SUBJECT:ZOOLOGY (B.Sc.)	
PROGRAMME OUTCOMES	Zoology is the broad discipline encompassing various subjects involved with the study of animals. Present trend has been shifted to frontier areas of animal sciences at the cost of traditional zoology. There is need to maintain a balance of the traditional zoology and modern science and applied approach. It enables the learners to prepare them for future employment in various fields including academics as well as competitive exams. PO1: Diversity of in vertebrates and chordates, their habitat, morphology and reproduction. PO2: Genetics and molecular biology of animals. PO3: Protozoans and disease causing protozoans and helminthes. PO4: Economic value of animalsand their use inGenetic Engineering.
PROGRAMME SPECIFIC OUTCOMES For Zoology Honors	PSO1:Pursue advanced studies and professional courses such as M.Sc, Graduate Diplomas, Certificates, and PhD programs in various scientific fields. PSO2:Cultivate a passion for research in areas like molecular biology, immunology, genetics, cell biology, developmental biology, chronobiology, and biochemistry. PSO3:Gain practical experience through projects, field visits, and seminars to apply theoretical knowledge in real-world settings. PSO4:Enhance observational, computational, and analytical skills necessary for emerging trends in genetics, molecular biology, and cell biology. PSO5:Develop a strong understanding of ethical practices in scientific research and apply them in studies related to genetics and molecular biology.
COURSEOUTCOME :	*After completion of the course the students will be able to:*
SemesterI	
Core-I **Non-chordates I: Protista to Pseudocoelomates**	CO1:Identify and describe the classification, cell structure, and reproductive methods of Protista, including Amoeba, Euglena, Plasmodium, and Entamoeba. CO2:Compare and contrast the classification, characteristic features, polymorphism, and alternation of generations in Cnidarian, and explain the evolutionary relationships of Ctenophora. CO3:Analyze the classification, characteristic features, and life cycle of Platyhelminthes, and assess the pathogenicity of Fasciola hepatica and Taenia solium. CO4:Investigate the life cycle and pathogenicity of Ascaris

	lumbricoides and Wuchereria bancrofti, and evaluate their adaptations to adverse environments. CO5:Apply knowledge of non-chordate classification and characteristics to synthesize insights into their evolutionary significance and ecological roles.
Core-II **Principles of Ecology**	CO1:Define the meaning and types of ecology, differentiate between types of ecosystems, food chains, food webs, and ecological pyramids, analyze energy flow, nutrient cycles, and physical factors in environments, and evaluate the role of ecology in wildlife conservation. CO2:Examine the attributes of populations, classify types of population regulation, and analyze various population interactions. CO3:Describe the characteristics of ecological communities, explain the concepts of ecotone, edge effect, ecological succession, and compare theories of climax communities. CO4:Interpret biological data through graphical representations (frequency polygon, histogram), apply sampling techniques, and calculate measures of central tendency (mean, median, mode) and dispersion (range, quartile deviation, mean deviation, standard deviation). CO5:Apply statistical methods to test hypothesis by using Chi-square tests and t-tests; analyze and interpret statistical results to draw meaningful conclusions from ecological and biological data.
GE-1 **Animal Diversity**	CO1:Identify the general characteristics and life cycles of protozoa, porifera, cnidaria, platyhelminthes, and nemathelminthes, including the life cycle of *Plasmodium*, the canal system of sponges, polymorphism in cnidarians, the life cycle of *Taeniasolium*, and the parasitic adaptations of helminths. CO2:Describe the general characteristics of annelida, arthropoda, mollusca, and echinodermata, including metamerism in annelids, social behavior in insects, torsion and pearl formation in mollusks, and the larval forms of echinoderms. CO3:Explain the key features of protochordata, osmoregulation and migration in fishes, as well as the general characteristics, terrestrial adaptations, and parental care of amphibians. CO4:Understand the origin and terrestrial adaptations of amniotic reptiles, as well as the origin and flight adaptations in birds, and early evolution and dentition in mammals.
SEC 1: **Environmetal Studies**	CO1: Understand the environment, different types of ecosystems, and the role of biogeochemical cycles in maintaining the environment, as well as various types of environmental pollution

and Disaster Management	and laws for pollution control. CO2:Explore population characteristics and growth, and gain insight into climate change and sustainable development. CO3:Learn about disaster management, including risk analysis, vulnerability assessment, institutional frameworks, preparedness measures, and survival skills for disasters. CO4:Study the dynamics and transmission of communicable and non-communicable diseases, including prevention of epidemics and pandemics, lifestyle management, and the role of different sectors in managing health disasters.
SEMESTER-II	
Core Paper III **Non- Chordates II: Coelomates**	PO1: Explain how coelom and segmentation evolved in coelomates and annelids, including their main features, classification, and excretion methods. PO2: Describe the main traits and classification of Arthropoda and Onychophora, focusing on Arthropod vision, respiration, insect metamorphosis, and social behaviors in bees and termites, and the role of Onychophora in evolution. PO3: Identify the main characteristics and classification of Mollusca, covering how they breathe, the processes of torsion and detorsion in Gastropoda, and the importance of the trochophore larva in evolution. PO4: Outline the characteristics and classification of Echinodermata, including the water-vascular system in starfish, different larval forms, and their connections to Chordates. PO5: Use information from "Ruppert and Barnes (2006) Invertebrate Zoology" to compare and understand the main features and evolutionary adaptations of major invertebrate groups.

Core Paper IV **Cell Biology**	PO1: Understand the basic types of cells, viruses, viroids, mycoplasma, and prions, and explain different models of plasma membrane structure and how substances move across membranes. PO2: Explain the structure and function of the cytoskeleton components and the endomembrane system. PO3: Describe the structure and function of mitochondria and peroxisomes, including the semi-autonomous nature of mitochondria, the endosymbiotic hypothesis, mitochondrial respiratory chain, and the chemiosmotic hypothesis. PO4: Identify the structure of the nucleus; understand chromatin types and their packaging, and explain the processes of mitosis, meiosis, and cell cycle regulation. PO5: Explain cell signalingmechanisms, particularly GPCRs and the role of second messengers like cAMP in cellular processes.
GE-II **Aquatic Biology**	CO1:Explore aquatic biomes, including freshwater ecosystems, estuaries, intertidal zones, oceanic pelagic zones, marine benthic zones, and coral reefs. CO2:Understand the classification and characteristics of lakes, the development of streams, and the adaptations of hill-stream fishes. CO3:Investigate sea water salinity and density, adaptations of deep-sea organisms, and the features of continental shelves, coral reefs, and seaweeds. CO4:Analyze water pollution from agricultural, industrial, sewage, thermal, and oil spills, including concepts like eutrophication, BOD, COD, and water quality assessment.
SEC 2: **M.I.L.(Odia/Alternative English)**	CO1:Understand cultural and social statuses in ancient, medieval, and modern civilizations. CO2:Analyze the status of women in various societies and evaluate the contributions of poets, writers, and philosophers to the development of civilization. CO3:Develop vocabulary skills and apply grammar rules effectively.
SEMESTER-III	
Core Paper V **Diversity and distribution of Chordates**	PO1:Analyze the characteristics, classification, and evolutionary theories of protochordates and the origin of chordates. PO2:Compare the general characteristics, classification, and

	evolutionary significance of Agnatha, Pisces, and Amphibia. PO3:Describe the general characteristics and classifications of Reptilia and Aves, including their adaptations and evolutionary connections. PO4:Summarize the general characteristics and classifications of Mammals and discuss their adaptive radiation and zoogeographic distribution. PO5:Interpret the distribution of vertebrates across different zoogeographical realms and evaluate the effects of plate tectonics and continental drift.
Core Paper VI **Physiology: Controlling and Coordinating Systems**	PO1:Describe the structure, location, classification, and functions of epithelial, connective, muscular, and nervous tissues, as well as bone and cartilage types, ossification, bone growth, and resumption. PO2:Explain the histology and molecular basis of muscle contraction, neuron structure, action potential propagation, synaptic transmission, reflex actions, and the physiology of hearing and vision. PO3:Describe the histology and physiology of the male and female reproductive systems including the hypothalamus-pituitary-gonadal axis, puberty, ovarian cycle, contraception methods, and placental hormones. PO4:Identify the histology and functions of endocrine glands, including the hypothalamus, pineal, pituitary, thyroid, parathyroid, pancreas, and adrenal glands, and explain their hormone mechanisms of action. PO5:Classify the hormonal mechanisms and effects of different endocrine glands and their impact on physiological processes.
Core Paper VII **Fundamentals of Biochemistry**	PO1:Explain the structures and biological significance of carbohydrates and lipids. PO2:Elucidate the structure and classification of amino acids, their physiological roles, the bonds that stabilize protein structures, levels of protein organization, and the processes of renaturation and denaturation, including detailed features of immunoglobulins. PO3:Understand the structures and functions of nucleic acids, including purines, pyrimidines, nucleosides, nucleotides, base pairing, DNA denaturation and renaturation with types of DNA and RNA, and the principles of DNA complementarity and hyperchromaticity.

	PO4:Define enzyme nomenclature, enzyme specificity, mechanisms of enzyme action, enzyme kinetics including the Michaelis-Menten equation, Km, Vmax, and Lineweaver-Burk plot, as well as enzyme inhibition and allosteric regulation. PO5:Descrive the factors influencing enzyme-catalyzed reactions, including multi-substrate reactions, enzyme inhibition, and the regulatory mechanisms controlling enzyme activity.
GE-III **Human Physiology**	CO1:Explain the structure and function of digestive glands, digestion and absorption processes, nervous and hormonal control of digestion, and the mechanics of respiration and gas transport. CO2:Describe the structure of neurons and the propagation of nerve impulses, as well as the structure of skeletal muscles, muscle contraction mechanisms, and the function of the neuromuscular junction. CO3:Understand the functional anatomy of the kidney, urine formation and regulation, heart structure, heartbeat coordination, cardiac cycle, and ECG. CO4:Identify the structure and function of endocrine glands, and explain spermatogenesis, oogenesis, and the menstrual cycle
SEC 3: **Communicative English**	Understand techniques for reading comprehension and develop interest in pronouns, nouns, adverbs, and adjectives. Learn about different types of tenses and verb classifications, and appreciate the importance of business communication. CO2:Enhance skills in reading comprehension through various techniques. CO3:Master the use of pronouns, nouns, adverbs, and adjectives in written and spoken language. CO4:Apply knowledge of tenses and verb classifications to improve grammar accuracy and recognize the significance of effective business communication in professional settings.
SEMESTER-IV	
Core Paper VIII **Comparative Anatomy of Vertebrates**	PO1:Analyze vertebrate evolution patterns and the organization and functions of various systems. PO2:Compare the integument and skeletal components across different vertebrates, noting their functions and modifications. PO3:Explain the evolution of the heart, modifications in aortic arches, and the structure of respiratory organs in aquatic, terrestrial, and aerial vertebrates, along with digestive system

	adaptations to various diets. PO4:Describe the evolution of the brain, sense organs, and excretory organs, emphasizing their complexity and development in mammals. PO5:Assess the structural and functional adaptations in vertebrates related to their evolutionary changes and ecological roles.
Core Paper IX **Physiology: Life Sustaining Systems**	PO1:Explain the structure and function of the digestive system and associated glands, including the processes of digestion, absorption, and hormonal regulation of gastric secretions. PO2:Describe the mechanism of respiration, including the transport of oxygen and carbon dioxide, the oxygen dissociation curve, and the control of respiration. PO3:Analyze the structure and function of the kidneys, including the regulation of acid-base balance, blood components, and blood groups. PO4:Describe the structure and function of conducting myocardial fibers, the cardiac cycle, cardiac output, and blood pressure regulation. PO5:Assess the physiological processes and regulatory mechanisms involved in digestion, respiration, renal function, and cardiovascular performance.
Core Paper X **Biochemistry of Metabolic Processes**	PO1:Analyze catabolism, anabolism, compartmentalization of metabolic pathways, the role of ATP as the energy currency of the cell, and the regulatory mechanisms involved. PO2:Explain the processes and regulation of carbohydrate metabolism, including glycolysis, the citric acid cycle, gluconeogenesis, and glycogenesis. PO3:Describe the oxidation and biosynthesis of fatty acids, the catabolism of amino acids, and the fate of carbon skeletons from various amino acids. PO4:Identify the components of the mitochondrial respiratory chain and the effects of inhibitors on the electron transport chain. PO5:Evaluate how metabolic processes are integrated and regulated to maintain cellular function and energy balance.
GE-IV **Animal Biotechnology**	CO1:Explain gene manipulation techniques like genetic engineering, cloning vectors, and transformation methods. CO2:Describe animal cell culture techniques and key methods

	like gel electrophoresis, DNA sequencing, and PCR. CO3:Compare different fermentation processes and downstream techniques for processing products. CO4:Understand how to create transgenic animals and use them for making vaccines and proteins.
SEC-4 **Quantitative & Logical Thinking**	CO1:Understand quantitative aptitude and data interpretation skills. CO2:Explore logical reasoning concepts, including Venn diagrams, mirror images, cube and dice problems, simple analogies, and logical statements. CO3:Learn about different polygons, such as triangles, squares, rectangles, and right-angled triangles, and calculate their area and perimeter. CO4:Analyze bar graphs and pie charts, and apply statistical measures like mean, median, and mode, as well as concepts of events, sample space, and probability.
SEMESTER-V	
Core Paper XI **Molecular Biology**	PO1:Describe the main features of DNA and RNA, how DNA replicates in both prokaryotes and eukaryotes, and how DNA repairs itself. PO2:Explain how cells make RNA and proteins, including how transcription and translation work in prokaryotes and eukaryotes, and the role of various molecules in this process. PO3:Analyze how eukaryotic RNA is modified after transcription, including how genes are spliced and edited. PO4:Illustrate how gene expression is regulated in prokaryotes and eukaryotes, including examples like the lac operon and gene silencing. PO5:Compare the processes of making proteins and regulating genes in prokaryotes versus eukaryotes.
Core Paper XII **Principles of Genetics**	PO1:Explain the principles of inheritance including Mendelian genetics, incomplete dominance, co-dominance, multiple alleles, and other genetic interactions, as well as linkage, crossing over, and chromosomal mapping. PO2:Identify different types of gene mutations and chromosomal aberrations, and describe how mutations are caused by UV light and chemical mutagens, along with methods to detect these

	mutations. PO3:Describe the mechanisms of sex determination in different organisms and explain the criteria and examples of extra-chromosomal inheritance, including mitochondrial mutations and maternal effects. PO4:Explain recombination processes in bacteria and viruses, including conjugation, transformation, and transduction, as well as the function of transposable genetic elements like transposons and their role in various organisms. PO5:Compare the different mechanisms of genetic recombination and inheritance across bacteria, viruses, and eukaryotes, focusing on their implications for genetics and evolution.
DSC-1 **Animal Behaviour and Chronobiology**	CO1: Understand the history of ethology and key experiments by Frisch, Pavlov, Lorenz, and Tinbergen, including concepts like innate behavior, sign stimuli, and code breakers. CO2: Explain stereotyped behaviors, instincts, learning types (associative, classical, operant), habituation, and imprinting. CO3: Explore social behaviors like communication, altruism, foraging, and sexual behaviors including mate choice, selection, and conflict. CO4: Describe the history of chronobiology and the importance of biological rhythms, including circadian, circannual, tidal, and lunar cycles, and the roles of photoperiod and melatonin.
DSC-2 **Immunology**	CO1:Understand innate and adaptive immunity, including immune system cells, humoral and cell-mediated responses, and autoimmunity related to Rheumatoid arthritis and AIDS. CO2:Learn about antigens, immunogens, haptens, adjuvants, B and T cell epitopes, immunoglobulin structure, antigen-antibody interactions, and techniques like ELISA and RIA. CO3:Explore MHC molecules and cytokines, and the pathways of antigen processing and complement systems. CO4:Review gene classification, types of hypersensitive reactions, and various vaccines.
SEMESTER-VI	
Core Paper XIII **Developmental Biology**	PO1:Understand the historical perspective and fundamental concepts of developmental biology, including phases of development, cell-cell interactions, pattern formation,

	differentiation, growth, gene expression, and the processes of gametogenesis and fertilization. PO2:Describe early embryonic development, focusing on cleavage patterns, types of blastula, fate maps, and early development stages in frogs and chicks up to gastrulation. PO3:Discuss late embryonic development, including the fate of germ layers, extra-embryonic membranes in birds, human embryo implantation, and the structure and functions of the placenta. PO4:Explain post-embryonic development processes such as metamorphosis and hormonal regulation, various modes of regeneration, and concepts of aging, including teratogenesis, in vitro fertilization, stem cells, and amniocentesis. PO5:Evaluate the implications of developmental biology techniques and concepts, including the impact of stem cell therapy and the role of teratogens in embryonic development.
Core Paper XIV **Evolutionary Biology**	PO1:Understand the theories and evidence of evolution, including the origins of life, historical evolutionary concepts, and evidence from the fossil record, variations, and extinction events. PO2:Explain the processes of evolutionary change, including population genetics, Hardy-Weinberg equilibrium, natural selection, genetic drift, and the roles of migration and mutation in allele frequency changes. PO3:Describe the species concept, modes of speciation, and adaptive radiation, focusing on micro evolutionary changes and isolating mechanisms. PO4:Describe the origin and evolution of humans, including key hominine characteristics, primate phylogeny, and methods for analyzing human evolution through phylogenetic trees and molecular data. PO5:Evaluate evolutionary processes and evidence, using concepts and examples to understand species formation, adaptation, and the evolutionary history of humans.
DSEIII: **FishandFisheries**	CO1:Understand systemic positions, types of fins, locomotion, scales, gills, swim bladders, electric organs, bioluminescence, mechanoreceptors, schooling, and migration in fishes. CO2:Explore inland and marine fisheries, factors affecting seasonal variations, fishing crafts and gears, resource depletion, and fisheries laws and regulations. CO3:Learn about sustainable aquaculture, polyculture, composite fish culture, induced breeding methods, fish hatchery

	management, aquarium maintenance, and factors affecting aquaculture. CO4:Examine diagnosis and treatment of viral, bacterial, and protozoan fish diseases, fish processing, fish byproducts, and the concept of transgenic and zebra fish.
DSEIV: **Project**	CO1: Prepare scientific projects related to courses of study. CO2: Prepare and Present a PowerPoint presentation of the project work.