

1. 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.
2. Sociobiology: Units of Sociobiology; major social behaviours; Alturism: Reciprocal altruism, group selection, kin selection and concept of inclusive fitness, cooperation, /reciprocation; Selfishness; Eusociality.
3. Reproductive strategies: Sexual selection, intrasexual selection (male rivalry), intersexual selection (female choice), infanticide, mate guarding.
4. 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.

ReferredBooks:
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. (7 th ed.) Sinaur Associates, Inc. 2001.

M.SC. 2nd SEMESTER
PaperCode: PG-ZOOL-2064 (ANIMAL PHYSIOLOGY)
(Marks 40+10) Theory credit: 4 Credits

Objectives: Animal physiology is the study of animal structure and function. This course onAnimal Physiology helps to understand how animals work at all levels, ranging from individual cells to the whole integrated organism. The scope of physiology includes elucidation of the function of all cells in all organs and all animals related to nervous, respiratory, circulatory and other physiological systems.

Learning Outcomes:Upon completion of the course students will be to:

1.comprehend some of the vital processes like circulation of blood and its coagulation processess, digestion, excretion
2. analyze the role of the respiratory systems, mechanism of muscle contraction and also about mechanism of vision and auditory impulse processing and also about neuronal impulse transmission

UNIT I: **Credits: 2**

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, 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: **Credits: 2**

1. Nervous system:Neurons and types of neurons, Types of synapses and synaptic knobs, Axonal transmission.
2. 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)
3. Special sensory system: Eye: Anatomical Organisation of retina, Photoreceptors: Processing of visual impulses Ear: Cochlea, basilar membrane, and organ of Corti. Processing of auditory impulses.
4. Muscle: Contractile proteins, Ultrastructure of skeletal muscles, Properties of muscle: muscle twist, summation, tetanus and fatigue, Sliding filament theory of muscle contraction.

ReferredBooks:

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

PaperCode -PG-ZOOL-2072 (Practical)

(BIODIVERSITY,ANIMALBEHAVIOUR&DEVELOPMENTALBIOLOGY)

(Marks 20) Practical credit: 2 Credits

Credits: 2

1. Collectionandidentificationofegg(atleastsixdifferenttypes)
2. Studyof lifecycle of *Drosophilamelanogaster*.
3. Dissectionandstudyoflarvalprepupalwing,leg,eye,andantennalimaginaldiscin*D. melanogaster*.
4. Preparationandstudyof frog/micesperm smear.
5. DetectionofSHproteinsduringvariousstagesintheearlydevelopmentofchick/ frogembryo.
6. Studyofdevelopmental stagesof fishfromeggtohatchling.
7. Invitrocultureofchickembryo.
8. Studyof chick embryo usingvital staining.
9. Studyof cell deathduringdevelopment.
10. Activitybudgetingof bird/mammal
11. Effectof toxicanton opercularmovementand surfacingin fish.
12. Effectoftoxicant onmovement offish.

M.SC. 2nd SEMESTER

PaperCode- PG-ZOOL-2082 (Practical)

(ENDOCRINOLOGY, ANIMAL PHYSIOLOGY, CELL CULTUREAND GENETIC ENGINEERING)

(Marks 20) Practical credit: 2 Credits

Credits: 2

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-III

Paper Code	CourseNmae	Credit	Contact hour	Total marks	Type
PG-ZOOL-3014	**Cell Biology**	4	54	40+10	Core (Theory)
PG-ZOOL-3024	**Immunology, Microbiology and Parasitology**	4	54	40+10	Core (Theory)
PG-ZOOL-3034	**Reproductive Biology**	4	54	40+10	Core (Theory)
PG-ZOOL-3044	**Entomology and Limnology**	4	54	40+10	Core (Theory)
PG-ZOOL-3056 (Open I)	**Integrative Biology**	6	81	60+15	Open
PG-ZOOL-3063	**Cell Biology, Histology, Histochemistry, Immunology and Reproductive Biology**	3	54	30+7.5	Practical
PG-ZOOL-3073	**Aquatic Biology, Fishery, Entomology and limnology, Parasitology**	3	54	30+7.5	Practical

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

Objectives:

- To make students learn detail about aspects of cell biology

Learning outcome: Students will be able to-

- Obtain in depth knowledge in cell biology

UNIT-1 **Credits-2**

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 plasmamembrane
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.

UNIT-2 **Credits-2**

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

Referred books:

1. The Cell A Molecular Approach, 5th edition, by Geoffrey M. Cooper and Robert E. Hausman
2. Molecular Biology of the Cell, 6th edition, by Bruce Albertset. al
3. Cell Biology, 7th edition, by Gerald Karp, Wiley International Publisher

M.Sc. 3rdSEMESTER
PaperCode- PG-ZOOL-3024 (IMMUNOLGY, MICROBIOLOGY AND PARASITOLOGY)
(Marks 40+10) Theory credit: 4 Credits

Objectives:

- To impart knowledge of the basic principles of immunology, bacteriology, virology, mycology, and parasitology

Learning outcome: Students will be able to learn

1. Detail understanding of different immune cells and immune responses
2. Develop a broader perspective in microbiology.
3. In parasitology part, life cycles of zoonotic parasites and the role of parasites in global public health is discussed.

UNIT-1 **Credits-2**

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 superfamily, Ig classes, subclasses and types; Myelema protein, monoclonal antibody.
5. Antigen-antibody reaction: antibody affinity and avidity cross reactivity, agglutination reaction, precipitation reaction.

UNIT-2 **Credits-2**

1. Microbial diversity: Prokaryotic microbes-Bacteria and archea; Eukaryotic microbes-Anaerobic and aerobic Protozoa.
2. Microbial pathogenesis: Invasiveness and Toxigenicity; pure culture techniques of microbes.
3. Applied microbiology: Microbial products; Food microbiology; Biocontrol; Biological weapons; Wastewater treatment.
4. Parasitism: General consideration, Types of parasites, Types of Hosts, symbiosis and Commensalism
5. Distribution, habit and habitat, structure and life cycle of economically important helminth parasites of man and domesticated animals: *Echinococcusgranulosus, Hymenolepis nana, Scistosomahaematobium, Trichinellaspiralis*and *Wuchereriabancrofti*

Referred books:

1. Kuby Immunology, 8th edition, by Jenni Punt et. al, Freeman
2. Cellular and Molecular Immunology, 9th edition, by Abbas et. al, Elsevier
3. Roitt's Essential Immunology, 13th edition, by P. J. Delves et. al, Wiley Blackwell
4. Prescott's Microbiology, 11th edition, by J. Willey et. al, McGraw Hill
5. Animal Parasitology, by J.D. Smyth, Cambridge University Press

M.Sc. 3rdSEMESTER
PaperCode- PG-ZOOL-3034 (REPRODUCTIVE BIOLOGY)
(Marks 40+10) Theory credit: 4 Credits

Objectives:

1. Detailed account of reproductive system and its physiological processes along with the hormonal control on the different aspects of reproduction
2. This course also focuses on assisted reproductive technologies

Learning outcome: Students will be able to learn-

1. Different aspects of reproductive biology and role of hormones involved

UNIT -1 **Credits-2**

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 -2 **Credits-2**

1. Mechanism of fertilization,
2. Implantation and role of hormones
3. Placenta and Placental hormones
4. Pregnancy and hormones of pregnancy.
5. Parturition in mammals
6. Development of breast, Lactation and hormonal regulation
7. Assisted reproductive Techniques: IVF-ET
8. Environmental endocrine issue: environmental estrogens, endocrine disruptors

Referred books:

1. Essential Reproduction, 7th Edition, by Martin H. Johnson, Wiley Blackwell
2. General Endocrinology, 6th Edition, by Turner and Bagnara
3. Endocrinology, 6th Edition, by Hadley, Pearson

M.Sc. 3rdSEMESTER
PaperCode- PG-ZOOL-3044 (ENTOMOLOGY AND LIMNOLOGY)
(Marks 40+10) Theory credit: 4 Credits

Objectives:

1. To study taxonomy, economy and concept of pest management
2. Different aspects of limnology,
3. To make students learn about prospects of fish germplasm, the potential of ornamental fish industry etc.

Learning outcome: Students will be able to-

1. Attain a solid foundation in insect biology and limnology
2. Aspects of pisciculture in NE region

UNIT -1 **Credits-2**

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 -2 **Credits-2**

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

Referred books:

1. Modern Entomology, by B. D. Tembhare, Himalaya Publishing House
2. Limnology, by Robert G. Wetzel
3. Fish and fisheries of India, by V.G. Jhingran

M.Sc. 3rdSEMESTER

PaperCode-PG-ZOOL-3056 (OPEN I): INTEGRATIVE BIOLOGY, Theory credit: 6 credits

Objective: To make students able to clear in depth concepts in few areas of biochemistry, cell and molecular biology and genetics.

Learning outcome:

1. This paper will help students to prepare for different examinations such as SET, NET etc.
2. Integrate factual knowledge and problem solving skills

Total credit: 6

CONTENTS –

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 micro RNA.
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.
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. 3rdSEMESTER
PaperCode- PG-ZOOL-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. Histological study 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. 3rdSEMESTER
PaperCode-PG-ZOOL-3073 (ENTOMOLOGY, LIMNOLOGY 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. Study of reproductive and digestive organs in fish
7. Identification of insects belonging to different orders.
8. Identification of different types of insect mouth parts, antennae and legs.
9. Salivary gland of honey bee — dissection and temporary mounting.
10. Dissection of sting apparatus in honeybee.
11. Study of prepared slides and museum specimens of selected parasites of representative groups of protozoans, parasites, helminthes and arthropods.
12. Preparation and identification of permanent slide of rectal ciliates in frog.
13. Culture and study of insect parasitoid on an insect host.

Semester-IV
Animal Physiology and Biochemistry (Special Paper I)

Paper Code	Course Name	Credit	Contact hour	Total marks	Type
PG-ZOOL-4014	**Biochemistry and Proteomics**	4	54	40+10	Elective (Theory)
PG-ZOOL-4024	**Enzymology and Recombinant Technology**	4	54	40+10	Elective (Theory)
PG-ZOOL-4034	**Physiology and Adaptational Biology**	4	54	40+10	Elective (Theory)
PG-ZOOL-4044	**Molecular Endocrinology and Reproductive Biology**	4	54	40+10	Elective (Theory)
PG-ZOOL-4054	**Immunology**	4	54	40+10	Core (Theory)
PG-ZOOL-4066	**Dissertation**	6	81	60+15	Dissertation
Zoo-4072	**Practical 1 (Biochemistry and Enzymology)**	2	54	20+5	Practical

M.Sc. 4th SEMESTER
Paper code: PG-ZOOL- 4016 (BIOCHEMISTRY AND PROTEOMICS)
PAPER CREDIT: (Marks 40+10) Theory credit: 4 Credits

Objectives:

This course focuses on metabolic processes of biomolecules, their synthesis and breakdown as well as energy production and utilization by the cells. This course also focuses cellular processes for turning the information within DNA into a protein product .The course is alsodesign to impart knowledge and understanding of this rapidly changing field of modern biology and fast evolving tools for proteome sequencing. The objective of the course is to map out the structures of protein and protein complexes present inside cell.

Learning outcomes: After completion of the course, students will be able to

1. Describe about biological oxidation reduction reaction, liberation of free energy,free energy change, high energy compounds and catabolic and anabolic reactions of biomolecules and their energy budgets.
2. Understand the basic steps of transcription of DNA into RNA, describe the role of RNA polymerases their types
3. Describe RNA post translational modifications and its purposes
4. Describe the structures of proteins, about protein data bank and much more new information about proteins
5. About the different techniques to study proteins and their structures and foldings.

UNIT I: BIOCHEMISTRY **Credits-2**

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 aapleortic reaction
3. **Lipids:** Cholesterol: Biosynthesis and degradation. Lipidtransport and storage. Biosynthesis of Eicosanoids: Prostaglandins, leucotrienes and thromboxanes. Biosynthesis and degradation of porphyrinandheme.
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 eukaryoticr RNA and tRNAs . RNA targeting and mRNA stability

UNIT II: PROTEOMICS **Credits-2**

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. Super secondary 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.

Referred books:

1. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., NewYork.
2. Berg, J.M., Tymoczko,J.L.andStryer,L.(2007).Biochemistry,VIEdition,
W.H. Freeman and Co., New York.
3.Murray,R.K., Bender,D.A.,Botham,K.M.,Kennelly,P.J.,Rodwell, V.W.and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd.,U.K.
5. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

M.Sc. 4th SEMESTER
Papercode: PG-ZOOL-4026 (ENZYMOLOGY AND RECOMIBNANT TECHNOLOGY
PAPER CREDIT: (Marks 40+10) Theory credit: 4 Credits
Objectives:
1. The main objective of this course is to impart knowledge on the theories of enzyme kinetics,the mechanisms of enzyme catalysis ,basic methods of studying enzymes, and to appreciate how individual reactions are controlled and integrated into the metabolic pathways of the cell.
2. The another objective of this course is to give students the knowledge of modern methods in recombinant technology, development of vectors and also about genomics.

Learning outcomes: Upon successful completion of this course, students will be able to:

1. Explain relationship between the structure and function of enzymes;
2. Explain how enzymes are able to increase speed of an biochemical reaction in sense of thermodynamics, kinetics and molecular interactions; use catalytic strategies in interpreting mechanisms of enzymatic action;
3. Interpret and explain significant mechanisms of regulation of enzymatic action and specifies Importance of enzymes in regulation of metabolism
4. Apply appropriate methods for determination of catalytic parameters and activity of enzymes and resolve problems considering kinetics and thermodynamics of enzymatic reactions.
5. Interpret about the construction of recombinant libraries, cloning vectors etc. At the end of the course students will have sufficient scientific understanding of the subject and have a good knowledge of application of Recombinant DNA techniques in life science research.

UNIT I: ENZYMOLOGY **Credits-2**

1. Kinetics: Single substrate reactions: Steady state and equilibrium kinetics, Michaelis-Menten equation and plot. Linear kinetic plots: Lineweaver Burk, Hanes Wolf, EadieHofstee, EadieScatchard 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 IrreversibleinhibitionCompetitive; Non-competitive; Un-competitive and mixed, Determination of nature of inhibition and Ki by LB
5. Regulation: Allosterism, covalent modifications and regulation by proteolyticclevage
6. Protein ligand binding measurement, Hill and Satchard plot

UNIT II: Recombinant Technology **Credits-2**

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 strategiesfor 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 itsapplication in research including cloning of PCR amplified fragments, mutagenesis andconstruction of Libraries. Real time/quantitative PCR.
6. Subtractive Libraries, Expression based strategies for cloning of functional genes.

Referred books:

1. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., NewYork.

2. Berg,J.M.,Tymoczko,J.L.andStryer,L.(2007).Biochemistry,VIEdition, W.H. Freeman and Co., New York.

3. Murray,R.K., Bender,D.A., Botham,K.M., Kennelly,P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.

4. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, PearsonPub.24

5. Principles and Techniques of Biochemistry and Molecular Biology, Seventh edition edited by Keith Wilson and John Walker, Cambridge University Press

6. Gene Cloning and DNA analysis, an introduction, by TA Brown, Wiley-Blackwell

M.SC 4th SEMESTER
PaperCode - PG-ZOOL-4034 (PHYSIOLOGY AND ADAPTATIONAL BIOLOGY)
(Marks 40+10) Theory credit: 4 Credits

Objectives:

The scope of physiology includes elucidation of the function of all cells in all organs and all animals related to nervous, respiratory, circulatory and other physiological systems. This course especially focuses on the modifications/adaptations found in different physiological systems of various organisms across the animal kingdom. The another objective of this course is to impart the knowledge of different animal adaptations in connection with the environmental changes and how animal physiological processes are built to cope up with different environmental stress.

Learning Outcomes: Upon completion of the course students will be to:

1. Comprehend some of the vital processes like circulation of blood and its coagulation processess, digestion, excretion.
2. Analyze the role of the respiratory systems, mechanism of muscle contraction and also about mechanism of vision and auditory impulse processing and also abou neuronal impulse transmission.
3. Describe about animals can adapt themselves in different environmental stress condition and how physiological system help to maintain homeostasis.
4. The students will have a good understanding of how animals work and how these animals' biology is influenced by the different environments of their niches and how animals adapt themselves to the changing environment and how they manage stress , about different receptors for sensing the environment. The students will be able to explore an original query in animal physiology and about different physiological processes necessary for sustaining life.

UNIT-1: PHYSIOLOGY **Credits-2**

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 andfrequency
4. Counter current mechanism of urineformation
5. Physiology of movement and locomotion, Biochemistry of contractile proteins, Sources of energy for muscle contraction, Sliding filament theory Excitation of contractionand mechanism of regulation of contraction by calcium Mechanism of relaxation
6. Auditory and visual motion processing

UNIT-2: ADAPTATIONAL BIOLOGY **Credits-2**

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: Electrical 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 andhormones. 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 currentheatexchangers.
5. **Space Physiology:** Physiological requirement of space travel

Referred books:

1. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., NewYork.
2. Berg,J.M.,Tymoczko,J.L.andStryer,L.(2007).Biochemistry,VIEdition, W.H. Freeman and Co., New York.
3. Murray,R.K.,Bender,D.A.,Botham,K.M.,Kennelly,P.J.,Rodwell, V.W.and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill CompaniesInc.
4. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd.,U.K.
5. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, PearsonPub.24

M.SC 4th SEMESTER
Paper Code-PG-ZOOL-4044 (MOLECULAR ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY)
(Marks 40+10) Theory credit: 4 Credits

Objectives:
1. The main objective of the course is to discuss the molecular,biochemical and physiological effects of different hormones of our body along with their mechanism of action and regulation.
2. To explain the basis of hormone assays and assessment of biological activity.
3. The another objective of this course is to provide students with sound coverage of human reproductive biology and provide important foundation to consider contraception,fertility and different reproductive technologies.

Learning outcomes: Upon completion of the course students will be able to
1. Give detail account of all the hormones of our body, regulation of their secretion and functions
2. Assess different bioassays for hormones
3. From the reproductive biology part students will learn about human reproductive systems, reproductive cycles,embryoimplantation,sterility and fertility and different methods of contraception as well as modern methods of assisted reproductive technologies.

UNIT I: MOLECULAR ENDOCRINOLOGY Credits-2

1. Hypothalmic releasing hormones: Regulation of hypothalamic hormonesecretion.

2 Pituitary hormones and regulation of pituitary hormonesecretion

3. Hormonalfeedback

4. Hormone receptors and Hormonal signaltransduction.

5. Neorosecretory hormones in insects and crustaceans and theirfunction

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 Credits-2

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, OligozoospermiaAsthenozoospermia and Varicocoele

4. Female: Origin, cause and treatment of femalesterility

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.

M.SC 4th SEMESTER
Paper code: PG-ZOOL-4054 (IMMUNOLOGY)
(Marks 40+10) Theory credit: 4 Credits

Objectives:

The prime objective of this course is to impart the students the basics of immunology so as to develop understanding of the subject, such as how does the immune system works? What are the molecular and cellular components and pathways of the immune system of an organism to protect from infectious agents or cancer. This comprehensive course also includes the structure, function and genetics of the components of immune system. The course also emphasizes recent advances in immunology like immunotherapy, transplantationalimmunology and immunological diseases.

Learning outcomes:

After completion of the course The students will be able to :

1. To identify the cellular and molecular basis of immune responsiveness and understand how the innate and adaptive immune responses coordinate to fight invading pathogens.
2. To understand the immune modulatory strategies essential for generating or suppressing immune responses as required in hypersensitivity reactions, transplantation, autoimmune diseases and cancer.
3. Explore the knowledge of existing vaccines and other immunotherapeutic strategies.

UNIT I: Credits-2

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 Credits-2

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

Suggested Readings:

1. Kindt,T., Goldsby, R.A., Osborne ,B.A (2007). Kuby Immunology. W.H. Freeman and Company
2. Abbas, A.K., Lichtman, A.H., Pillai,S.(2014). Basic immunology. Elsevier, Relxindiapvt .ltd.

M.SC. 4th SEMESTER
Paper code: PG-ZOOL-4066 (DISSERTATION)
Credit=6, Contact Hour=81, Total Marks=60+15=75

M.SC 4th SEMESTER
PRACTICAL Paper code: PG-ZOOL-4072 (BIOCHEMISTRY, PROTEOMICS AND ENZYMOLOGY) CREDIT: 02

1. Estimation of tissue protein by Bradford / Lowry method.
2. Estimation of total free amino acid by using Ninhydrin reagent/ separation of amino acids by TLC.
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. Determination of inhibitor constant (ki) for L-Orinithine against Arginase enzyme by LB plot, determination of Km value
8. Study of estrous cycle in rat/mice
9. Histological detection of a glucose-6phosphate
10. To study sperms count and motility in mice
11. Histological study of testis, ovary, pancreas, pituitary, adrenal, thyroid and parathyroid in mammals.
12. SDS-PAGE analysis of proteins.
13. Purification of IgG from plasma using Protein ASepharose affinity chromatography.
14. Devlopment of antibodies in animal model system (Rabbit/Mice/Goat)

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SEMESTER -IV
Animal Ecology & Wildlife Biology (Special Paper II)

Code	Course	Credits	Contact hours	Total Marks	Types
PG-ZOOL-4014	Ecosystem Stability	4	54	40+10=50	Elective(Theory)
PG-ZOOL--4024	Wildlife and WildlifeHabitat Relations	4	54	40+10=50	Elective(Theory)
PG-ZOOL--4034	WildlifePopulationEcologyandMethods	4	54	40+10=50	Elective(Theory)
PG-ZOOL--4044	WildlifeConservation	4	54	40+10=50	Elective(Theory)
PG-ZOOL--4054	WildlifeManagement	4	54	40+10=50	Elective(Theory)
PG-ZOOL--4066	Dissertation	6	81	60+15=75	Dissertation
PG-ZOOL--4072	Practical	2	54	20+5=25	Practical

M. Sc. FOURTH SEMESTER

SPECIAL PAPER: ANIMAL ECOLOGY & WILDLIFE BIOLOGY

PAPER: ECOSYSTEM FUNCTIONS AND STABILITY

PAPER CODE- PG-ZOOL-4014 **Full Marks: 50**

External Assessment- (Theory:40 **Practical: --)** **Internal: 10**

Total credits: 4

Study objective:

The functions of the ecosystem are as follows: It regulates the essential ecological processes, supports life systems and renders stability. It is also responsible for the cycling of nutrients between biotic and abiotic components. It maintains a balance among the various trophic levels in the ecosystem.

Learning outcomes:

After completion of the course, students will be able to

1. Understand the basic structure and function of ecosystem.
2. Understand the relationship between different components of ecosystem.
3. Understand the collective life activities of plants, animals, and microbes and the effects these activities (e.g., feeding, growing, moving, excreting waste) have on the physical and chemical conditions of their environment.

Unit-I: Ecosystem Function (Credits 2)

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, Competitive Displacement, Principles of co-existence.

Unit-II: 2 Ecosystem Stability (Credits 2)

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, Ecological Risk Assessment, Analytical methods for ecological risk assessment in terrestrial and Aquatic ecosystem and planning and strategies.

Suggested Reading:

1. Ecology, 6e Sixth Edition (English, Paperback, Charles J. Krebs)
2. Elements of Ecology (Others, Paperback, Smith)
3. Models in Ecology (English, Paperback, Maynard-Smith John)
4. Fundamentals of Ecology (English, Paperback, Odum Eugene)

M. Sc. FOURTH SEMESTER

SPECIAL PAPER: ANIMAL ECOLOGY & WILDLIFE BIOLOGY

PAPER: WILDLIFE AND WILDLIFE HABITAT RELATIONS

PAPER CODE- PG-ZOOL-4024 **Full Marks: 50**

External Assessment- (Theory:40 Practical: --) **Internal: 10**

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

Study objective:

The course will focus on wildlife-Habitat Relationships apart from the introductory portion. The course will provide wildlife professionals and students with an understanding of the importance of habitat relationships in studying and managing wildlife. The course will offer a unique synthesis and critical evaluation of data, methods, and studies, along with specific guidance on how to conduct rigorous studies.

Learning outcomes: After completion of the course, students will be able to

1. Understand the in-depth information on the concepts associated with wildlife-habitat relationships.
2. Understand the understanding of the importance of habitat relationships in studying and managing wildlife.
3. Understand the focuses on understanding the intrinsic and extrinsic factors that drive wildlife habitat use patterns and population dynamics.

UNIT-I: Wildlife Habitat (2 Credits)

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)

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.

Suggested Reading:

1. Wildlife Habitat Management: Concepts and Applications in Forestry, Second Edition, By Brenda C. McComb.
2. Wildlife-Habitat Relationships: Concepts and Applications.
3. Wildlife-Habitat Relationships, Michael L. Morrison, Bruce Marcot, William Mannan

M. Sc. FOURTH SEMESTER

SPECIAL PAPER: ANIMAL ECOLOGY & WILDLIFE BIOLOGY

PAPER: WILDLIFE POPULATION ECOLOGY AND METHODS

PAPER CODE- PG-ZOOL-4034 **Full Marks: 50**

External Assessment- (Theory:40 Practical: --) **Internal: 10**

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

Study objectives

The course will focus on the spatial and temporal patterns in the abundance and distribution of organisms and of the mechanisms that produce those patterns.

Learning outcomes: After completion of the course, students will be able to understand

1. different population monitoring techniques being applied for different endangered wild animals in protected areas.
2. Techniques like camera trapping, radio collar, non-invasive methods, mobile application, GPS, GIS, direct head count, etc. are commonly used for monitoring wildlife.

Unit-I: Wildlife Population Ecology (Credit 2)

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 color banding pattern and metallic rings; Home range: Importance of Home range in species conservation, Territoriality.

Unit-II: Wildlife Study Methods (Credit 2)

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.

Suggested Reading:

1. Theory of Wildlife Population Ecology, By Bruce D. Leopold.
2. Wildlife Ecology, Conservation, and Management, By John M. Fryxell, Anthony R. E. Sinclair, Graeme Caughley
3. Conservation of Wildlife Populations: Demography, Genetics, and Management: By L. Scott Mills.
4. Population Ecology: A Unified Study of Animals and Plants books. Michael Begon, Martin Mortimer, David J. Thompson.
5. Wildlife Population Monitoring. By: Marco Ferretti

M. Sc. FOURTH SEMESTER

SPECIAL PAPER: ANIMAL ECOLOGY & WILDLIFE BIOLOGY

PAPER: WILDLIE CONSERVATION

PAPER CODE- PG-ZOOL-4044 **Full Marks: 50**

External Assessment- (Theory:40 Practical: --) Internal: 10

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

Study objectives:

The course will focus on protection of endangered species by banning hunting, giving legal protection to their habitats and finally, restricting wildlife trade. Rhus the main moto is to aware the population regarding the conservation of wildlife and habitat.

Learning outcomes: After completion of the course, students will be able to understand

1. wildlife conservation policies, programmes, and institutions must achieve desirable ecological outcomes such as species recovery, changes in population trends, or habitat protection, as well as desirable social outcomes such as reductions in economic losses, disease transmission, or human-wildlife conflict.
2. The course has a transdisciplinary approach that integrates the science of wildlife conservation with social issues in managing and mitigating wildlife conflict and natural resource management.

Unit-I: Wildlife Conservation (2 Credits)

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)

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.

Suggested Reading:

1. Wildlife Management and Conservation. Contemporary Principles and Practices. By: James W. Cain, Paul R. Krausman.
2. Road to Nowhere
3. Wildlife Conservation in India-1. By H. S. Pabla.
4. Conservation of Wildlife Populations
5. Demography, Genetics, and Management. By L. Scott Mills

M. Sc. FOURTH SEMESTER

SPECIAL PAPER: ANIMAL ECOLOGY & WILDLIFE BIOLOGY

PAPER: WILDLIE MANAGEMENT

PAPER CODE- PG-ZOOL-4054 **Full Marks: 50**

External Assessment- (Theory:40 **Practical: --)** **Internal: 10**

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

Study objectives:

The course will focus on knowledge of ecosystem and biodiversity conservation and management along with wildlife rescue and rehabilitation as well as legal instruments for wildlife conservation. It includes the cognitive aspects and technological skills necessary to further a career in the wildlife field. It trains the candidate in skills required for assessment and monitoring of biodiversity as well as wildlife management through a combination of course work, intensive field work.

Learning outcomes:

After completion of the course, students will be able to

1. Understand public's attitude to wildlife conservation, we must first understand the relationship between humans and wildlife.
2. Understand conservation outcomes, focusing on local issues, partnerships, and action is key**.**

Unit I: Wildlife Management (Credits 2)

Wildlife Protection (Act) 1972, Wetland (Act) 2016, Biodiversity (Act) 2002, CITES, Wildlife Crime, Conservation Breeding and Economics, Breeding species in Captivity, Effective Population size, 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. 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)

Reasons of wildlife Taxonomic Diversity in NE Region, Utilitarian Values of Wildlife and species management, 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.

Suggested Reading:

1. Wildlife Management and Conservation. Contemporary Principles and Practices. By: James W. Cain, Paul R. Krausman.
2. Wildlife Management, Failures, Successes and Prospects, By Jafari R. Kideghesho.

M. Sc. FOURTH SEMESTER

SPECIAL PAPER: ANIMAL ECOLOGY & WILDLIFE BIOLOGY

PAPER: WILDLIE CONSERVATION

PAPER CODE- PG-ZOOL-4066 **DISSERTATION**

Total Credits: 6 **Total Marks: (60+15=75)**

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

M. Sc. FOURTH SEMESTER

SPECIAL PAPER: ANIMAL ECOLOGY & WILDLIFE BIOLOGY

PAPER: WILDLIE CONSERVATION

PAPER CODE- PG-ZOOL-4072

Total Credits: 2 **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, 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. Field base/ laboratory base studies of Bird, butterfly and herpetofauna; **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, GIS techniques, Identification of important food plant species of birds and mammals.

3. Statistical Analysis of Wildlife Data

ANOVA, t- test using equal variance assuming, Paired sample t- test.

4. Viva voce & Practical note book.