M.SC. ZOOLOGY

SEMESTER 1 & 2

Upon completing the M.Sc. Zoology program, students will:

1. Gain Comprehensive Zoological Knowledge: Acquire expertise in taxonomy, animal diversity, anatomy, physiology, molecular biology, genetics, and applied zoology.
2. Develop Research and Analytical Skills: Learn laboratory techniques like microscopy, chromatography, spectroscopy, and molecular genetics for biological research.
3. Understand Environmental and Conservation Principles: Study biodiversity conservation strategies, wildlife management, and sustainable ecosystem practices.
4. Apply Biotechnological and Biomedical Concepts: Explore immunology, toxicology, animal behaviour, and their applications in medicine, agriculture, and industry.
5. Enhance Problem-Solving and Critical Thinking: Develop logical reasoning, scientific problem-solving, and statistical analysis skills for biological research.
6. Prepare for Careers in Research and Industry: Gain practical expertise for employment in academia, biotechnology, aquaculture, and wildlife conservation.
7. Understand Ethical and Sustainable Scientific Practices: Learn ethical considerations in research, biodiversity conservation, and sustainable development.
8. Engage in Lifelong Learning and Innovation: Stay updated with scientific advancements, interdisciplinary research, and modern technological applications.

SEMESTER I

COURSE CODE: MSC1C 113

COURSE NAME: ANIMAL SYSTEMATICS AND FUNCTIONAL ANATOMY

Unit I: Animal Systematics

Students will learn about classification principles, taxonomy, and phylogenetics. They will study various classification systems, including those proposed by Carl Linnaeus, Ernst Haeckel, and Carl Woes. The unit introduces traditional and modern classification techniques such as numerical taxonomy and DNA barcoding. Students will explore how taxonomic characters are used to differentiate species. They will also understand the importance of systematics in evolutionary biology and conservation.

Unit II: Functional Anatomy of Invertebrates

This unit focuses on the structural and functional organization of invertebrates. Students will study body symmetry, coelom, segmentation, and feeding mechanisms in different phyla. They will explore specialized adaptations such as filter feeding in mollusks and hydrostatic skeletons in annelids. The unit also includes locomotion mechanisms like ciliary, amoeboid, and muscular movements. Furthermore, students will examine osmoregulation, respiratory pigments, and neuroendocrine coordination in invertebrates.

Unit III: Functional Anatomy of Vertebrates

Students will explore comparative anatomy across vertebrate groups. The unit covers the evolutionary development of digestive, circulatory, excretory, nervous, endocrine, and reproductive systems. They will study the anatomical adaptations of vertebrates to different environments, such as aquatic, terrestrial, and aerial habitats. Special emphasis is given to respiratory mechanisms, including lung evolution in amphibians and air sacs in birds. The unit also highlights endocrine regulation and homeostasis in vertebrates.

Unit IV: Zoogeography

This unit examines the geographical distribution of animals across different regions of the world. Students will learn about the major zoogeographical regions and factors influencing species dispersal. They will study extinction patterns, endemic species, and the impact of human activities on animal distribution. The role of geographical barriers, continental drift, and climate in shaping biodiversity will be explored. Conservation strategies for protecting endangered and exotic species will also be discussed.

COURSE CODE: MSC1C 114

COURSE NAME: CELL BIOLOGY

Unit I: Bio membranes & Cytoskeleton

Students will study the structure and function of biological membranes, including the fluid mosaic model. They will explore membrane transport mechanisms such as passive diffusion, active transport, and facilitated diffusion. The role of cytoskeletal elements like microtubules, actin filaments, and intermediate filaments in maintaining cell shape and motility will be covered. The unit also examines motor proteins like kinesin and dynein in intracellular transport. Additionally, students will understand the structural organization of cilia and flagella.

Unit II: Cell Organelles

This unit provides an in-depth understanding of cellular organelles, including mitochondria, chloroplasts, nucleus, ER, Golgi apparatus, lysosomes, and ribosomes. Students will study the role of mitochondria in ATP synthesis and oxidative phosphorylation. The mechanisms of protein sorting, transport, and secretion via the ER and Golgi complex will be explored. Lysosomal enzymes and their functions in cellular digestion will be discussed. Students will also examine ribosome structure and protein synthesis.

Unit III: Cell Cycle, Apoptosis, and Cancer

The regulation of the cell cycle, including checkpoints, cyclins, and CDKs, will be covered in this unit. Students will study the process of mitosis and meiosis and their significance in growth and reproduction. The molecular mechanisms of programmed cell death (apoptosis) and necrosis will be explored. They will learn about oncogenes, tumor suppressor genes, and metastasis in cancer biology. The unit also discusses the role of stem cells and their potential applications in regenerative medicine.

Unit IV: Animal Cell Culture

Students will learn about the basic requirements and techniques for animal cell culture. They will study sterilization methods, preparation of culture media, and maintenance of cell lines.

Different culture techniques such as primary culture, organotypic culture, and 3D culture will be explored. The scaling-up process for large-scale cell culture applications will be discussed. Students will also learn about contamination control and cryopreservation techniques in cell culture.

COURSE CODE: MSC1C 115

COURSE NAME: BIOANALYTICAL TECHNIQUES

Unit I: Microscopy and Histochemical Techniques

This unit introduces students to various types of microscopy, including light, electron, fluorescence, and phase-contrast microscopy. They will study histochemical staining methods for detecting cellular structures. The process of tissue fixation, embedding, and sectioning will be explored. Students will learn about mordants, metachromatic staining, and immunohistochemical techniques. They will also understand the applications of microscopy in biomedical and zoological research.

Unit II: Spectroscopy

Students will study the principles and applications of spectroscopic techniques, including UV-visible, IR, Raman, and NMR spectroscopy. They will explore how these techniques are used for structural elucidation of biomolecules. The unit covers molecular modeling and protein structure determination using X-ray diffraction and mass spectrometry. Additionally, students will learn about fluorescence spectroscopy and its applications in cellular imaging.

Unit III: Chromatographic Techniques

This unit focuses on different chromatographic separation techniques such as gas chromatography (GC), high-performance liquid chromatography (HPLC), and thin-layer chromatography (TLC). Students will learn about ion-exchange chromatography, gel filtration, and affinity chromatography. They will study the principles of column chromatography and the role of detectors in analytical separations. The applications of chromatographic methods in biochemical research will be discussed.

Unit IV: Centrifugation and Electrophoretic Techniques

Students will learn about various types of centrifugation techniques, including differential, density gradient, and ultracentrifugation. They will study the principles of electrophoresis, including agarose gel electrophoresis, SDS-PAGE, and isoelectric focusing. The applications of electrophoretic techniques in DNA, RNA, and protein separation will be covered. The process of blotting techniques such as Southern, Northern, and Western blotting will also be explored.

COURSE CODE: MSC1C 116

COURSE NAME: ECOLOGICAL SCIENCE

Unit I: Ecological Principles

Students will learn the concepts of habitat and ecological niche, including fundamental and realized niches. They will study population ecology, growth models, life history strategies, and metapopulation dynamics. The importance of species interactions such as competition,

herbivory, carnivory, pollination, and symbiosis will be explored. Resource partitioning and character displacement in ecological communities will also be discussed. The unit provides a foundation for understanding ecosystem dynamics and biodiversity.

Unit II: Community Ecology

This unit explores the structure and organization of ecological communities, including species diversity and community attributes. Students will study the concept of ecological succession, types of succession, and the role of pioneer species. They will analyse species distribution patterns and the impact of environmental gradients on biodiversity. Edge effects, ecotones, and keystone species will be discussed in detail. Methods for measuring biodiversity and community structure will also be covered.

Unit III: Environmental Science

Students will understand the physical, biotic, and abiotic components of the environment. The structure and composition of the atmosphere, hydrosphere, lithosphere, and biosphere will be studied. They will explore different biomes, including tropical rainforests, deserts, grasslands, and aquatic ecosystems. The impact of climate change, habitat destruction, and anthropogenic activities on global ecosystems will be discussed. The role of protected areas such as sanctuaries, national parks, and botanical gardens in conservation will also be covered.

Unit IV: Pollution and Environmental Impact Assessment

This unit focuses on different types of environmental pollution, including air, water, soil, and noise pollution. Students will learn about the sources, effects, and control measures of environmental pollutants. The impact of pollutants on human health, biodiversity, and climate will be studied. Techniques for monitoring environmental quality and pollution control strategies will be explored. Students will also learn about environmental impact assessment (EIA) methodologies and the application of remote sensing and GIS in environmental management.

Lab I & II (Practical Outcomes)

Course Practical Lab I: MSC1P 113

Practicals based on topics covered in Animal Systematics and Diversity and Cell Biology

Upon completing this practical course, students will be proficient in classifying microorganisms, invertebrates, and various animal phyla using identification keys. They will develop analytical skills in examining insect mouthparts, antennae, and freshwater invertebrates while understanding their adaptations. Students will learn to construct phylogenetic trees using UPGMA and cladistics to infer evolutionary relationships. They will gain hands-on experience in microscopic techniques for cell studies, including preparing temporary mounts, identifying organelles, and analysing mitotic and meiotic divisions in plant tissues. Additionally, students will acquire expertise in animal tissue culture, including laboratory equipment handling, media preparation, and sterilization techniques. Emphasis will be placed on laboratory safety, experimental design, and data interpretation. These skills will enhance their research capabilities in taxonomy, evolutionary biology, cytogenetics, and biotechnology. The course provides a strong foundation for careers in academia, research, and applied biological sciences.

Course Practical Lab II: MSC1P 114

Practical based on topics covered in Bioanalytical Techniques and Ecological Science

Students will gain hands-on expertise in bioanalytical techniques, including pH measurement, buffer preparation, stock solution calculations, and amino acid separation using TLC. They will learn advanced cell separation methods such as density gradient centrifugation and partition coefficient determination. The course will also develop their skills in ecological studies, including quadrat, transect, and point-frame methods for assessing community structure, species diversity, and vegetation analysis. Students will explore ecosystem succession and its role in biodiversity conservation. A field visit to a protected area will provide practical exposure to real-world ecological applications, enhancing their ability to conduct independent research in bioanalytics and ecological science.

SEMESTER II

COURSE CODE: MSC1C 213

COURSE NAME: FUNDAMENTALS OF BIOCHEMISTRY

Unit I: Carbohydrate Metabolism

Students will study the classification and structure of carbohydrates, including monosaccharides, disaccharides, and polysaccharides. The glycolysis pathway, its regulation, and the role of key enzymes will be explored. They will understand the interconnections between gluconeogenesis, glycogenolysis, and glycogenesis. The pentose phosphate pathway and its significance in nucleotide biosynthesis will be covered. The role of carbohydrates in energy metabolism and cellular functions will also be discussed.

Unit II: Protein Metabolism

This unit introduces the structure, classification, and properties of proteins and amino acids. Students will study protein biosynthesis, folding, and degradation. The nitrogen cycle, nitrogen fixation, and nitrogen excretion through the urea cycle will be explained. The role of vitamins in protein metabolism and their biochemical significance will be covered. The synthesis and breakdown of nucleotides and their role in genetic information storage will also be explored.

Unit III: Lipid Metabolism

Students will learn about the classification of lipids and their biological functions. The synthesis and degradation of fatty acids, triglycerides, and phospholipids will be studied. The role of lipoproteins in lipid transport and metabolism will be discussed. The significance of cholesterol biosynthesis and its regulation in health and disease will be explored. The metabolic interrelations between carbohydrates, proteins, and lipids in energy homeostasis will also be covered.

Unit IV: Enzymology

This unit explores the classification, structure, and mechanism of enzyme action. Students will study enzyme kinetics, including Michaelis-Menten and Lineweaver-Burk plots. The role of coenzymes, allosteric regulation, and enzyme inhibition will be discussed. Enzyme engineering

and applications of enzymes in industry and medicine will be covered. Students will also understand enzyme-based diagnostic techniques and their applications in clinical biochemistry.

COURSE CODE: MSC1C 214

COURSE NAME: EVOLUTION AND ANIMAL BEHAVIOUR

Unit I: Evolution Theories

Students will explore the history of evolutionary thought, including Lamarckism, Darwinism, and the Modern Synthesis. They will study molecular evolution, phylogenetics, and the evidence supporting evolution. The role of genetic mutations, recombination, and polyploidy in evolution will be examined. Isolation mechanisms and speciation processes will be discussed. The unit also includes the Hardy-Weinberg equilibrium and its applications in population genetics.

Unit II: Adaptations & Evolutionary Trends

This unit covers different types of adaptations such as desert, arboreal, fossorial, volant, and aquatic adaptations. Students will study mimicry, polymorphism, and their evolutionary significance. Geological time scales and the evolution of major vertebrate groups will be discussed. Trends in human evolution, including fossil evidence and genetic analysis, will be explored. The future prospects of evolution and its implications for biodiversity will also be covered.

Unit III: Animal Behaviour

Students will learn about ethology and the contributions of pioneers like Karl von Frisch, Konrad Lorenz, and Niko Tinbergen. The neurophysiological basis of behaviour and the role of hormones in behavioural regulation will be discussed. Learning mechanisms, including classical and operant conditioning, habituation, and imprinting, will be explored. The significance of biological rhythms, sleep cycles, and hibernation in animal behaviour will be examined. The role of genetic and environmental factors in shaping behaviour will also be covered.

Unit IV: Social & Sexual Behaviour

This unit explores social organization, communication, and group behaviour in animals. The role of pheromones, vocalization, and body language in communication will be discussed. Mating strategies, sexual dimorphism, and reproductive competition will be studied. The concept of kin selection, altruism, and cooperative behaviour will be examined. Case studies of social behaviour in insects (bees, ants) and primates will also be explored.

COURSE CODE: MSC1C 215

COURSE NAME: MAMMALIAN PHYSIOLOGY

Unit I: Digestive & Excretory Systems

Students will explore the anatomy and physiology of the digestive system, including enzymatic digestion and nutrient absorption. The role of gastrointestinal hormones in digestion will be studied. The structure and function of kidneys, nephron physiology, and urine formation will be covered. The regulation of water and electrolyte balance through hormonal control will be

discussed. Disorders related to digestion and excretion, such as ulcers and kidney diseases, will also be explored.

Unit II: Circulatory System

This unit covers the structure and function of the heart, blood vessels, and the cardiac conduction system. Students will study the regulation of blood pressure and cardiac output. The composition and functions of blood, blood groups, and the mechanism of blood clotting will be discussed. The role of lymphatic circulation and its importance in immune function will be explored. Cardiovascular disorders and their physiological basis will also be covered.

Unit III: Physiology of the Nervous System

Students will explore the organization and function of the nervous system, including the central (CNS) and peripheral (PNS) nervous systems. They will study the structure and types of neurons, neural glial cells, and the role of myelination in nerve impulse conduction. The molecular basis of resting and action potentials, synaptic transmission, and neurotransmitter release will be examined. Special emphasis will be given to neurotransmitters like acetylcholine, dopamine, serotonin, and GABA, and their role in brain function. The physiology of sensory perception, including the mechanisms of vision, hearing, taste, and smell, will also be covered.

Unit IV: Physiology of the Respiratory and Muscular Systems

This unit covers the mechanics of breathing, including the role of the diaphragm and intercostal muscles in pulmonary ventilation. Students will study gas exchange at the alveolar level, oxygen transport, and the regulation of respiratory rates by neural and chemical factors. The role of haemoglobin in oxygen transport and the Bohr effect will be explored in detail. In the muscular system, students will understand the types of muscle tissues (skeletal, cardiac, and smooth), their contraction mechanisms, and the sliding filament theory. The metabolic pathways involved in muscle contraction and energy production, including anaerobic and aerobic respiration, will also be discussed.

COURSE CODE: MSC1C 216

COURSE NAME: ENTOMOLOGY AND ECONOMIC ZOOLOGY

Unit I: Overview of Entomology

Students will study the classification, diversity, and significance of insects in ecosystems and human life. The unit covers the morphological features of insects, including the structure of the exoskeleton, head, thorax, abdomen, and appendages. The physiology of digestion, respiration, excretion, circulation, and reproduction in insects will be explored. The importance of metamorphosis and its types (holometabolous, hemimetabolous, and ametabolous) will be discussed. Special emphasis will be given to insects of medical, agricultural, and ecological importance.

Unit II: Insect Ecology, Behaviour, and Control

This unit focuses on the environmental factors influencing insect populations, including temperature, humidity, and seasonal variations. Students will explore insect-plant interactions, pollination, and the ecological role of insects in decomposition and nutrient cycling. The study

of insect behaviour, including mating rituals, foraging, and defensive mechanisms, will be covered. Pest control strategies such as biological control, integrated pest management (IPM), and the use of insect growth regulators (IGRs) will be discussed. The impact of insecticides and their environmental consequences will also be explored.

Unit III: Poultry Breeding and Dairy Farming

Students will study the habitat, feeding habits, and breeding techniques of domesticated poultry species. They will learn about different breeds of chickens and their significance in commercial egg and meat production. The process of artificial incubation, hatching, and chick rearing will be discussed. In dairy farming, students will explore cattle and buffalo breeds, milk production processes, and factors influencing milk yield. The importance of disease control, vaccination, and veterinary care in poultry and dairy farming will also be covered.

Unit IV: Aquaculture and Economic Zoology

This unit provides an in-depth understanding of the scope and significance of aquaculture in food production and the economy. Students will study different types of aquaculture systems, including freshwater, brackish water, and marine aquaculture. They will explore cultivable fish species, pond management techniques, and fish breeding methods. The role of ornamental fish production, pearl culture, and mussel farming in aquaculture will be discussed. The significance of economic zoology in sericulture, apiculture, and vermiculture will also be covered.

Lab I & II (Practical Outcomes)

Course Practical Lab I: MSC1P 213

Practicals based on topics covered in Fundamentals of Biochemistry and Evolution and Animal Behaviour

Students will develop expertise in biochemical estimation techniques, including quantification of reducing sugars, proteins, RNA, and amino acids using standard analytical methods. They will gain insights into evolutionary biology through chart-based studies and understand behavioural responses in various organisms, such as geotaxis in earthworms and phototaxis in insect larvae. The course will enhance their understanding of human cognitive and motor learning through maze experiments, eye-hand coordination assessments, and optical illusion studies. Additionally, students will observe behavioural patterns like antennal grooming in cockroaches and circadian rhythms in humans. These practicals will provide essential skills for research in biochemistry, behavioural ecology, and neurobiology.

Course Practical Lab II: MSC1P 213

Practicals based on topics covered in Mammalian Physiology and Entomology and Economic Zoology

Students will gain expertise in haematological techniques, including bleeding and clotting time determination, haemoglobin estimation, RBC and WBC counting, and blood grouping. They will develop practical skills in enzymatic analysis, urine sample testing, and osmotic fragility assessments. The course also emphasizes entomological studies, including insect identification, life cycle maintenance, and preparation of permanent mounts of various insect structures. Additionally, students will study economically important species such as poultry, fish, and

livestock, focusing on breed identification and disease diagnosis. Field visits to poultry farms, breeding centres, and fish farms will provide real-world exposure, enhancing their understanding of applied zoology in agriculture and public health.

SEMESTER III

COURSE CODE: MSC1C 313

COURSE NAME: GENETICS AND MOLECULAR BIOLOGY

Unit 1: Histone Proteins, Nucleosome, Heterochromatin

Students will understand the structure and function of histone proteins and describe the roles of histones in DNA packaging and how they contribute to the formation of nucleosomes and higher-order chromatin structures. Can analyse the organization of DNA in chromosomes and explain the solenoid structure of chromatin and its role in efficient DNA compaction and regulation. Differentiate between constitutive and facultative heterochromatin and understand the properties of heterochromatin and how they influence gene expression and chromosome behaviour. Comprehend the mechanism of X-chromosome inactivation, the biological importance of X-inactivation and its implications in gene dosage compensation. They will explore newer concepts of genome organization and describe the molecular aspects of inheritance and genome organization, including split genes, pseudo genes, and repetitive sequences. Analyse the role of transposons and conserved genes and discuss the role of transposons in genomic evolution and how conserved genes are crucial for basic cellular functions.

Unit 2: Linkage, Crossing Over, and Chromosome Mapping

Students will understand linkage and crossing over and explain the significance of linkage and crossing over in genetic recombination and inheritance. Explore the cytological and molecular mechanisms of crossing over, the process and molecular basis of recombination during meiosis. Identify and classify different types of chromosomes based on their morphology. Learn chromosome mapping techniques and perform and understand two-factor and three-factor crosses to map the position of genes on chromosomes. Understand the mechanisms of sex determination and explore how sex determination occurs in various organisms, including the role of environmental factors and molecular mechanisms. Understand sex-linked inheritance and comprehend how sex-linked traits are inherited and how these influences genetic inheritance patterns in organisms like Chlamydomonas.

Unit 3: DNA as Hereditary Material, Gene Structure, and Expression

Students will understand the structure and function of nucleic acids and describe the molecular structure of DNA and RNA, emphasizing differences between prokaryotic and eukaryotic genomes. Analyse DNA replication and explain the process of DNA replication and the regulatory role of DNA methylation in gene expression. Understand the concept of a gene and Define genes and their roles in the molecular machinery of the cell. Understand the central dogma of molecular biology, including transcription, RNA processing, and the formation of mRNA. Learn about the process of translation and how proteins undergo modifications after synthesis. Analyse gene regulation and understand the mechanisms by which gene expression is regulated, with a particular focus on the operon model of gene regulation.

Unit 4: Structural Changes in DNA Material and Extra-Chromosomal Inheritance

Students will understand molecular basis of mutations and how spontaneous and induced mutations occur at the molecular level, and the consequences for genetic variation. Learn about DNA damage and repair mechanisms that maintain genomic integrity. Understand numerical chromosomal aberrations and explore the causes and effects of aneuploidy and euploidy, and how they impact organismal development. Understand structural chromosomal abnormalities such as translocations, inversions, deletions, insertions, and their implications for genetic disorders. Comprehend the concept of extra-chromosomal inheritance such as mitochondrial inheritance and plasmid-based inheritance.

COURSE CODE: MSC1C 314

COURSE NAME: DEVELOPMENTAL BIOLOGY

Unit I: Basic Concepts of Development

Understand the basic concepts of developmental biology and define key terms such as potency, commitment, and specification, and explain their roles in early development. Comprehend processes involved in development such as induction, competence, determination, and differentiation during embryogenesis. Analyse morphogenetic gradients and understand how morphogenetic gradients influence cell fate decisions and contribute to proper tissue and organ formation. Learn the concept of genomic equivalence and its implications for cellular differentiation and developmental potential.

Unit II: Cytoplasmic Determinants, Gametogenesis, Fertilization, and Early Development

Comprehend the role of cytoplasmic determinants and understand how maternal factors influence early development and their role in the patterning of the embryo. Analyse the phenomenon of imprinting and explain the genetic basis of imprinting and its significance in development. Explore the use of mutants and transgenics and understand how mutations and transgenic organisms are used to analyse the molecular mechanisms of development. Understand gametogenesis and fertilization and describe the processes of gamete production in animals, including the role of cell surface molecules in sperm-egg recognition. Study early development in animals and the processes of embryo sac development, zygote formation, cleavage, blastula formation, and the formation of embryonic fields. Understand the processes of gastrulation and the formation of the three germ layers in animals, which are crucial for organ development.

Unit III: Embryogenesis, Morphogenesis, and Organogenesis

Students will Understand how symmetry is established during early development, setting the stage for body plan formation. Analyse morphogenesis and organogenesis in animals and describe the processes of cell aggregation and differentiation, using *Dictyostelium* as a model organism. Explore the role of pattern formation in organisms such as *Drosophila*, amphibians, and chicks, and its importance for body axis formation. Comprehend organogenesis in model organisms, Discuss the process of vulva formation in *Caenorhabditis elegans* and how organogenesis occurs in vertebrates, such as eye lens induction and limb development. Understand the mechanisms of regeneration in vertebrates and Analyse how some vertebrates regenerate tissues and organs, and the molecular signals that guide this process.

Unit IV: Hormonal Regulation, Teratogenesis, and Sex Determination

Students will Understand the role of hormones in development and discuss how hormones regulate developmental processes such as amphibian and insect metamorphosis. Comprehend the effects of teratogenic agents and analyse the mechanisms through which teratogens cause developmental abnormalities and their genetic regulation. Study the causes and regulation of aging and understand the genetic and environmental factors that contribute to aging, and explore how developmental biology intersects with aging. Learn about sex determination in mammals: Discuss the genetic and environmental mechanisms underlying sex determination and differentiation in mammals. Understand the causes of infertility and the various assisted reproductive technologies (ART) such as in vitro fertilization (IVF), and their relevance to developmental biology.

COURSE CODE: MSC1C 315

COURSE NAME: ADVANCE TECHNIQUES IN ZOOLOGY

Unit 1: Techniques for Biodiversity Assessment

Students will Understand quantitative biodiversity assessment and comprehend the various types of transects and quadrates used for assessing biodiversity and their significance in ecological studies. Learn data analysis techniques, Analyse and interpret biodiversity data using appropriate statistical methods to evaluate species richness, diversity indices, and community structure. Understand different population census techniques for vertebrates and methods used for censusing vertebrate populations, such as mark-recapture, line transect, and point counts, and their applications in field studies. Learn about sampling techniques for invertebrates, including pitfall traps, sweep nets, and light traps, and their role in biodiversity assessment. Gain knowledge of how to analyse DNA sequences to construct phylogenetic trees, understanding evolutionary relationships between species.

Unit 2: Remote Sensing and Applications

Students will understand the fundamentals of remote sensing (RS), Gain an overview of the history, development, and scope of remote sensing in ecological and environmental studies. Learn about energy sources and electromagnetic radiation (EMR) and comprehend how electromagnetic radiation interacts with the Earth's surface and the role of different energy sources in remote sensing. Understand RS sensors and platforms, gain knowledge about the different remote sensing sensors and platforms, including satellites, drones, and aerial imagery, and their applications in ecological research. Analyse image processing and classification and learn how to process and classify remote sensing images using software tools to extract meaningful environmental information. Understand the concepts of land cover and land use analysis and how remote sensing techniques are used to assess changes in land use patterns. Explore the diverse applications of remote sensing in ecological monitoring, habitat mapping, conservation efforts, and natural resource management.

Unit 3: GIS Basics

Understand the fundamentals of GIS and Gain an understanding of Geographic Information Systems (GIS), including their basic components, structure, and functionalities. Learn the core functions of GIS such as data input, spatial analysis, and output presentation, and their significance in environmental studies. Familiarize with GIS software and gain hands-on

experience with GIS software, learning how to process spatial data and perform basic GIS analyses in a laboratory setting. Learn about the different spatial data models (vector and raster), and how they are used to represent geographic features in GIS. Develop the skills to present GIS data through maps, graphs, and reports, enabling clear communication of spatial analysis results.

Unit 4: GIS Applications

Students will learn to use GIS for ecological modelling, such as habitat suitability modelling, ecosystem services analysis, and landscape ecology studies. Understand species distribution models (SDMs) and Gain knowledge on how GIS-based species distribution models are developed and applied to predict species' geographic ranges and responses to environmental changes. Understand how GIS is used in landscape fragmentation analysis, identifying habitat loss, and its impact on biodiversity conservation. Learn how GIS is applied in conservation planning, habitat restoration, wildlife corridors, and sustainable management of natural resources.

COURSE CODE: MSC1C 315

COURSE NAME: WILDLIFE AND CONSERVATION BIOLOGY- I

Unit I: Introduction to Wildlife and Conservation

Students can Define wildlife and explain its role in ecosystems, human well-being, and biodiversity. Discuss the importance of wildlife conservation in maintaining ecological balance. Explore wildlife and habitats of the Indian subcontinent and Gain knowledge of the diverse wildlife species and habitats across the Indian subcontinent, including forests, wetlands, and grasslands, and their ecological significance. Comprehend the history and background of conservation and trace the historical development of wildlife conservation efforts globally and in India, highlighting key milestones and influential figures in the conservation movement. Analyse important issues for wildlife conservation in India and understand key conservation challenges in India, such as habitat loss, poaching, human-wildlife conflict, and the effects of climate change on wildlife.

Unit II: Wildlife Management and Protected Areas

Students understand the history and advances in wildlife management and Learn about the evolution of wildlife management practices and the current approaches to managing wildlife populations and habitats. Explore the concept of protected areas and learn their role in wildlife conservation, including national parks, sanctuaries, and biosphere reserves. Familiarize with significant protected areas in India, especially in Gujarat, such as Gir National Park (home to Asiatic lions), and understand their conservation importance. Understand habitat improvements and management strategies and learn techniques for improving and managing wildlife habitats, including habitat restoration, enhancement of corridors, and monitoring habitat quality. Analyse current wildlife conservation practices in India and understand the contemporary approaches used in wildlife conservation in India, such as species-specific conservation programs, anti-poaching measures, and community-based conservation efforts.

Unit III: Wildlife Population and Habitat Monitoring

Students will learn wildlife census and population estimation techniques and learn to apply various methods for estimating wildlife populations, including direct observation, camera traps, and tracking techniques. Learn how to measure and analyse wildlife habitat use and occupancy through field methods and statistical techniques, aiding in understanding species' habitat preferences. Understand and apply techniques for evaluating wildlife habitats, such as vegetation surveys, soil sampling, and water quality analysis, to assess habitat suitability. Understand wildlife population monitoring techniques and gain knowledge on how to monitor wildlife populations over time, using tools like mark-recapture, radio telemetry, and genetic analysis for population dynamics studies.

Unit IV: Human-Wildlife Interaction and Conflict Management

Students will understand the complex interactions between humans and wildlife, including issues such as land use changes, poaching, and the impact of human activities on wildlife habitats. Learn about management and mitigation of human-wildlife conflicts and understand strategies for managing human-wildlife conflicts, particularly in areas where wildlife and human settlements overlap. This includes methods such as fencing, relocation, and compensation programs. Examine case studies of human-wildlife conflicts and study real-world case studies of human-wildlife conflict, such as elephant raids on crops, tiger attacks on livestock, and the management practices employed to mitigate such conflicts. Understand and learn about the safe and humane techniques used to immobilize and rescue injured or distressed wildlife, including chemical immobilization, darting techniques, and the role of wildlife rescue centres.

Lab I & II (Practical Outcomes)

Course Practical Lab I: MC1P 313

Practicals based on topics covered in Genetics and Molecular Biology and Devlopmental Biology

By the end of this practical course, students will develop expertise in cytogenetics, embryology, and reproductive biology through hands-on experience. They will learn to identify Barr bodies to understand X-chromosome inactivation and its implications in genetic disorders. Students will acquire skills in whole blood culture for chromosome preparation, Giemsa staining for chromosomal analysis, and DNA isolation techniques, essential for genetic research and diagnostics. They will examine vertebrate embryonic development using frog and chick embryo slides and charts while mastering whole-mount preparation techniques. Additionally, they will analyze sperm morphology, motility, viability, and perform total sperm counts to assess fertility parameters. Advanced studies on acrosomal integrity and teratogen activity tests will enhance their understanding of reproductive health and the impact of toxic agents on embryonic development. This course will equip students with essential laboratory skills for careers in genetics, reproductive biology, and biomedical research.

Course Practical Lab II: MC1P 313

Practicals based on topics covered in Advanced Techniques in Zoology, Wildlife, and Conservation Biology

By the end of this practical course, students will develop proficiency in GPS and mapping techniques, gaining expertise in using handheld and mobile-based GPS tools for landscape analysis. They will learn to interpret topographic maps and toposheets, download and process satellite images, and apply GIS and remote sensing techniques for environmental monitoring, including change detection analysis using LULC classification. Students will calculate ecological indices through geo-processing, perform geo-referencing of toposheets, and study vector models for spatial analysis. They will explore web-based applications for GIS and RS analysis and apply these tools to wildlife habitat mapping across the Indian subcontinent. Additionally, students will learn to identify wildlife signs, conduct field-based bird species recognition, and perform vegetation sampling to assess biodiversity. Practical skills in wildlife population estimation using transect, point count, and block count methods will be developed. Lastly, they will gain hands-on experience with equipment used for immobilization, handling, and rescue of wild animals, preparing them for careers in wildlife research, conservation, and ecological monitoring. Conduct field excursions to protected areas within Gujarat to observe wildlife and prepare scientific reports based on field observations.

SEMESTER IV

COURSE CODE: MSC1C 413

COURSE NAME: IMMUNOLOGY

UNIT I

Students will understand the concepts of immunity and differentiate between innate and adaptive immunity, and understand their roles in immune defence. Comprehend the process of haematopoiesis and how its regulation is critical for the development of immune cells. Understand the cells and organs of the immune system and identify the primary and secondary lymphoid organs and their roles in immune cell development, activation, and response. Understand the key receptors involved in innate immunity, including TLRs (Toll-like receptors), CLRs (C-type lectin receptors), and RLRs (RIG-I-like receptors), and their roles in sensing pathogens. Study and discuss the inflammatory response in immunity and the role of Natural Killer (NK) cells in immune surveillance and pathogen defence. Understand antigens and immune recognition and distinguish between immunogenicity and antigenicity, and explain the concept of epitopes and haptens. Learn about the major pathways of complement activation (classical, alternative, and lectin), their functions in immune defence, regulation mechanisms, complement deficiencies, and microbial evasion strategies.

Unit II

Learn the structure of immunoglobulins (antibodies), their diverse classes, and the functional roles of each class in immune responses. Understand the signal transduction pathways initiated by B cell receptors (BCR), and their role in activating B cells and initiating immune responses. Understand lymphocyte receptor gene organization: Hozumi and Tonegawa's experiment on immunoglobulin gene organization, and learn the mechanisms behind VDJ recombination in B cells. Learn about allelic exclusion, B cell isotype switching, and somatic hypermutation, and how these processes contribute to immune diversity. Differentiate between membrane-bound and soluble forms of immunoglobulins, and understand their roles in immunity. Study T cell

receptor gene expression and understand the organization and expression of T cell receptor genes and their importance in T cell activation. Learn antigen-antibody interaction and Explore techniques like immunoprecipitation, agglutination, and methods to determine affinity in antigen-antibody interactions. Study immunofluorescence and FACS (fluorescence-activated cell sorting) techniques for analysing immune responses.

Unit III

Students will Understand the Major Histocompatibility Complex (MHC) and comprehend the structure, function, and inheritance patterns of MHC molecules, and their critical role in antigen presentation. Analyse antigen processing and presentation pathways and Differentiate between the endogenous and exogenous pathways of antigen processing and presentation, including the role of MHC molecules in both pathways. Understand how non-peptide antigens are presented by MHC. Understand the T-dependent and T-independent B cell responses, and how memory cells are generated in response to antigen exposure. Understand the two-signal hypothesis for T cell activation, the role of superantigens, and how T cells differentiate into effector and memory cells. Differentiate between TH1 and TH2 responses and their roles in immunity.

Unit IV

Students will Understand cell-mediated effector responses and learn how effector cytotoxic T lymphocytes (CTLs) are generated and their mechanisms of killing infected or abnormal cells, including granzyme/perforin-mediated cytolysis and Fas-FasL-mediated cytolysis. Study the role of Natural Killer (NK) cells in directly killing infected or transformed cells. Define cytokines, understand their properties, types of receptors, and their involvement in immune regulation. Discuss associated diseases related to cytokine dysregulation and their therapeutic applications. Study cytokine signaling pathways and learn about cytokine signaling mechanisms such as the JAK-STAT pathway and FAS-FASL signaling pathway. Analyse immune responses to infections and understand the immune responses to infections caused by viruses, bacteria, fungi, and parasites. Learn how pathogens evade immune responses and the strategies employed by the immune system to combat infections.

COURSE CODE: MSC1C 414

COURSE NAME: TOXICOLOGY AND HISTOLOGICAL TECHNIQUES

Unit I

Students can Define toxicology and its scope and understand the fundamental concept of toxicology, including its subfields like eco-toxicology, and recognize its environmental significance and relevance in health science. Learn the basic classification and nature of toxic effects. Explore how toxic substances affect living organisms at different levels and how these effects can be categorized. Understand the principles of dose-response relationships, including concepts such as synergism, antagonism, and the significance of determining ED50 (effective dose for 50% of population) and LD50 (lethal dose for 50% of population). Examine acute and chronic exposures and differentiate between acute and chronic toxic exposures and their varying effects on organisms over short and long periods. Identify the various factors that influence toxicity, such as pharmacodynamics, chemo dynamics, and interspecies differences in drug metabolism (dose conversion between animals and humans). Understand how toxins

can damage vital organs such as the liver and kidneys. Study the metabolic pathways of drugs like paracetamol and aspirin, and their toxic effects on tissues.

Unit II

Students will Understand xenobiotics metabolism and Learn about the absorption, distribution, and metabolism of xenobiotics (foreign chemical substances) in the body, including the Phase I and Phase II reactions. Understand the biochemical processes involved in Phase I reactions such as oxidation, reduction, hydrolysis, and hydration, and Phase II conjugation reactions like methylation, glutathione conjugation, and amino acid conjugation. Understand how the body detoxifies xenobiotics and the role of enzymes in this process. Explore the biochemical mechanisms of toxicity, such as disturbances in excitable membrane functions, altered calcium homeostasis, and covalent binding of cellular macromolecules. Examine the genetic basis of toxicity, including mutations, DNA damage, and the tissue specificity of toxic effects. Understand the different protocols for toxicity testing, including genetic toxicity testing and mutagenesis assays. Study in vitro systems like the Ames test, bacterial mutation test, and fluctuation tests, as well as in vivo tests like DNA repair assays, chromosome damage tests, and apoptosis/necrosis evaluations.

Unit III

Students will Understand pesticide toxicity and Learn about the toxicological effects of various pesticides, including organochlorines, anti-cholinesterase agents (organophosphates and carbamates), and fungicides. Examine the long-term environmental impact of pesticide use, including contamination of soil, water, and food chains. Explore biopesticides and understand the role of biopesticides in pest control and their environmental advantages over chemical pesticides. Learn about food toxicity and understand the relationship between diet and health outcomes, particularly in the context of cardiovascular diseases and cancer. Study the toxicological properties of food additives and their safety.

Unit IV: Histological Techniques

Students will Understand the basic principles of histology (the study of tissues) and histochemistry (the study of chemical constituents in tissues), and their importance in the study of toxicology and pathology. Gain knowledge about tissue processing methods, including fixation (preserving tissues for examination), embedding, and microtomy (cutting tissues into thin slices for microscopic examination). Study various staining techniques, including acid, basic, neutral, and vital stains, and their application in identifying different tissue components. Learn about specific histochemical stains used to highlight particular cellular components (e.g., lipids, proteins, enzymes) in tissue samples. Learn Staining of frozen and paraffin sections

COURSE CODE: MSC1C 415

COURSE NAME: TOXICOLOGY AND HISTOLOGICAL TECHNIQUES

Unit I: Basics and Concepts of Biostatistics

Understand and classify biological data into qualitative (nominal, ordinal, ranked) and quantitative (discrete, continuous) types. Distinguish between population and sample and their relevance in biological research. Learn and apply methods of data collection, including experimental data and survey data, using different sampling techniques such as simple random

sampling, stratified sampling, and cluster sampling. Construct and interpret frequency distributions and relative frequencies to summarize data. Gain proficiency in graphical presentation methods, including bar charts, histograms, frequency polygons, scatter plots, box plots, and line graphs to represent biological data effectively.

Unit II: Statistical Tests in Biology

Demonstrate knowledge of measures of central tendency (mean, median, mode), including quartiles, deciles, and percentiles, for both raw and grouped data. Calculate and interpret measures of dispersion (range, interquartile range, variance, standard deviation, coefficient of variation) to understand the variability of biological data. Understand and apply measures of skewness and kurtosis to assess the shape of the distribution in biological data. Conduct and interpret Student's t-test (paired and unpaired) to assess the differences between two groups. Perform and interpret Analysis of Variance (ANOVA) to compare means across multiple groups in biological studies. Use regression and correlation analysis to assess relationships between biological variables. Apply the Chi-square test to determine associations between categorical variables in biological research.

Unit III: Basic Research Methodology

Understand the process of formulating a research problem, defining aims and objectives, and structuring a thesis, report, or scientific paper. Comprehend the principles of hypothesis testing and the mentor-mentee relationship in research. Apply strategies for optimizing experimental protocols, ensuring data validation, and implementing graphical data analysis techniques in biological research. Understand and apply multivariate analysis techniques to explore complex biological datasets. Understand the concept of plagiarism, and learn methods to avoid it in research writing.

Unit IV: Scientific Writing

Identify different types of scientific research and their methodologies. Develop skills in writing research schemes and proposals, ensuring clarity and precision in presenting research ideas. Understand the role of national and international funding agencies and their importance in supporting scientific research. Learn how to write effective review articles and understand the submission processes for scientific publications.

COURSE CODE: MSC1C 415

COURSE NAME: TOXICOLOGY AND HISTOLOGICAL TECHNIQUES

Unit I: Wildlife Research and Monitoring

Understand and differentiate between conventional and advanced research and monitoring techniques used in wildlife studies. Learn the application of camera trapping in wildlife monitoring and data collection, and analyse its effectiveness in various ecosystems. Understand the principles and applications of radio telemetry in tracking animal movements and behaviour. Develop practical skills to design wildlife research projects using conventional and advanced monitoring techniques.

Unit II: Advances in Wildlife Research

Understand the concept and methods of non-invasive conservation genetics and its applications in wildlife research and conservation. Gain knowledge about wildlife diseases, their impact on ecosystems, and methods for assessing and controlling wildlife health. Learn about the role of information technology in wildlife research, including the use of in silico techniques to model wildlife populations and ecosystems. Analyse the role of wildlife forensics in crime control, and study case examples to understand its application in legal contexts. Understand the objectives and methods of captive breeding programs, and evaluate their importance in wildlife conservation efforts.

Unit III: Important Legislations for Wildlife

Comprehend the Indian Wildlife Protection Act (1972) and its significance in the protection of wildlife and their habitats. Understand the Forest Act (1927) and its role in regulating forest resources and wildlife conservation in India. Learn about the National Biodiversity Act (2002), and its importance in preserving biodiversity at the national level. Understand the role of laws and regulations in wildlife conservation and the enforcement of policies to protect endangered species.

Unit IV: Wildlife Conservation at Global Scale

Understand the role and contributions of the International Union for Conservation of Nature (IUCN) as a global conservation organization. Learn about CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), its regulations, and its impact on global wildlife conservation. Gain knowledge of TRAFFIC's role in monitoring wildlife trade and its efforts to combat illegal wildlife trafficking. Explore the opportunities for wildlife research at a global scale, including international collaborations, funding, and conservation efforts.

Lab I & II (Practical Outcomes)

Course Practical Lab I: MSC1P 413

Practicals based on topics covered in Immunology, Toxicology and Histological Techniques

After completing these practicals, students will acquire essential skills in immunology, biochemistry, and toxicology. They will be able to perform Differential Leukocyte Count (DLC) to assess immune responses and detect infections. Practical expertise in immunological techniques such as Ouchterlony Double Diffusion, Radial Immunodiffusion, Immunoelectrophoresis, Sandwich Dot ELISA, and Latex Agglutination will enhance their ability to study antigen-antibody interactions and diagnose diseases. Students will learn lymphocyte separation using density gradient methods, a crucial skill in immunological research. Additionally, they will gain proficiency in environmental and biochemical analyses, including organic matter estimation in bottom soil, lipid peroxidation measurement in tissues to assess oxidative stress, and total protein quantification using the Folin Phenol reagent. They will also develop competency in food adulteration tests to ensure consumer safety. Finally, students will analyse the effects of different saline solutions and toxin concentrations on mammalian blood, contributing to their understanding of toxicology and pharmacology research.

Course Practical Lab II: 414

Practicals based on topics covered in Biostatistics and Research Methodology &Wildlife and Conservation Biology- II

After completing these practicals, students will develop competence in data analysis and statistical applications, including converting ungrouped data into grouped data using Sturges' formula, representing data through various diagrams and graphical methods, and applying statistical tests like the F-test and Chi-square test for biological research. They will gain proficiency in research methodology and wildlife monitoring techniques by operating camera traps, radio telemetry equipment, and identifying mammalian hairs for species classification. Students will also learn to detect and analyse endo-parasites from wildlife faecal matter, contributing to disease ecology and conservation. They will be trained in designing research proposals for wildlife studies and utilizing mobile applications like eBird for birdwatching, roadkill monitoring apps for assessing human-wildlife conflicts, and other conservation-based tools. Additionally, they will prepare case studies on critical wildlife conservation issues, including wildlife crime investigations, Red List species assessments, and CITES/TRAFFIC trade regulations. Lastly, students will engage in field-based conservation education by participating in nature education camps, workshops, and seminars, applying theoretical knowledge to real-world conservation challenges.