SCHOOL OF SCIENCES-ZOOLOGY

M.Sc. Zoology (Semester- II)

DSC-4: Molecular Biology (Theory)

Semester: II	Paper: Discipline Specific Course
Credit: 04	Paper Title: **Molecular Biology(Theory)**
Instruction: 4hr/Wk	Paper Code: MSZY201CCT
Semester Exam: 70	Internal Assessment: 30
Course Objective	The objective of the course is to introduce students to principles of molecular biology which includes genomic organization, DNA replication, transcription, translation, both in prokaryotes and eukaryotes.
Course Outcome	At the end of the course the student would be able to: Understand basics of molecular biology, organisation of prokaryotic and eukaryotic genome, DNA, RNA replication in prokaryotes and eukaryotes. They will have basic insights about translation of genetic code into proteins, Comprehension of DNA damage (mutations) and repair pathways involved
UNIT-I Structural Organisation of Genome and Replication	1.1: DNA as a genetic material, transforming principle, Harshey and Chase Experiment, semiconservative model of replication – Messelson and Stahl Experiment.
	1.2: Genome Organisation - C-value Paradox, genome size, Cot curves, Repetitive and non-repetitive DNA sequences, pseudo genes, gene families, gene clusters organelle genome.
	1.3:Enzymes involved in the replication of DNA
	1.4: Origin of replication fork - Replication of circular and linear DNA, Replication of mitochondrial genome.
UNIT-II Transcription and Translation	2.1: Structure of gene in prokaryotes and eukaryotes.
	2.2: Transcription in Prokaryotes and Eukaryotes. (RNA Polymerases, Transcription Factors, Initiation, Elongation, Termination), Post Transcriptional modifications- Splicing, 5' capping, 3'poly A tail.
	2.3: Translation in Prokaryotes and Eukaryotes (Genetic code, Wobble Hypothesis, Ribosomes, m-RNA, Peptidyl transferases, Initiation, Elongation, Termination).
	2.4: Post translational modifications – chemical modification, proteolytic cleavage, protein splicing.
UNIT-III Regulation of Gene Expression in Prokaryotes and Eukaryotes	3.1: Operon model in Prokaryotes (Lac operon and tryptophan Operon)
	3.2: DNA methylation and gene regulation (CpG islands)
	3.3: Post transcriptional gene regulation (Ex: Ferritin and Transferrin receptor)
	3.4: Epigenetics and RNA interference
UNIT-IV DNA Damage and Repair	4.1: DNA damages (oxidative damages, depurinations, depyrimidinations, O 6 -methylguanines, cytosine deamination, single and double strand breaks).
	4.2: Mutation and Agents causing mutations – physical and chemical agents.
	4.3: Types of mutagenesis–transition, transversion, frameshifts, missense and non-sense mutations.
	4.4: Types of DNA repair – Photo-reactivation, Excision repair (base excision repair, nucleotide excision repair), mismatch repair, SOS repair, and recombination repair.

Molecular Biology Lab (Practical)

Semester: II	Paper: Discipline Specific Course (Practical)
Credit: 02	Paper Title: **Molecular Biology Lab**
Instruction: 4hr/Wk	Paper Code: MSZY 201 CCP
Semester Exam: 35	Internal Assessment: 15
Course Objective	The course aims to provide practical experience in molecular biology techniques, including DNA isolation, PCR, gel electrophoresis, and protein analysis. It focuses on equipping students with the skills necessary to work with nucleic acids and proteins in laboratory settings.
Course Outcome	Upon completion, students will have gained hands-on expertise in molecular biology techniques such as plasmid isolation, genomic DNA extraction, PCR amplification, and protein analysis using SDS-PAGE. This will enable them to independently perform experiments and analyze molecular data.
Practical	1. Isolation of Plasmid DNA/ Isolation of Human Genomic DNA from Blood. a) Isolation of plasmid from E. coli by alkaline lysis method b)Genomic DNA isolation using phenol extraction method
	2. Agarose Gel Electrophoresis a) TBE/TAE buffer preparation b) Agarose gel preparation and electrophoresis
	3. Polymerase chain Reaction a) Primer designing using online tools like NCBI Primer BLAST b) DNA amplification using PCR c) Analysis of PCR product by agarose gel electrophoresis
	4: Protein Determination by PAGE. a) Preparation of phosphate buffered saline (PBS) and radioimmunoprecipitation assay buffer (RIPA) buffer b) Cell lysate preparation from bacteria/mammalian cells c) Polyacrylamide gel preparation (SDS-PAGE) d) Preparation of sample loading and running buffer e) Coomassie staining and destaining of SDS-PAGE gel

References Books:

1. Snustad, D.P. & Simmons. M.J., Principles of Genetics, John Wiley & Sons Inc (7th ed.)
2. Walson. J.D. et.al., Molecular Biology of gene, Pearson Education (7th ed.)
3. Pierce. B.A., Genetics: Conceptual Approach,W H Freeman & Co (6th ed.)
4. Hyde. D.R., Genetics and Molecular Biology, McGraw Hill Education (1st ed.)
5. Wilson & Walker., Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press (7th ed.)

DSC-5: Immunology (Theory)

Semester: II	Paper: Discipline Specific Course (Theory)
Credit: 04	Paper Title: **Immunology (Theory)**
Instruction: 4hr/Wk	Paper Code: MSZY202CCT
Semester Exam: 70	Internal Assessment: 30
Course Objective	The primary objective of this course is to provide an in-depth understanding of the immune system, its components, and its functions in maintaining homeostasis and combating diseases. The course aims to introduce students to the molecular and cellular basis of immunity, mechanisms of immune responses, and their application in diagnostics, therapeutics, and disease management. Additionally, the course emphasizes the development of critical thinking and practical knowledge in immunology for advanced research and applications.
Course Outcome	By the end of this course, students will have a comprehensive understanding of the immune system, including innate and acquired immunity, immune cells and organs, and the structure and function of antibodies. They will learn about antigen-antibody interactions, cytokines, and antibody diversity, as well as monoclonal antibody technology and its applications. The course will cover humoral and cell-mediated immunity, hypersensitivity, autoimmunity, MHC function, transplantation immunology, and the principles behind vaccines and targeted cancer therapies. Students will be equipped with the knowledge to apply immunological concepts in both research and clinical practice.
UNIT-I Overview of Immune System	1.1: Immunity, Types of Immunity (Innate and Acquired immunity, complement system). Cells and Organs of Immune System (Lymphoid Progenitor, myeloid progenitor, primary lymphoid organ and secondary lymphoid organ).
	1.2:Antigens (immunogenicity Vs antigenicity, factors influencing antigenicity, adjuvants, haptens, epitopes, super antigens).
	1.3:Immunoglobulin (basic structure of antibody molecule, different classes of antibody, action of antibody, Antigenic determinants on immunoglobulin).
	1.4:Cytokines (structure, properties, types, functions).
UNIT-II Antibody Diversity	2.1:Organisation& Expression of immunoglobulin genes (Mechanism of DNA rearrangements, allelic exclusion).
	2.2:Antibody diversity (variable-region gene arrangements, class switching among constant region genes).
	2.3:Antigen-antibody reactions (strength of Antigen-Antibody reaction, cross reactivity, precipitation reaction, agglutination reaction, immunoprecipitation, immunofluorescence).
	2.4: Monoclonal antibodies and its applications in diagnosis and therapeutics (Hybridoma Technology).
UNIT-III Primary and secondary immune response	3.1:Primary and secondary immune response.
	3.2:Humoral Immunity - B-cell maturation and activation (clonal selection theory).
	3.3:Cell mediated immunity - T-cell maturation and activation (thymic selection).
	3.4:Hypersensitivity (Types) and autoimmunity (Systemic and Organ Specific).

UNIT-IV Major Histocompatibility complex and Vaccine	4.1:Major Histocompatibility complex in mouse and human (MHC- class I and class II, Gene organisation of MHC, Haplotype, antigen processing and presentation).
	4.2:Transplantation Immunology (allograft, autograft, syngraft, Xenograft, graft vs host reactions).
	4.3:Vaccines (inactivated, killed, DNA, and recombinant vaccines).
	4.4:Targeted Cancer Therapy (Magic bullets, CAR-T cell)

Immunology Lab (Practical)

Semester: II	Paper: Discipline Specific Course (Practical)
Credit: 02	Paper Title: **Immunology Lab**
Instruction: 4hr/Wk	Paper Code: MSZY 202 CCP
Semester Exam: 35	Internal Assessment: 15
Course Objective	The course provides hands-on training in blood grouping, β-HCG detection by Dot ELISA, ELISA, and flow cytometry, with an emphasis on their clinical and research applications.
Course Outcome	Students will be proficient in performing and interpreting these techniques, understanding their significance in diagnostics, and applying them effectively in laboratory settings.
Practical	1:Plasma and Serum isolation.
	2:Differential Leukocyte Count
	3: Agglutination-ABO blood grouping.
	4: Haemaglutination
	5.Double diffusion
	6.Enzyme Linked Immuno Sorbent Assay
	7.Flow Cytometry

References Books:

- Sell. S., Immunology, Immunopathology and Immunity, American Society for Microbiology (6^{th} ed.)
- Abbas A.K.et. Al., Cellular and Molecular Biology, Elsevier (9^{th} ed.)
- Martin. S.J. et. Al., Essential Immunology, John Wiley (Original) (13^{th} ed.)
- Abbas. A.K. et.al., Basic Immunology, Churchill Livingstone (7^{th} ed.)
- Punt. J. et. Al., Kuby Immunology, WH Freeman(10^{th} ed.)

DSC-6: Comparative Animal Physiology (Theory)

Semester: II	Paper: Discipline Specific Course
Credit: 04	Paper Title: **Comparative Animal Physiology (Theory)**
Instruction: 4hr/Wk	Paper Code: MSZY203CCT
Semester Exam: 70	Internal Assessment: 30
Course Objective	The course aims to provide a comprehensive understanding of the physiological mechanisms underlying the functioning of various organ systems in animals, with a comparative perspective across diverse species.
Course Outcome	Students will explore the adaptations and variations in physiological processes in response to environmental challenges, ecological niches, and evolutionary pressures. The course emphasizes integrative learning by connecting molecular, cellular, and systemic aspects of physiology, fostering a deeper appreciation of the diversity and unity in animal life.
UNIT-I Circulatory and Respiratory System	1.1: Comparative anatomy of heart, specialized tissue; cardiac cycle; specialized adaptations for various lifestyles
	1.2: Electrocardiogram (ECG); blood vessels; composition of blood; blood pressure; regulation of blood pressure.
	1.3:Adaptations for aerial and aquatic respiration; structure and function of lung
	1.4: Respiratory capacity and volume; transportation and exchange of gases (O_2andCO_2); regulation of respiration.
UNIT-II Digestive and Excretory System	2.1: Physiological anatomy of Gastro-Intestinal Tract (GIT).
	2.2: Adaptive strategies in feeding and digestion.
	2.3: Ccomparative digestion and nutrient utilization (carbohydrates, proteins, fats and amino acid).
	2.4: Adaptations in excretory systems; mode of excretion; ultra-structure of nephron; urine formation; waste elimination; regulation of water balance; acid-base balance; regulation of blood fluid and ionic concentration.
UNIT-III Nervous System	3.1:Comparative neuroanatomy of the brain and spinal cord; behavioral and physiological adaptations
	3.2:Behavioral and physiological adaptations; central and peripheral nervous system
	3.3: Sensory and motor neurons, action potential, nerve impulse; polarization and depolarization of the cell
	3.4:Sense organs: mechanoreceptors; chemo-receptors; auditory organs and hearing.
UNIT-IV Reproductive and Endocrine System	4.1: Comparative reproductive strategies; physiological adaptations in reproductive systems.
	4.2:Basic structure of sperm and ovum; fertilization; sperm entry; mixing of cytoplasm and formation of grey crescent; mode of reproduction.
	4.3: Structure and function of major exocrine and endocrine glands.
	4.4: Modes of hormone secretion; basic mechanism of hormone action.

Comparative Animal Physiology Lab (Practical)

Semester: II	Paper: Discipline Specific Course (Practical)
Credit: 02	Paper Title: **Comparative Animal Physiology Lab**
Instruction: 4hr/Wk	Paper Code: MSZY 253 CCP
Semester Exam: 35	Internal Assessment: 15
Course Objective	The course aims to introduce students to the principles of animal physiology, emphasizing comparative analysis of organ systems across diverse species.
Course Outcome	Students will develop a general understanding of physiological processes and adaptations in animals across various species. They will gain basic skills in observing and analyzing structural and functional aspects of organ systems, while exploring how these systems respond to different environmental conditions.
Practicals	1: Histological examination of gill structures: Adaptations for aquatic respiration in freshwater and marine fish.
	2: Dissection and functional analysis of accessory excretory structures: Comparative study of Malpighian tubules of insects and fish kidney.
	3: Isolation and microscopic study of grasshopper kidney, sperm, and ovum.
	4: Osmotic Relationships and RBC Fragility: comparative analysis using Fish and Human Blood.

References Books:

* Kardong. K. et. al., Comparative Vertebrate Anatomy: A Laboratory Dissection Guide, McGraw-Hill Education (8th ed.)
* Kent. G.C.et. al., Comparative Anatomy of the Vertebrates, McGraw-Hill Education (9th ed.)
* Nilsson. G.S., Respiratory Physiology of Vertebrates: Life with and without oxygen, Cambridge University Press, (1st ed.)
* Aschoff. J., Vertebrate Circadian Systems: Structure and Physiology, Springer, (1st ed.).
* Barret. K.E., Review of Medical Physiology, McGraw Hill Medical, (25th ed.)
* Hall. J.E., Textbook of Medical Physiology, Saunders Elsevier (14th ed.)

DSE-2: Animal Behaviour and Chronobiology (Theory)

Semester: II	Paper: Discipline Specific Elective (Theory)
Credit: 04	Paper Title: **Animal Behavior and Chronobiology Theory**
Instruction: 4hr/Wk	Paper Code: MSZY 203 DST
Semester Exam: 70	Internal Assessment: 30
Course Objective	This course aims to provide students with an in-depth understanding of animal behavior, including the proximate and ultimate causes, patterns, and types of behavior. It covers aspects such as migration, homing, communication methods, social behavior, and sexual behavior, with a focus on their adaptive significance in different species. Additionally, the course introduces chronobiology, biological rhythms, and the role of melatonin in regulating seasonal reproduction.
Course Outcome	By the end of the course, students will be able to grasp the foundational concepts of animal behavior, including stereotyped and acquired behaviors, and understand the ecological and evolutionary contexts behind migration, homing, and communication. Students will also understand chronobiology, biological rhythms, and the adaptive significance of biological clocks in animals.
UNIT-I Introduction to Animal Behaviour	1.1: Introduction to Animal Behaviour; Proximate and ultimate causes of behaviour; Patterns of behaviour.
	1.2:Stereotyped behaviour-Spatial orientation, Reflexes, Instincts, Motivation; Acquired Behaviour: Learning (Non associative and Associative): Habituation, imprinting and Memory;
	1.3:Migration and homing with special reference to birds.
	1.4:Communication in animals: Types of communication: Visual, olfactory, auditory and tactile. Camouflage and Mimicry - types of mimicry.
UNIT-II Ecological Aspects and Social Behaviour	2.1:Ecological Aspects and Social Behaviour: Habitat selection, Food selection and optimal foraging theory, Anti-predator behaviour; Individual behaviour (Conflict and Aggression)
	2.2: Host-parasite relation; territoriality and dispersal. Social Behaviour: Concept of Society; Aggregation (schooling of fishes flocking in birds, herding in mammals); group selection, kin selection
	2.3: Social organization in insects and primates. Communication and the senses
	2.4:Altruism; Insects' society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance.
UNIT-III Sexual Behaviour	3.1:Sexual Behaviour: Evolution of sex, reproductive strategies, mating systems; Asymmetry of sex, Sexual dimorphism
	3.2:Mate choice, courtship, sexual selection (Intra-sexual selection and Inter-sexual selection); male rivalry ;female choice
	3.3:Sexual conflict in parental care; Hormones and behaviour
	3.4:Chemical communication-pheromones types in insects (Orthoptera, Lepidopterans and Hymenopterans) and their functions; Pheromones in vertebrates(Reptiles and mammals) and their function.
UNIT-IV Introduction to Chronobiology	4.1: Introduction to Chronobiology: Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period.
	4.2: Adaptive significance of biological clocks. Biological Rhythm: Types and characteristics of biological rhythms.
	4.3:Short and Long term rhythms; Circadian rhythms; Circannual rhythms; Tidal /Lunar rhythms
	4.4:Concept of synchronization and phase shift; Photic and non-photic zeitgebers; Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.

References Books:

- Alcock. J., Animal Behavior: An Evolutionary Approach, Sinauer Associates Inc US (9th ed.)
- Wilson. E., Sociobiology: The New Synthesis, Harvard University Press (2nd ed.)
- Dixson. A.F., Sexual Selection and the Origins of Human Mating Systems, OUP Oxford (1st ed.)
- Gillette. M., Chronobiology: Biological Timing in Health and Disease, Academic Press, (1st ed.)