# Shri Shivaji Science And Arts College, Chikhli

## Department Of Zoology

### Program Outcome, Program Specific Outcome and Course Outcome

## Program Outcomes

| PO No. | Title of PO |
|---|---|
| PO1 | **Scientific Knowledge** |
| | Apply the knowledge of basic science (Physics, Chemistry, Biology, Mathematics, etc.) and specialized subjects to solve complex scientific problems. Graduates should understand the fundamental principles and theories that govern the natural world. |
| PO2 | **Critical Thinking** |
| | Take informed actions after identifying the assumptions that frame our thinking and actions. Graduates should be able to check the degree to which these assumptions are accurate and valid, looking at ideas and decisions from different perspectives. |
| PO3 | **Problem Analysis** |
| | Identify, formulate, and analyze complex scientific problems reaching substantiated conclusions using first principles of natural sciences. This includes the ability to design experiments and interpret data. |
| PO4 | **Usage of Modern Tools** |
| | Create, select, and apply appropriate techniques, resources, and modern scientific and IT tools-including prediction and modeling to complex scientific activities with an understanding of their limitations. (e.g., using lab equipment like Spectrophotometers or software like MATLAB/Python). |
| PO5 | **Research-Related Skills** |
| | Develop the ability to conduct literature searches, design research methodologies, analyze results, and report findings in a clear and concise manner. This prepares students for higher studies (M.Sc./Ph.D.). |
| PO6 | **Communication Skills** |
| | Speak, read, write, and listen clearly. Graduates should be able to communicate complex scientific information to both specialists and non-specialists through reports, presentations, and digital media. |
| PO7 | **Ethics** |
| | Apply ethical principles and commit to professional ethics and responsibilities of scientific practice. This includes avoiding plagiarism, ensuring data integrity, and understanding the moral consequences of scientific research (e.g., bioethics). |
| PO8 | **Environment and Sustainability** |
| | Understand the impact of scientific solutions in societal and environmental contexts. Graduates should demonstrate the knowledge of and need for sustainable development and environmental protection. |
| PO9 | **Social Interaction and Effective Citizenship** |
| | Elicit views of others and mediate disagreements to help reach conclusions in group settings. Demonstrate empathetic social concern and the ability to act with an informed awareness of issues as a responsible citizen. |
| PO10 | **Self-directed and Life-long Learning** |
| | Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes. Science evolves rapidly; graduates must be able to keep their knowledge current. |

# Program Specific Outcomes

| PSO No. | Title of PSO |
|---|---|
| PSO1 | Understanding Animal Diversity and Taxonomy |
| | **PSO:** Students will be able to identify, classify, and differentiate between various groups of invertebrates and vertebrates.<br>**Details:** Gain knowledge of the systematic positions, morphological features, and evolutionary relationships of different phyla, from Protozoa to Mammalia. |
| PSO2 | Proficiency in Biological Processes (Physiology & Biochemistry) |
| | **PSO:** Students will understand the functional mechanisms and metabolic pathways of living organisms.<br>**Details:** Explain the molecular and cellular basis of physiological functions such as digestion, respiration, circulation, and excretion. Understand how biochemical molecules (proteins, lipids, carbohydrates) sustain life. |
| PSO3 | Genetics, Molecular Biology, and Evolution |
| | **PSO:** Students will be able to analyze the mechanisms of inheritance and the molecular basis of life.<br>**Details:** Understand Mendelian genetics, DNA replication, gene expression, and the principles of organic evolution. Ability to trace the ancestry of various life forms through fossil records and molecular evidence. |
| PSO4 | Applied Zoology and Entrepreneurship |
| | **PSO:** Graduates will be able to apply zoological knowledge to economically important fields.<br>**Details:** Develop technical skills in areas like Sericulture, Apiculture, Aquaculture and Vermiculture. This prepares students for self-employment and small-scale industries. |
| PSO5 | Ecological Awareness and Conservation |
| | **PSO:** Students will understand the complex interactions within ecosystems and the importance of biodiversity.<br>**Details:** Evaluate the impact of climate change and human activity on animal populations. Demonstrate knowledge of wildlife conservation laws, endangered species management, and sustainable environmental practices. |
| PSO6 | Technical and Laboratory Skills |
| | **PSO:** Students will become proficient in standard biological techniques and the use of modern laboratory equipment.<br>**Details:** Master techniques such as microscopy, microtomy (tissue slicing), staining, pH meter, and basic bioinformatics tools. Ability to conduct dissections (as per ethical guidelines) and field studies. |
| PSO7 | Cell and Developmental Biology |
| | **PSO:** Students will understand life at its most fundamental levels, from a single cell to a complex organism.<br>**Details:** Describe the structure and functions of cell organelles and the processes of gametogenesis, fertilization, and embryonic development in various animal models. |
| PSO8 | Health and Immunology |
| | **PSO:** Students will be able to explain the human immune system and the pathophysiology of common diseases.<br>**Details:** Understand the role of vaccines, the mechanism of disease transmission by vectors (like mosquitoes), and the body's defense mechanisms against pathogens. |

# Course Outcomes

## B. Sc. I-SEM-I

## Course Name: Fundamental Biology of Invertebrates (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Systematic Classification and Identification** |
| | **Outcome:** Identify and classify invertebrates from various phyla (Protozoa to Echinodermata) based on their specific diagnostic features.<br>**NEP Focus:** Developing foundational taxonomic skills and a scientific temper in organizing biological diversity. |
| CO2 | **Comparative Structural Analysis** |
| | **Outcome:** Describe and compare the functional anatomy of various invertebrate types, including their digestive, circulatory, respiratory, and nervous systems.<br>**NEP Focus:** Critical thinking by analyzing how different body plans (radial vs. bilateral symmetry) solve the same biological problems. |
| CO3 | **Evolutionary Lineage and Trends** |
| | **Outcome:** Explain the evolutionary milestones in the invertebrate lineage, such as the origin of multicellularity, the development of the coelom (body cavity), and the significance of metameric segmentation.<br>**NEP Focus:** Understanding the history of life and the continuity of biological processes over millions of years. |
| CO4 | **Pathophysiology and Human Health (Parasitology)** |
| | **Outcome:** Analyze the life cycles, modes of transmission, and pathogenicity of medically and economically important parasites (e.g., *Plasmodium*, *Fasciola*, *and Ascaris*).<br>**NEP Focus:** Connecting classroom learning to community health and societal well-being. |
| CO5 | **Economic and Vocational Zoology** |
| | **Outcome:** Evaluate the economic importance of invertebrates in sectors like agriculture (pollinators, soil fertility), textiles (sericulture), and food industries (prawns, pearl culture).<br>**NEP Focus:** Enhancing employability and entrepreneurial mindset by identifying biological resources for sustainable livelihood. |
| CO6 | **Ecological Dynamics and Conservation** |
| | **Outcome:** Assess the ecological roles of invertebrates, such as coral reef formation, their position in food webs, and their sensitivity to climate change.<br>**NEP Focus:** Environmental awareness and sensitivity towards biodiversity conservation as a global citizen. |

# Course Outcomes

## B. Sc. I-SEM-I

## Course Name: Fundamental Biology of Invertebrates (Practical)

By the end of the practical course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Proficiency in Microscopic Techniques** |
| | **Outcome:** Demonstrate the ability to operate compound and stereo-microscopes to observe and identify microscopic invertebrates.<br>**Skill:** Preparation of temporary and permanent mounts of small organisms (e.g., Protozoa, Hydra, or Sponge spicules). |
| CO2 | **Taxonomic Identification & Classification** |
| | **Outcome:** Identify and classify diverse invertebrate specimens (from Protozoa to Echinodermata) based on key morphological characters.<br>**Skill:** Use of taxonomic keys and museum specimens to distinguish between similar-looking species. |
| CO3 | **Anatomical Skill & Virtual Visualization** |
| | **Outcome:** Explain the internal organization of invertebrates through the study of anatomical models, digital simulations, or ethical dissections (where permitted).<br>**Skill:** Mapping internal organ systems (Digestive, Nervous, and Reproductive) of types like *Pheretima* (Earthworm) or *Palaemon* (Prawn). |
| CO4 | **Histological Analysis** |
| | **Outcome:** Identify various tissues and specialized cells of invertebrates through permanent slides.<br>**Skill:** Differentiating between cell types like *Choanocytes* in sponges, *Cnidoblasts* in Coelenterates, and transverse sections (T.S.) of body walls. |
| CO5 | **Environmental & Field Observation** |
| | **Outcome:** Document the behavior and diversity of invertebrates in their natural or local habitats.<br>**Skill:** Collection and preservation techniques (dry/wet) following ethical guidelines, and recording field observations in a "Natural History" diary. |
| CO6 | **Data Recording & Scientific Communication** |
| | **Outcome:** Maintain an accurate laboratory record book with scientifically labeled diagrams and systematic descriptions.<br>**Skill:** Translating visual observations into accurate biological drawings. |

# Course Outcomes

## B. Sc. I-SEM-I

## Course Name: GOEC-1 Economic Zoology (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Concept of Sustainable Livelihood** |
| | **Outcome:** Explain the importance of animals in human economy and identify various avenues for self-employment in the zoological sector.<br>**NEP Focus:** Developing an entrepreneurial mindset and understanding the role of "Blue" and "Green" economies. |
| CO2 | **Apiculture and Sericulture Management** |
| | **Outcome:** Describe the biology, life cycles, and commercial management of Honey bees and Silkworms.<br>**Detail:** Understand the techniques of honey extraction, beeswax production, and the processing of different types of silk (Mulberry, Tassar, Eri, Muga). |
| CO3 | **Aquaculture and Fisheries** |
| | **Outcome:** Evaluate the techniques used in freshwater and marine aquaculture, including fish, prawn, and pearl culture.<br>**Detail:** Analyze fish breeding methods (induced breeding), pond management, and the nutritional value of aquatic products for food security. |
| CO4 | **Vermiculture and Organic Farming** |
| | **Outcome:** Demonstrate knowledge of earthworm species suitable for Vermicomposting and their role in sustainable agriculture.<br>**Detail:** Explain the process of converting organic waste into nutrient-rich fertilizer and its economic benefits over chemical fertilizers. |
| CO5 | **Integrated Pest Management (IPM)** |
| | **Outcome:** Identify major pests of crops and stored grains and propose eco-friendly methods for their control.<br>**Detail:** Understand the biology of pests and the application of biological, chemical, and integrated control measures to minimize economic loss. |
| CO6 | **Dairy and Poultry Farm Management** |
| | **Outcome:** Discuss the principles of livestock management, including breed selection, housing, nutrition, and disease control in poultry and dairy industries.<br>**Detail:** Evaluate the economic contribution of meat, eggs, and milk production to the national economy. |
| CO7 | **Lac Culture and Other Animal Products** |
| | **Outcome:** Explain the cultivation of Lac insects and the extraction of other animal-derived products like wool, leather, and pharmaceuticals. |

# Course Outcomes

## B. Sc. I-SEM-I

## Course Name: GOEC-2 Wildlife Ecotourism (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Understand the Principles of Ecotourism** |
| | **Outcome:** Define and explain the fundamental concepts of ecotourism, distinguishing it from mass tourism and nature-based tourism.<br>**Knowledge:** Grasp the "Quebec Declaration on Ecotourism" and the ethical guidelines that govern sustainable travel. |
| CO2 | **Comprehend Wildlife Ecology and Biodiversity** |
| | **Outcome:** Describe the diversity of Indian flora and fauna and understand the ecological roles of different species within their habitats.<br>**Knowledge:** Identify key "Protected Areas" in India, including National Parks, Wildlife Sanctuaries, and Biosphere Reserves. |
| CO3 | **Analyze the Role of Tourism in Conservation** |
| | **Outcome:** Evaluate how ecotourism acts as a tool for wildlife conservation by generating revenue for habitat protection and raising public awareness.<br>**Knowledge:** Understand the "Economics of Conservation" and how tourism can fund anti-poaching and restoration efforts. |
| CO4 | **Identify Threats and Challenges** |
| | **Outcome:** Analyze the negative impacts of unregulated tourism on wildlife, such as habitat fragmentation, behavioral changes in animals, and human-wildlife conflict.<br>**Knowledge:** Discuss the concept of "Carrying Capacity"—the maximum number of visitors an area can sustain without environmental degradation. |
| CO5 | **Knowledge of Legal and Policy Frameworks** |
| | **Outcome:** Explain the major national and international laws protecting wildlife and regulating tourism.<br>**Knowledge:** Gain familiarity with the **Wildlife Protection Act (1972)**, CITES, and the role of organizations like the NTCA (National Tiger Conservation Authority). |
| CO6 | **Community Participation and Socio-economic Impact** |
| | **Outcome:** Evaluate the importance of involving local and indigenous communities in ecotourism projects to ensure equitable benefit-sharing.<br>**Knowledge:** Understand "Community-Based Ecotourism" (CBET) models and their role in rural development and poverty alleviation. |
| CO7 | **Professional Skills in Wildlife Interpretation** |
| | **Outcome:** Develop basic skills required for a wildlife naturalist or guide, including wildlife photography, animal tracking, and the use of field equipment (GPS, Binoculars).<br>**Knowledge:** Learn the art of "Interpretation"—translating scientific information into engaging stories for tourists. |

# Course Outcomes

## B. Sc. I-SEM-I

## Course Name: SEC-Beekeeping-I (Practical)

By the end of the practical course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Identification of Bee Biology and Castes** |
| | Students will be able to identify different species of honey bees (*Apis cerana, Apis Mellifera, etc.*) and distinguish between the Queen, Drone, and Worker bees based on morphological features and life stages (Egg, Larva, Pupa). |
| CO2 | **Proficiency in Beekeeping Equipment** |
| | Students will demonstrate the correct selection, handling, and maintenance of essential apiary tools such as the smoker, hive tool, bee veil, gloves, and brush, ensuring safety for both the keeper and the bees. |
| CO3 | **Hive Assembly and Site Management** |
| | Students will be able to identify various parts of modern hives (Newton and Langstroth), explain the criteria for selecting an ideal apiary site, and demonstrate the process of hive installation and frame management. |
| CO4 | **Field Management and Inspection Skills** |
| | Students will gain hands-on experience in colony inspection, assessing the health of the brood, checking for the presence of the queen, and identifying local bee flora (nectar and pollen sources). |
| CO5 | **Honey Extraction and Quality Analysis** |
| | Students will perform the practical steps of harvesting honey using indigenous and modern extractors, and conduct basic tests to check the purity and moisture content of the harvested honey. |
| CO6 | **Diagnosis of Pests and Diseases** |
| | Students will be able to recognize symptoms of common bee diseases (like Foulbrood or Sacbrood) and identify major pests (wax moths, mites, and wasps) to suggest appropriate biological or chemical controls. |
| CO7 | **Entrepreneurial Documentation** |
| | Students will learn to maintain apiary records, including colony performance charts, expenditure logs, and production yields, which are essential for running a small-scale beekeeping business. |

# Course Outcomes

## B. Sc. I-SEM-II

## Course Name: Fundamental Biology of Chordates (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Chordate Fundamentals and Classification**<br>**Outcome:** Demonstrate a comprehensive understanding of the basic chordate body plan and taxonomic hierarchy.<br>**Detail:** Identify the primary diagnostic characters (notochord, dorsal hollow nerve cord, and pharyngeal gill slits) and classify chordates from Protochordata to Mammalia up to the level of orders. |
| CO2 | **Evolutionary Significance of Protochordates**<br>**Outcome:** Analyze the biological characteristics and Phylogenetic position of lower chordates.<br>**Detail:** Explain the process of retrogressive metamorphosis in Urochordates (e.g., *Herdmania*) and the structural organization of Cephalochordates (e.g., *Amphioxus*) as an evolutionary bridge. |
| CO3 | **Biology and Adaptation of Fishes**<br>**Outcome:** Evaluate the anatomical diversity and physiological adaptations of the Class Pisces.<br>**Detail:** Compare Chondrichthyes and Osteichthyes, and explain specialized survival mechanisms such as migration patterns, osmoregulation, and the role of accessory respiratory organs. |
| CO4 | **Amphibian Diversity and Terrestrial Transition**<br>**Outcome:** Describe the biological strategies involved in the transition from aquatic to terrestrial life.<br>**Detail:** Discuss the origin of tetrapods, various modes of parental care in amphibians, and the physiological significance of neoteny and paedogenesis. |
| CO5 | **Reptilian Evolution and Specialized Structures**<br>**Outcome:** Demonstrate knowledge of the evolutionary milestones and functional anatomy of reptiles.<br>**Detail:** Explain the importance of the amniotic egg in land colonization, the classification of reptiles based on skull fenestration, and the biting mechanism of venomous snakes. |
| CO6 | **Avian Specializations and Flight Mechanics**<br>**Outcome:** Examine the morphological and anatomical adaptations required for an aerial lifestyle in birds.<br>**Detail:** Analyze volant (flight) adaptations, the mechanics of the perching transition, and the navigation techniques used during long-distance bird migration. |
| CO7 | **Mammalian Organization and Diversity**<br>**Outcome:** Identify the unique characteristics and evolutionary radiation of the Class Mammalia.<br>**Detail:** Differentiate between Prototheria, Metatheria, and Eutheria, and explain the functional significance of mammalian dentition and integumentary derivatives (hair, horns, and glands). |
| CO8 | **Comparative Vertebrate Anatomy**<br>**Outcome:** Trace the evolutionary progression of major organ systems across the chordate series.<br>**Detail:** Compare the structural evolution of the vertebrate heart, kidney, and brain to understand how biological complexity increased from lower vertebrates to mammals. |

# Course Outcomes

## B. Sc. I-SEM-II

## Course Name: Fundamental Biology of Chordates (Practical)

By the end of the practical course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Taxonomic Identification and Classification** |
| | **Outcome:** Identify and classify diverse chordate specimens based on their morphological characteristics.<br>**Detail:** Examine museum specimens from Protochordates, Fishes, Amphibians, Reptiles, Birds, and Mammals to recognize key diagnostic features and assign them to their respective taxonomic groups. |
| CO2 | **Practical Anatomical Proficiency** |
| | **Outcome:** Demonstrate a clear understanding of the internal organization and organ systems of chordates.<br>**Detail:** Utilize dissections (manual or virtual/digital models) of representative types like *Labeo* or *Rat* to study the digestive, circulatory, and urino-genital systems in a laboratory setting. |
| CO3 | **Microscopic Examination and Slide Study** |
| | **Outcome:** Analyze the microscopic structure of chordate tissues and developmental stages.<br>**Detail:** Prepare temporary mounts (such as fish scales) and observe permanent slides of protochordate sections (e.g., *Amphioxus* T.S.) and vertebrate histology to understand cellular and tissue-level organization. |
| CO4 | **Vertebrate Osteology and Skeletal Analysis** |
| | **Outcome:** Distinguish and describe the skeletal framework of various vertebrate classes.<br>**Detail:** Study the axial and appendicular skeleton, including the skull, vertebrae, girdles, and limb bones of amphibians, reptiles, birds, and mammals to understand structural support and evolution. |
| CO5 | **Functional Morphology and Adaptation** |
| | **Outcome:** Correlate specific morphological structures with the ecological niches and habits of chordates.<br>**Detail:** Analyze specialized adaptations through practical observation, such as different types of fish scales, the diversity of beaks and claws in birds, and (various) dental patterns in mammals. |
| CO6 | **Scientific Documentation and Lab Ethics** |
| | **Outcome:** Maintain precise biological records while adhering to ethical guidelines for animal handling.<br>**Detail:** Systematically document observations in a laboratory record book and demonstrate an understanding of the "Prevention of Cruelty to Animals" (PCA) guidelines during the study of biological specimens. |
| CO7 | **Field Observations and Biodiversity Mapping** |
| | **Outcome:** Apply classroom knowledge to observe and document chordate diversity in natural habitats.<br>**Detail:** Conduct field visits to local ponds, aviaries, or zoological parks to observe the behavior and foraging habits of chordates and prepare a basic report on local vertebrate fauna. |

# Course Outcomes

## B. Sc. I-SEM-II

## Course Name: GOEC-3 Human Health and Infectious Diseases (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Health and Pathophysiology**<br>**Outcome:** Understand the basic concepts of human health, the nature of diseases, and the general pathophysiology of infectious processes.<br>**Detail:** Students gain a foundational understanding of what constitutes "health" versus "disease." This includes learning about the classification of diseases (infectious vs. non-infectious) and the basic biological changes that occur in the human body when an infection takes hold. |
| CO2 | **Infectious Agents**<br>**Outcome:** Identify various types of infectious agents (bacteria, viruses, fungi, and parasites) and explain their specific modes of transmission.<br>**Detail:** This outcome focuses on microbiology and Parasitology. Students learn to distinguish between different pathogens such as *Mycobacterium tuberculosis* (bacteria), Influenza/SARS-CoV-2 (viruses), and *Plasmodium* (parasites). It covers how these agents enter the host via air, water, food, or vectors. |
| CO3 | **Pathogenesis & Epidemiology**<br>**Outcome:** Describe the clinical manifestations, pathogenesis, and epidemiological patterns of major communicable diseases.<br>**Detail:** Students study specific case studies of diseases like Tuberculosis, Malaria, Cholera, Hepatitis, and HIV/AIDS. They learn about the "Epidemiological Triad" (Agent, Host, and Environment) and how to track the spread of diseases within a population. |
| CO4 | **Immune Response**<br>**Outcome:** Explain how the human immune system recognizes and responds to different infectious pathogens.<br>**Detail:** This section covers the basics of Immunology. Students learn about innate immunity (skin, mucous, inflammatory response) and adaptive immunity (B-cells, T-cells, and antibody production), specifically focusing on how the body creates "memory" to fight future infections. |
| CO5 | **Prevention and Management**<br>**Outcome:** Discuss and apply principles of disease prevention, including vaccination, sanitation, and public health management strategies.<br>**Detail:** The final focus is on "One Health" and public health. This includes the importance of the Universal Immunization Programme (UIP), the role of antibiotics and the threat of antimicrobial resistance (AMR), and personal/community hygiene practices to mitigate outbreaks. |

# Course Outcomes

## B. Sc. I-SEM-II

## Course Name: GOEC-4 Animal Behaviour and Ecology (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Fundamentals of Ethology**<br>**Course outcome:** Understand the basic concepts of animal behavior and the biological mechanisms that drive them.<br>**Course Detail:** Students will gain knowledge about the history of ethology and distinguish between innate behaviors (instincts, fixed action patterns) and learned behaviors (imprinting, classical conditioning, and operant learning). It also covers how genetics and the environment influence behavior. |
| CO2 | **Social Behavior and Communication**<br>**Course outcome:** Analyze the social structures, reproductive strategies, and communication methods in animal societies.<br>**Course Detail:** This outcome focuses on social organization, including hierarchies, altruism, and kin selection. Students study various communication signals (chemical/pheromones, visual, acoustic, and tactile) and explore mating systems and the levels of parental care across different taxa. |
| CO3 | **Ecosystem Structure and Function**<br>**Course outcome:** Comprehend the components of an ecosystem and the flow of energy through the biosphere.<br>**Course Detail:** Students will learn about the interactions between biotic and abiotic factors. The course details the dynamics of food chains, food webs, and ecological pyramids, while explaining the laws of thermodynamics in the context of energy transfer across trophic levels. |
| CO4 | **Population and Community Ecology**<br>**Course outcome:** Evaluate population dynamics and the various types of inter-specific interactions within a community.<br>**Course Detail:** This section covers population attributes such as density, natality, mortality, and age distribution. Students will analyze population growth models (Exponential and Logistic curves) and study biological interactions like competition, predation, parasitism, and mutualism. |
| CO5 | **Biodiversity and Conservation Biology**<br>**Course outcome:** Apply ecological principles to assess environmental challenges and the importance of biodiversity conservation.<br>**Course Detail:** Students will understand the impact of human activities on the environment, including habitat fragmentation and climate change. The course provides details on wildlife management, the "niche" concept, and strategies for the conservation of endangered species through in-situ and ex-situ methods. |

# Course Outcomes

## B. Sc. I-SEM-II

## Course Name: VSC- Vocational Skill Course (Practical)

By the end of the practical course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Microscopy and Histological Analysis** |
| | **Course outcome:** Demonstrate proficiency in using advanced microscopes for detailed histological studies.<br>**Course Detail:** Students learn the application of Phase Contrast, Fluorescence, and Confocal microscopy. This includes understanding how modern optics provides high-resolution images of cellular structures and tissue sections that are essential for medical and biological research. |
| CO2 | **Micro-techniques and Specimen Preservation** |
| | **Course outcome**: Master modern methods for preparing permanent slides and preserving biological specimens for museum display.<br>**Course Detail:** This covers advanced staining techniques, resin embedding, and the latest preservatives used in taxidermy. Students gain skills in maintaining the structural integrity and color of specimens for long-term educational and research use. |
| CO3 | **ICT Integration in Anatomical Studies** |
| | **Course outcome:** Utilize Information and Communication Technology (ICT) tools as an ethical alternative to traditional animal dissections.<br>**Course Detail:** Students explore 3D modeling software, virtual reality (VR) simulations, and interactive digital atlases to study internal anatomy. This outcome focuses on reducing animal sacrifice while enhancing the precision of anatomical learning. |
| CO4 | **Laboratory Animal Facility Management** |
| | **Course outcome:** Implement standard protocols for the ethical setup and maintenance of a laboratory animal house.<br>**Course Detail:** This involves learning about the environmental requirements (temperature, ventilation, and lighting), sanitation, and feeding schedules for lab animals. It emphasizes compliance with CPCSEA guidelines and ethical treatment of animals in research. |
| CO5 | **Aquarium Engineering and Design** |
| | **Course outcome:** Apply technical knowledge to design and construct various functional aquarium systems.<br>**Course Detail:** Students learn about the structural requirements of glass and acrylic tanks, the installation of filtration systems (mechanical, biological, and chemical), and the integration of aeration and heating systems for different aquatic environments. |
| CO6 | **Ornamental Fish Selection and Management** |
| | **Course outcome:** Evaluate and select compatible fish species to maintain a healthy and balanced community aquarium.<br>**Course Detail:** This outcome focuses on "friendly" fish species selection, understanding water chemistry (pH, hardness, ammonia levels), and recognizing social behaviors to prevent inter-species aggression in a captive ecosystem. |
| CO7 | **Fundamentals of Apiculture Installation** |
| | **Course outcome:** Understand the technical requirements and site selection for the successful installation of honeybee hives.<br>**Course Detail:** Students gain a primary idea of hive types (such as Langstroth or Newton), |

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|---|---|
| | the importance of bee flora (foraging area), and the basic equipment needed to establish a colony for honey production and pollination services. |
| **CO8** | **Emergency Response for Snakebites** |
| | **Course outcome:** Execute immediate first-line treatment and differentiate between venomous and non-venomous snakebites.<br>**Course Detail:** Practical training involves the "RIGHT" protocol (Reassurance, Immobilization, Get to Hospital, Tell the Doctor). Students learn what *not* to do (e.g., incisions or tourniquets) and how to identify clinical symptoms of envenomation. |
| **CO9** | **Avian Migration Tracking Technologies** |
| | **Course outcome:** Identify and explain the modern scientific methods used to monitor bird migratory routes.<br>**Course Detail:** This covers the methodology of bird banding (ringing), satellite telemetry, GPS logging, and the use of geolocators. Students learn how these tools help in mapping flyways and conserving migratory species. |
| **CO10** | **Advanced Methodologies in Animal Research** |
| | **Course outcome:** Familiarize with cutting-edge non-invasive and molecular tools used in modern animal studies.<br>**Course Detail:** Students receive a brief overview of advanced techniques such as DNA bar-coding, camera trapping, bio-acoustics, and remote sensing. This outcome emphasizes the shift toward high-tech, non-disturbing methods for studying wildlife and animal behavior. |

# Course Outcomes

## B. Sc. I-SEM-II

## Course Name: SEC-Beekeeping-II (Practical)

By the end of the practical course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Colony Inspection and Safe Handling**<br>**Course outcome:** Demonstrate expertise in the safe handling of live bee colonies and routine hive maintenance.<br>**Course Detail:** Students will practice the correct use of protective gear (bee veils, gloves) and smokers. The practical involves opening the hive, identifying the queen, workers, and drones, and inspecting frames for brood, honey, and pollen storage without agitating the colony. |
| CO2 | **Seasonal Management and Feeding**<br>**Course outcome:** Implement specific management protocols for different seasons and dearth periods.<br>**Course Detail:** This includes hands-on training in providing artificial feeding (sugar syrup and pollen supplements) during dearth periods. Students learn how to prepare the colony for the honey flow season, manage swarming, and perform "uniting" or "splitting" of colonies based on seasonal requirements. |
| CO3 | **Post-Harvest Technology and Extraction**<br>**Course outcome:** Execute the professional extraction, filtration, and processing of honey and beeswax.<br>**Course Detail:** Practical sessions cover the use of centrifugal honey extractors, uncapping knives, and honey filters. Students gain skills in processing beeswax using solar or steam wax meters and understanding the moisture content requirements for shelf-stable honey. |
| CO4 | **Diagnosis of Diseases and Pests**<br>**Course outcome:** Identify common honeybee pathogens, parasites, and predators through field and lab observations.<br>**Course Detail:** Students learn to recognize symptoms of diseases such as Thai Sacbrood virus and Foulbrood. Practical identification of pests like the Greater Wax Moth, Varroa mites, and predatory wasps is covered, along with the application of integrated pest management (IPM) techniques. |
| CO5 | **Quality Control and Entrepreneurial Skills**<br>**Course outcome:** Apply standards for honey quality testing, packaging, and economic planning for a commercial apiary.<br>**Course Detail:** This covers basic physical and chemical tests for honey purity (e.g., Fiehe's test). Students learn about bottling, labeling according to FSSAI standards, and preparing a cost-benefit analysis (project report) for setting up a small-scale beekeeping business. |

# Course Outcomes

## B. Sc. II-SEM-III

## Course Name: Cytology (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Fundamental Cellular Organization**<br>**Course outcome** Understand the structural and functional differences between prokaryotic and eukaryotic cells.<br>**Course detail** Students will learn the evolution of the eukaryotic cell through endosymbiotic theory and gain an in-depth understanding of the chemical composition and basic architecture of cells, including the role of the cytosol and the cytoskeleton in maintaining cell shape. |
| CO2 | **Membrane Biology and Transport Mechanisms**<br>**Course outcome** Analyze the molecular structure of the plasma membrane and the mechanisms of cellular transport.<br>**Course detail** This outcome covers the Fluid Mosaic Model of the cell membrane, the role of membrane proteins, and the physiological processes of passive transport (diffusion, osmosis), active transport (pumps like Na+/K+), and bulk transport (endocytosis and exocytosis). |
| CO3 | **Organelle Ultrastructure and Function**<br>**Course outcome** Identify and describe the specialized functions of various intracellular organelles.<br>**Course detail** Students will study the Ultrastructure and functional integration of organelles such as the Endoplasmic Reticulum (protein synthesis), Golgi Complex (processing), Mitochondria (bioenergetics), Lysosomes (intracellular digestion), and Peroxisomes (metabolism). |
| CO4 | **Nuclear Structure and Genetic Material Packaging**<br>**Course outcome** Explain the organization of the nucleus and the structural hierarchy of chromosomes.<br>**Course detail** This includes the study of the nuclear envelope, nucleoplasm, and nucleolus. Detailed focus is given to chromatin organization, the nucleosome model, and the structure of specialized chromosomes (polytene and lampbrush) and their significance in gene expression. |
| CO5 | **Regulation of the Cell Cycle and Division**<br>**Course outcome** Demonstrate a comprehensive understanding of the molecular events of cell division and its regulation.<br>**Course detail** The course details the phases of the cell cycle (G1, S, G2, & M), the mechanics of Mitosis and Meiosis, and the regulatory checkpoints. Students will also learn about the consequences of cell cycle dysregulation, leading to abnormal growth or cancer. |
| CO6 | **Cell Signaling and Communication**<br>**Course outcome** Comprehend the fundamental pathways of cellular communication and signal transduction.<br>**Course detail** Students will explore how cells receive and respond to external stimuli through various receptors (GPCRs, Enzyme-linked receptors) and the role of second messengers (cAMP, Ca2+) in translating these signals into specific cellular actions. |
| CO7 | **Applications of Cytological Techniques**<br>**Course outcome** Gain theoretical proficiency in the tools and techniques used to study cell biology.<br>**Course detail** The outcome focuses on the principles of microscopy (Light, Electron, and Fluorescence), cell fractionation, and specific staining techniques (e.g., Feulgen reaction for DNA), preparing students for practical laboratory applications and research. |

# Course Outcomes

## B. Sc. II-SEM-III

## Course Name: Developmental Biology of Vertebrates (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Historical Perspective and Foundational Concepts**<br>**Course outcome** Understand the historical background and the evolution of theories in developmental biology.<br>**Course detail** Students will study the historical development of embryology, moving from early theories like Preformation and Epigenesis to the modern concepts of Von Baer's laws and Weismann's Germ Plasm theory. They will understand the transition from descriptive to experimental embryology. |
| CO2 | **Gametogenesis and Reproductive Biology**<br>**Course outcome** Comprehend the cellular and molecular mechanisms of gamete formation.<br>**Course detail** This outcome details the processes of Spermatogenesis and Oogenesis in mammals and other vertebrates. Students will learn about the Ultrastructure of sperm and eggs, the role of Sertoli and Leydig cells, hormonal regulation of gamete production, and vitellogenesis (yolk formation). |
| CO3 | **Mechanisms of Fertilization**<br>**Course outcome** Explain the biochemical and physiological events occurring during fertilization.<br>**Course detail** Students will analyze the stages of fertilization, including sperm-egg recognition, acrosomal reaction, and the cortical reaction to prevent polyspermy. The course also covers the activation of egg metabolism and the fusion of genetic material to form a Totipotent zygote. |
| CO4 | **Early Embryonic Development and Germ Layer Formation**<br>**Course outcome** Analyze the patterns of cleavage and the morphogenetic movements during gastrulation.<br>**Course detail** This outcome focuses on the types of cleavage (holoblastic vs. meroblastic) and the process of gastrulation in models like Amphibians and Birds. Students will learn about fate maps and how morphogenetic movements (invagination, involution, and epiboly) lead to the formation of the three primary germ layers: ectoderm, mesoderm, and endoderm. |
| CO5 | **Late Development and Foetal Support Systems**<br>**Course outcome** Understand the development of extra-embryonic structures and organogenesis.<br>**Course detail** Students will study the formation and function of extra-embryonic membranes (Amnion, Chorion, Allantois, and Yolk sac) in chicks and mammals. The course specifically details the types and functions of the placenta in mammals and the basic principles of how primary organs begin to differentiate. |
| CO6 | **Embryonic Induction and Pattern Formation**<br>**Course outcome** Describe the role of organizers and cell-to-cell signaling in development.<br>**Course detail** This involves the study of Spemann's Primary Organizer and the concept of embryonic induction. Students will learn how specific groups of cells influence the developmental fate of neighboring cells through chemical signaling to establish the vertebrate body plan. |
| CO7 | **Applied Developmental Biology and Modern Techniques**<br>**Course outcome** Evaluate the applications of developmental biology in medicine and research.<br>**Course detail** Students will gain insight into modern reproductive technologies, including In-Vitro Fertilization (IVF), the biology of Stem Cells (totipotency vs. Pluripotency), and the ethical considerations of cloning and regenerative medicine. |

# Course Outcomes

## B. Sc. II-SEM-III

## Course Name: Cytology & Developmental Biology of Vertebrates (Practical)

By the end of the practical course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Proficiency in Microscopy and Basic Cytological Techniques** |
| | **Course outcome** Operate various types of microscopes and prepare temporary mounts of animal cells.<br>**Course detail** Students will learn the principles, handling, and maintenance of simple and compound microscopes. They will develop skills in preparing temporary stained slides of buccal epithelial cells and striated muscle cells to observe basic cellular architecture. |
| CO2 | **Visualization of Cell Division (Mitosis and Meiosis)** |
| | **Course outcome** Identify and illustrate the different stages of cell division through squash preparations.<br>**Course detail** Students will perform the onion root tip squash technique to study the various phases of mitosis (Prophase, Metaphase, Anaphase, and Telophase). They will also examine permanent slides of grasshopper testis or other tissues to understand the stages of meiosis and the significance of chromosomal reduction. |
| CO3 | **Histochemical Analysis of Biomolecules** |
| | **Course outcome** Apply specific staining techniques to identify chemical constituents within cells.<br>**Course detail** This outcome involves performing Histochemical tests such as the Feulgen reaction for DNA identification and Mercuric Bromophenol Blue for proteins. Students will understand how specific dyes bind to cellular components, enabling the visualization of genetic material and metabolic products. |
| CO4 | **Identification of Gametogenesis and Reproductive Tissues** |
| | **Course outcome** Examine and differentiate the histological structure of vertebrate reproductive organs.<br>**Course detail** Through the study of permanent histological sections of the testis and ovary of mammals (e.g., rat or rabbit), students will identify various stages of spermatogenesis (spermatogonia to mature sperm) and oogenesis (primordial to Graafian follicles). |
| CO5 | **Comparative Study of Vertebrate Embryogenesis** |
| | **Course outcome** Recognize the developmental stages of different vertebrate models through slides and specimens.<br>**Course detail** Students will identify the early developmental stages (cleavage, blastula, and gastrula) of frogs and fish. They will also study the different types of vertebrate eggs (microlecithal, mesolecithal, and microlecithal) to understand how yolk content influences development. |
| CO6 | **Mastery of Chick Embryology** |
| | **Course outcome** Analyze the temporal progression of development in avian embryos.<br>**Course detail** Using whole mounts and sections, students will study chick embryos at various hours of incubation (e.g., 24h, 48h, 72h, and 96h). They will learn to identify key structures like the primitive streak, somites, heart tubes, and the development of the brain and eye vesicles. |
| CO7 | **Study of Extra-embryonic Membranes and Placentation** |
| | **Course outcome** Describe the morphology and function of support systems in vertebrate development.<br>**Course detail** Students will examine the extra-embryonic membranes (Amnion, Chorion, Allantois, and Yolk Sac) in chick embryos and the different histological types of mammalian placentae (Epitheliochorial, Haemochorial, etc.) to understand how embryos are nourished and protected. |

# Course Outcomes

## B. Sc. II-SEM-III

## Course Name: IKS-Amazing World of Animals and Scope in Zoology (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Foundation of Indian Knowledge System (IKS) in Zoology**<br>**Course outcome:** Understand the historical significance and unique classification methods of animals in ancient Indian traditions.<br>**Course detail:** Students will explore the fundamental concepts of IKS, including the classification of animals as seen in ancient Vedic and post-Vedic literature. They will learn about the Indian philosophical perspectives of *Ahimsa* (non-violence) and *Dharma* in the context of human-animal relationships and traditional ecological ethics. |
| CO2 | **Ancient Animal Husbandry and Veterinary Sciences**<br>**Course outcome:** Analyze the history and practices of animal care and veterinary medicine in ancient India.<br>**Course detail:** This outcome focuses on the traditional history of animal keeping and the evolution of veterinary sciences (e.g., *Ashvashastra* for horses and *Gajashastra* for elephants). Students will gain insights into ancient surgical and medicinal treatments for animals that existed long before modern veterinary science. |
| CO3 | **Indian Faunal Diversity and Geographical Isolation**<br>**Course outcome:** Appreciate the unique biological heritage and faunal diversity of the Indian subcontinent.<br>**Course detail:** Students will study the splendid geographical isolation of India and how it contributed to the evolution of unique faunal diversity. The course details the distribution of endemic Indian species and the traditional ways in which local communities identified and preserved these animals. |
| CO4 | **Animals in Indian Literature and Culture**<br>**Course outcome:** Evaluate the cultural and ethical significance of animals as portrayed in ancient Indian fables and arts.<br>**Course detail:** This involves the study of animal-centric ancient texts such as the *Panchatantra* and *Hitopadesha*. Students will analyze how these fables use animal behavior to teach moral values and how traditional arts and festivals highlight the cultural significance and protection of various species. |
| CO5 | **Modern Scope and Career Avenues in Zoology**<br>**Course outcome:** Identify the professional opportunities and diverse fields of specialization within the discipline of Zoology.<br>**Course detail:** Students will explore the modern "Scope of Zoology," including career paths in research, wildlife conservation, forensic zoology, animal husbandry, and entrepreneurship in fields like sericulture, apiculture, and aquaculture. This outcome prepares students to align their interests with national development goals. |
| CO6 | **Integration of Traditional Wisdom with Modern Research**<br>**Course outcome:** Synthesize traditional ecological knowledge (TEK) with modern conservation biology and research.<br>**Course detail:** Students will learn how to integrate indigenous wisdom with modern zoological concepts to solve contemporary environmental issues. This includes studying case studies where traditional conservation practices (like sacred groves or community-led protection) have effectively preserved biodiversity. |
| CO7 | **Professional Ethics and Scientific Temper**<br>**Course outcome:** Develop a scientific temper while maintaining a value-based ethical approach toward animal life.<br>**Course detail:** This outcome focuses on the ethical treatment of animals in laboratories and the field. By combining modern bio-ethics with the IKS concept of "interconnectedness," students are encouraged to conduct research that is both scientifically rigorous and ethically sound. |

# Course Outcomes

## B. Sc. II-SEM-III

## Course Name: Forensic Zoology (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Introduction to Forensic Science and Zoology**<br>**Course outcome:** Understand the fundamental principles of forensic science and the specific role of a zoologist in criminal investigations.<br>**Course detail:** Students will learn the history and scope of forensic zoology, the different types of biological evidence, and how zoological knowledge is applied to solve crimes involving both humans and animals. |
| CO2 | **Forensic Entomology and Time of Death**<br>**Course outcome:** Apply the knowledge of insect life cycles to estimate the Post-Mortem Interval (PMI).<br>**Course detail:** This outcome covers the study of carrion insects (like blowflies and beetles) that colonize a corpse. Students will learn how environmental factors affect insect succession and how to use this data to determine the time since death in legal cases. |
| CO3 | **Wildlife Forensics and Conservation Laws**<br>**Course outcome:** Identify illegal wildlife trade practices and understand the legal framework for animal protection.<br>**Course detail:** Students will study the identification of poached animal parts (ivory, skins, horns, bones). The course details the **Wildlife Protection Act (1972)** and CITES, training students to assist in the prosecution of wildlife traffickers and poachers. |
| CO4 | **Microscopic Analysis of Hair and Fibers**<br>**Course outcome:** Differentiate between species based on the microscopic examination of hair, fur, and feathers.<br>**Course detail:** Students will learn to analyze the medullary index, cuticle patterns, and pigment distribution in animal hair. This skill is crucial for identifying animal species present at a crime scene or validating the authenticity of commercial animal products. |
| CO5 | **Forensic DNA Profiling and Genetics**<br>**Course outcome:** Explain the molecular techniques used for species identification and individualization.<br>**Course detail:** This outcome focuses on the application of DNA barcoding, PCR (Polymerase Chain Reaction), and mitochondrial DNA analysis. Students will understand how genetic markers are used to identify species from highly processed or degraded biological samples. |
| CO6 | **Forensic Osteology and Odontology**<br>**Course outcome:** Analyze skeletal and dental remains to determine species, age, and cause of death.<br>**Course detail:** Students will study comparative Osteology to distinguish between human and animal bones. They will also learn how dental remains (Odontology) can be used to identify species and provide clues about the nutritional history or age of the animal/individual. |
| CO7 | **Evidence Collection and Crime Scene Management**<br>**Course outcome:** Demonstrate the proper protocols for the collection, preservation, and documentation of biological evidence.<br>**Course detail:** This outcome prepares students for field-work, focusing on maintaining the "Chain of Custody," preventing sample contamination, and the ethical responsibilities of serving as an expert witness in a court of law. |

# Course Outcomes

## B. Sc. II-SEM-III

## Course Name: Forensic Zoology (Practical)

By the end of the practical course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Microscopic Analysis of Animal Integument**<br>**Course outcome:** Identify and differentiate species based on the microscopic examination of hair, fur, and feathers.<br>**Course detail:** Students will learn to prepare temporary mounts of hair samples from various animals (e.g., dog, cat, human, cattle). They will analyze the medullary index, cuticle scales, and cortical pigments to identify the species of origin, which is a vital skill for trace evidence analysis. |
| CO2 | **Practical Forensic Entomology**<br>**Course outcome:** Collect and identify necrophagous insects to estimate the Post-Mortem Interval (PMI).<br>**Course detail:** Students will perform the collection and preservation of maggots, pupae, and adult flies from simulated carrion. They will use taxonomic keys to identify forensically important insects (like Blowflies and Flesh flies) and calculate the age of larvae to determine the time since death. |
| CO3 | **Comparative Osteology and Bone Identification**<br>**Course outcome:** Distinguish between human and non-human skeletal remains through morphological observation.<br>**Course detail:** Through the study of skeletal models and specimens, students will identify key diagnostic features of skulls, vertebrae, and long bones. They will learn to determine the species, approximate age, and sex from skeletal remains found at a crime scene. |
| CO4 | **Forensic Serology and Blood Analysis**<br>**Course outcome:** Conduct presumptive and confirmatory tests to identify biological fluids and their origin.<br>**Course detail:** Students will perform biochemical tests (such as the Kastle-Meyer test or Benzidine test) to detect the presence of blood. They will also learn techniques to differentiate between human and animal blood using species-specific precipitin tests or microscopic erythrocyte morphology. |
| CO5 | **Identification of Wildlife Contraband**<br>**Course outcome:** Identify illegal wildlife products and poached materials using morphological and chemical clues.<br>**Course detail:** This practical involves the study of simulated poached items such as ivory, tiger claws, rhino horns, snake skins, and turtle shells. Students will learn the physical characteristics used by forensic experts to authenticate these materials and distinguish them from fakes. |
| CO6 | **Molecular Forensic Techniques**<br>**Course outcome:** Demonstrate the process of DNA extraction and visualization for species identification.<br>**Course detail:** Students will practice the isolation of genomic DNA from animal tissues (like liver or muscle). They will learn the principles of Agarose Gel Electrophoresis to visualize DNA fragments, providing a foundation for advanced DNA barcoding used in modern forensic labs. |
| CO7 | **Crime Scene Management and Documentation**<br>**Course outcome:** Execute the standard protocols for the collection, packaging, and preservation of biological evidence.<br>**Course detail:** In a simulated crime scene environment, students will learn the "Chain of Custody" procedure. This includes proper labeling, preventing cross-contamination, and using the correct preservatives for biological samples (like ethanol for insects or dry packaging for hair) to ensure evidence is admissible in court. |

# Course Outcomes

## B. Sc. II-SEM-III

## Course Name: GOEC-5 Ornithology Insights (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Evolutionary History and Taxonomy of Birds**<br>**Course outcome:** Trace the origin of birds and classify them based on their Phylogenetic relationships.<br>**Course detail:** Students will explore the evolutionary transition from theropod dinosaurs to modern birds, focusing on the significance of *Archaeopteryx*. They will also learn the principles of avian classification and the distinguishing characteristics of major bird orders and families, with a specific focus on common Indian species. |
| CO2 | **Avian Morphology and Adaptations for Flight**<br>**Course outcome;** Analyze the structural and anatomical modifications that enable birds to master aerial environments.<br>**Course detail** This outcome covers the study of feather types and functions, skeletal adaptations (such as pneumatic bones and the keel), and the mechanics of flight. Students will also examine how beak shapes and foot structures have adapted to different feeding habits and habitats. |
| CO3 | **Physiological Systems and Bioenergetics**<br>**Course outcome:** Understand the specialized internal systems that support the high metabolic demands of birds.<br>**Course detail** Students will study the unique avian respiratory system (including air sacs), the efficient four-chambered heart, and the digestive system modified for diverse diets. The course also explains endothermy (warm-bloodedness) and how birds regulate body temperature in extreme environments. |
| CO4 | **Ethology, Communication, and Migration**<br>**Course outcome:** Examine the complex behaviors, social structures, and migratory patterns of birds.<br>**Course detail:** This involves the study of bird songs and calls, courtship displays, and social hierarchies. A significant portion is dedicated to avian migration—understanding why birds migrate, the flyways they use, and the navigational cues (like magnetic fields and stars) they employ for long-distance travel. |
| CO5 | **Reproductive Biology and Life Cycles**<br>**Course outcome:** Explain the strategies involved in avian breeding, nesting, and the development of young.<br>**Course detail:** Students will learn about different types of nests, the structure and chemistry of the avian egg, and incubation behaviors. The outcome also details the differences between altricial and precocial young and the various levels of parental care observed across different species. |
| CO6 | **Conservation Ecology and Avian Threats**<br>**Course outcome:** Evaluate the ecological roles of birds and the human-induced threats facing avian populations.<br>**Course detail:** This outcome focuses on birds as bio-indicators of environmental health. Students will analyze threats such as habitat loss, climate change, and pesticide use (e.g., the Diclofenac crisis in vultures). It also covers conservation strategies, protected areas, and the IUCN status of endangered Indian birds. |
| CO7 | **Bird watching, Citizen Science, and Career Prospects**<br>**Course outcome:** Develop practical skills for bird identification and recognize the professional scope of ornithology.<br>**Course detail:** Students will be introduced to the ethics of bird watching, the use of field guides and binoculars, and the importance of "Citizen Science" platforms like eBird. This outcome also highlights career avenues in wildlife photography, ecotourism, environmental consultancy, and academic research. |

# Course Outcomes

## B. Sc. II-SEM-III

## Course Name: VSC Microtechnique (Practical)

By the end of the practical course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Proficiency in Laboratory Safety and Instrumentation**<br>**Course outcome:** Demonstrate the correct handling of laboratory equipment and adherence to safety protocols.<br>**Course detail:** Students will learn the operational procedures for essential Microtechnique tools, including the microtome, paraffin oven, water bath, and high-precision balances. Emphasis is placed on the safe handling of hazardous chemicals (fixatives and solvents) and the disposal of biological waste as per standard lab safety guidelines. |
| CO2 | **Tissue Fixation and Preservation Techniques**<br>**Course outcome:** Select and apply appropriate fixatives to preserve the structural integrity of biological tissues.<br>**Course detail:** Students will gain hands-on experience in preparing common fixatives like 10% Neutral Buffered Formalin, Bouin's Fluid, and Carnoy's Fluid. They will understand the chemical basis of fixation and how to choose a specific fixative based on the tissue type and the intended downstream staining process. |
| CO3 | **Mastery of the Tissue Processing Cycle**<br>**Course outcome:** Perform the sequential steps of dehydration, clearing, and infiltration for permanent slide preparation.<br>**Course detail** This outcome focuses on the "ascending grade" alcohol series for dehydration and the use of clearing agents like Xylene or Toluene. Students will learn the importance of timing in each step to prevent tissue shrinkage or hardening, ensuring that the tissue is properly prepared for paraffin wax infiltration. |
| CO4 | **Paraffin Embedding and Block Preparation**<br>**Course outcome:** Create high-quality paraffin blocks using correct tissue orientation.<br>**Course detail:** Students will learn to use embedding stations or L-molds to cast tissue samples into paraffin wax blocks. A critical skill developed here is "orientation"—positioning the tissue (transverse, longitudinal, or oblique) so that the subsequent sections reveal the desired anatomical structures. |
| CO5 | **Precision Sectioning via Microtomy**<br>**Course outcome:** Operate a Rotary Microtome to produce thin, uniform tissue ribbons.<br>**Course detail:** This is the core technical skill of the course. Students will learn to trim blocks, adjust knife angles, and cut sections ranging from 5 to 10 microns in thickness. They will also practice the "floating out" technique using a warm water bath to remove wrinkles from sections before mounting them onto glass slides. |
| CO6 | **Histological Staining and Mounting Procedures**<br>**Course outcome:** Execute staining protocols to differentiate cellular components and prepare permanent mounts.<br>**Course detail:** Students will perform routine staining; specifically the Hematoxylin and Eosin (H&E) protocol, to visualize nuclei and cytoplasm. They will also learn "double staining" and the final step of permanent mounting using DPX or Canada Balsam, ensuring the slides are bubble-free and preserved for long-term study. |
| CO7 | **Quality Control and Troubleshooting**<br>**Course outcome:** Identify and rectify common artifacts and errors in slide preparation.<br>**Course detail:** Students will learn to critically evaluate their own slides for common Microtechnique artifacts such as "chatter," "knife marks," "compression," or "over-staining." They will develop analytical skills to troubleshoot which step in the processing went wrong and how to correct it in future preparations. |

# Course Outcomes

## B. Sc. II-SEM-III

## Course Name: FP in Zoology

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Research Formulation and Planning**<br>**Course outcome:** Develop the ability to identify a relevant zoological problem and design a structured field study.<br>**Course detail:** Students will learn how to conduct a preliminary literature review, formulate a clear hypothesis, and select appropriate field sites. They will design a step-by-step methodology for investigating specific ecological, behavioral, or physiological questions regarding local fauna. |
| CO2 | **Application of Field Techniques**<br>**Course outcome:** Master the use of specialized tools and methods for collecting biological data in various ecosystems.<br>**Course detail:** Students will gain hands-on experience in using field equipment such as GPS, binoculars, quadrats, transects, and collection nets. They will learn various sampling techniques, including point counts for birds, sweep netting for insects, and water quality sampling for aquatic life. |
| CO3 | **Biodiversity Documentation and Taxonomy**<br>**Course outcome:** Identify and document local faunal diversity within a specific geographical area.<br>**Course detail:** Through direct observation and the use of field guides or digital identification apps, students will learn to classify animals in their natural habitats. They will maintain field diaries to record species richness, population abundance, and seasonal variations in diverse environments. |
| CO4 | **Quantitative Data Analysis**<br>**Course outcome:** Organize, analyze, and interpret raw field data using statistical and graphical tools.<br>**Course detail:** Students will learn to compile field observations into structured datasets. They will apply basic statistical tests (such as mean, standard deviation, or diversity indices) and create visual representations like graphs and charts to interpret their findings and draw scientifically valid conclusions. |
| CO5 | **Scientific Reporting and Documentation**<br>**Course outcome:** Communicate research findings through a professionally structured technical report.<br>**Course detail:** Students will learn the standard format of a scientific project report, including an Abstract, Introduction, Materials and Methods, Results, Discussion, and Bibliography. This outcome also includes developing the skills to present findings orally or through poster presentations. |
| CO6 | **Field Ethics and Environmental Stewardship**<br>**Course outcome:** Conduct field studies with high ethical standards and minimal impact on the environment.<br>**Course detail:** Students will be sensitized to the ethical treatment of animals during field observations. They will follow "Leave No Trace" principles, ensuring their presence does not disrupt the ecosystem, cause stress to wildlife, or violate local conservation laws and regulations. |
| CO7 | **Professional Skill Development and Career Readiness**<br>**Course outcome:** Enhance employability through the acquisition of practical, real-world zoological skills.<br>**Course detail:** The field project fosters essential soft skills such as teamwork, leadership, time management, and problem-solving in unpredictable outdoor conditions. These experiences prepare students for careers in wildlife conservation, environmental consultancy, NGO work, and advanced academic research. |

# Course Outcomes

## B. Sc. II-SEM-IV

## Course Name: Fundamental of Genetics (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Principles of Heredity and Mendelian Genetics**<br>**Course outcome:** Develop a comprehensive understanding of the laws of inheritance and the ability to predict phenotypic and genotypic ratios.<br>**Course detail:** Students will study Mendel's experiments, including the concepts of dominance, segregation, and independent assortment. They will learn to apply these principles to solve genetic problems using Punnett squares and probability methods (product and sum rules) to predict outcomes of monohybrid and dihybrid crosses. |
| CO2 | **Extensions of Mendelism and Gene Interactions**<br>**Course outcome:** Analyze complex inheritance patterns that deviate from standard Mendelian ratios due to allelic and non-allelic interactions.<br>**Course detail:** The course covers various gene interactions such as incomplete dominance, co-dominance, and multiple alleles (e.g., ABO blood groups). Students will investigate epistatic interactions (dominant and recessive epistasis), lethal genes, and pleiotropy, learning how these factors modify typical phenotypic expressions in different organisms. |
| CO3 | **Linkage, Crossing Over, and Chromosomal Mapping**<br>**Course outcome:** Gain the ability to explain the physical basis of inheritance and calculate the relative distance between genes on a chromosome.<br>**Course detail:** Students will learn about the chromosome theory of inheritance, the concepts of complete and incomplete linkage, and the mechanism of crossing over. They will practice constructing genetic maps based on recombination frequencies derived from two-point and three-point test crosses to understand gene linear arrangement. |
| CO4 | **Sex Determination and Sex-Linked Inheritance**<br>**Course outcome:** Understand the biological mechanisms that determine sex and the patterns of inheritance for traits located on sex chromosomes.<br>**Course detail:** This unit details various sex-determination systems (XX-XY, ZZ-ZW, and genic Balance theory in Drosophila). Students will analyze the inheritance of X-linked and Y-linked traits, focusing on human conditions like Hemophilia and Color Blindness, and understand the concept of dosage compensation (Barr bodies). |
| CO5 | **Genetic Mutations and Chromosomal Aberrations**<br>**Course outcome:** Identify the causes and consequences of changes in genetic material at the molecular and chromosomal levels.<br>**Course detail:** Students will explore different types of mutations, including point mutations (missense, nonsense, frameshift) and their inducing agents (physical and chemical mutagens). They will also study structural chromosomal changes (deletions, duplications, inversions, translocations) and numerical aberrations like aneuploidy and polyploidy. |
| CO6 | **Human Genetics and Pedigree Analysis**<br>**Course outcome:** Develop the skill to trace hereditary traits through generations and understand the genetic basis of human disorders.<br>**Course detail:** The course introduces the construction and interpretation of human pedigree charts to determine the mode of inheritance (Autosomal/Sex-linked, Dominant/Recessive). Students will learn about the genetic basis of common disorders such as Sickle Cell Anemia, Thalassemia, and Down Syndrome, providing a foundation for genetic counseling. |

# Course Outcomes

## B. Sc. II-SEM-IV

## Course Name: Advanced Genetics (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Molecular Regulation of Gene Expression**<br>**Course outcome:** Analyze the complex regulatory mechanisms that control gene activity in prokaryotic and eukaryotic systems.<br>**Course detail:** Students will study advanced operon models, chromatin remodeling, and the role of enhancers and silencers. They will explore post-transcriptional and translational control mechanisms, including RNA interference (RNAi), gene silencing, and the biological significance of non-coding RNAs in cellular homeostasis. |
| CO2 | **Epigenetics and Genome Plasticity**<br>**Course outcome:** Evaluate how non-genetic factors and environmental stimuli influence hereditary phenotypic changes.<br>**Course detail:** The course covers the molecular basis of epigenetics, focusing on DNA methylation, histone modifications (acetylation and methylation), and genomic imprinting. Students will investigate how these changes contribute to cell differentiation, X-chromosome inactivation, and the development of complex diseases like cancer. |
| CO3 | **Population Genetics and Evolutionary Dynamics**<br>**Course outcome:** Apply mathematical and statistical models to understand the genetic structure and evolution of populations.<br>**Course detail:** Students will master the Hardy-Weinberg Principle and its applications. They will analyze the impact of evolutionary forces such as natural selection, genetic drift (bottleneck and founder effects), mutation pressure, and gene flow on allele frequencies. The course also introduces the concepts of molecular clocks and phylogenetic reconstruction. |
| CO4 | **Quantitative Genetics and Complex Traits**<br>**Course outcome:** Determine the genetic basis of continuous variation and the methods used to map polygenic traits.<br>**Course detail:** This unit focuses on traits controlled by multiple genes (QTLs). Students will learn to calculate heritability (broad and narrow sense), analyze genotype-environment interactions, and understand the statistical methods used in Quantitative Trait Loci (QTL) mapping. Applications in animal breeding and human disease susceptibility will be discussed. |
| CO5 | **Genomics, Proteomics, and Bioinformatics**<br>**Course outcome:** Gain proficiency in the large-scale analysis of genomes and the computational tools used in modern genetic research.<br>**Course detail:** Students will study the transition from structural to functional genomics, including Next-Generation Sequencing (NGS) technologies. They will learn about comparative genomics, the human genome project, and the use of bioinformatics databases (NCBI, Ensembl) for gene annotation, sequence alignment, and protein structure prediction. |
| CO6 | **Recombinant DNA Technology and Genome Editing**<br>**Course outcome:** Design strategies for genetic engineering and evaluate the applications of advanced gene-editing tools.<br>**Course detail:** This course covers the principles of molecular cloning, vector systems, and the creation of transgenic organisms. Students will explore cutting-edge technologies like CRISPR-Cas9, Zinc Finger Nucleases (ZFNs), and TALENs. Discussions will include the therapeutic potential of gene therapy and the ethical, Biosafety, and intellectual property (IPR) issues surrounding GMOs. |

# Course Outcomes

## B. Sc. II-SEM-IV

## Course Name: Fundamental of Genetics & Advanced Genetics (Practical)

By the end of the practical course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Culture and Handling of Model Organisms**<br>**Course outcome:** Develop technical skills in maintaining and manipulating biological models for genetic studies.<br>**Course detail:** Students will learn the preparation of culture media (such as cornmeal agar) and the lifecycle of *Drosophila melanogaster*. They will practice the immobilization and sexing of flies, distinguishing between males and females under a stereomicroscope, which is foundational for performing genetic crosses. |
| CO2 | **Statistical Validation of Genetic Ratios**<br>**Course outcome:** Apply mathematical tools to verify biological inheritance patterns and determine goodness of fit.<br>**Course detail:** Students will solve problems related to Mendelian monohybrid and dihybrid ratios using probability rules. They will learn to apply the Chi-square test to experimental data (derived from fly crosses or maize cobs) to determine if observed phenotypic deviations from expected ratios are statistically significant. |
| CO3 | **Cytological Preparation of Giant Chromosomes**<br>**Course outcome:** Master the micro-dissection and staining techniques required to visualize specialized chromosomal structures.<br>**Course detail:** Students will perform the dissection of salivary glands from *Drosophila* or *Chironomus* larvae. They will learn the "squash" technique and Aceto-orcein staining to observe Polytene chromosomes, identifying specific features like "bands," "inter-bands," and "puffs" which represent active gene transcription sites. |
| CO4 | **Study of Human Morphogenetic Traits**<br>**Course outcome:** Gain the ability to identify and document the distribution of heritable phenotypic variations in human populations.<br>**Course detail:** Students will conduct a survey of various Mendelian traits in humans, such as PTC (Phenylthiocarbamide) tasting ability, earlobe attachment, tongue rolling, and widow's peak. They will record data, calculate trait frequencies, and understand the concept of dominant vs. recessive expression in a real-world context. |
| CO5 | **Clinical Cytogenetics and Karyotyping**<br>**Course outcome:** Develop the ability to analyze chromosomal constitutions and identify clinical abnormalities.<br>**Course detail:** Students will practice the arrangement of homologous chromosomes into idiograms. They will analyze human karyotypes (from photographs or digital tools) to identify numerical aberrations such as Trisomy 21 (Down Syndrome), XO (Turner Syndrome), and XXY (Klinefelter Syndrome), as well as structural changes like deletions or translocations. |
| CO6 | **Advanced Pedigree Construction and Analysis**<br>**Course outcome:** Master the skill of tracing hereditary disorders through family lineages using standardized nomenclature.<br>**Course detail:** Students will be provided with clinical case histories to construct multi-generational pedigree charts. They will apply logic to determine the mode of inheritance— |

| | |
|---|---|
| | whether Autosomal Dominant, Autosomal Recessive, X-linked, or Y-linked—and calculate the probability of risk for future generations. |
| **CO7** | **Molecular Genomic Techniques**<br>**Course outcome:** Acquire hands-on experience in the extraction and qualitative analysis of genetic material.<br>**Course detail:** Students will perform the isolation of genomic DNA from biological samples (such as goat liver, plant tissue, or human blood/saliva) using the phenol-chloroform method or kit-based methods. They will learn to perform Agarose Gel Electrophoresis (AGE) to visualize DNA and assess its integrity and concentration. |
| **CO8** | **Population Genetics and Bioinformatics Tools**<br>**Course outcome:** Utilize computational and mathematical models to analyze genetic diversity and sequence data.<br>**Course detail:** Students will solve advanced problems based on the Hardy-Weinberg equilibrium, including cases with multiple alleles and selection pressure. They will also be introduced to bioinformatics databases (NCBI-GenBank) to perform BLAST (Basic Local Alignment Search Tool) for sequence comparison and phylogenetic analysis. |
| **CO9** | **Permanent Slide Preparation of Meiotic Stages**<br>**Course outcome:** Demonstrate proficiency in preparing high-quality cytological slides to study gametogenesis.<br>**Course detail:** Students will use floral buds (onion/lily) or grasshopper testes to prepare squash mounts. They will focus on identifying the sub-stages of Prophase-I (Leptotene, Zygotene, Pachytene, Diplotene, and Diakinesis) to observe chiasmata formation and the physical basis of genetic recombination. |

# Course Outcomes

## B. Sc. II-SEM-IV

## Course Name: Fundamental of Ecology (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Principles of Ecosystem Structure**<br>**Course outcome:** Develop a fundamental understanding of the biosphere and the complex interactions between biotic and abiotic components.<br>**Course detail:** Students will study the hierarchy of ecological organization and the influence of limiting factors (Liebig's Law and Shelford's Law). They will analyze how physical factors such as light, temperature, water, and soil characteristics shape the distribution and adaptations of living organisms in various habitats. |
| CO2 | **Population Dynamics and Regulation**<br>**Course outcome:** Analyze the characteristics of biological populations and the mathematical models that describe their growth and fluctuations.<br>**Course detail:** The course covers population parameters including density, natality, mortality, and age structure. Students will explore exponential and logistic growth curves, life tables, and survivorship curves. They will also investigate r and K selection strategies and the mechanisms of population regulation through density-dependent and density-independent factors. |
| CO3 | **Community Organization and Species Interactions**<br>**Course outcome:** Evaluate the structural attributes of biological communities and the nature of relationships between different species.<br>**Course detail:** Students will learn about community characteristics such as species richness, dominance, and diversity indices. The unit details interspecific interactions including competition, predation, parasitism, mutualism, and commensalism. Additionally, students will study the process of ecological succession, from pioneer stages to the climax community. |
| CO4 | **Ecosystem Energetics and Biogeochemical Cycles**<br>**Course outcome:** Understand the flow of energy and the recycling of essential nutrients within various ecosystems.<br>**Course detail:** Students will investigate trophic levels, food chains, and complex food webs. They will apply the Laws of Thermodynamics to ecological productivity (primary and secondary) and ecological pyramids. The course also tracks the movement of matter through carbon, nitrogen, and phosphorus cycles, highlighting the link between the organic and inorganic worlds. |
| CO5 | **Applied Ecology and Environmental Challenges**<br>**Course outcome:** Identify human-induced environmental impacts and evaluate strategies for sustainable management and conservation.<br>**Course detail:** This unit focuses on contemporary issues such as habitat fragmentation, pollution, and global climate change. Students will explore the principles of wildlife conservation (In-situ and Ex-situ), the importance of biodiversity hotspots, and the concept of sustainable development in the context of maintaining ecological balance. |
| CO6 | **Zoogeography and Faunal Distribution**<br>**Course outcome:** Gain insights into the geographic distribution of animals and the factors contributing to faunal diversity across different realms.<br>**Course detail:** Students will study the characteristics of the major terrestrial biomes and the zoogeographical realms of the world (e.g., Oriental, Ethiopian, Neotropical). They will learn about the barriers to dispersal, the theory of island biogeography, and the unique faunal compositions that define different regions of the Earth. |

# Course Outcomes

## B. Sc. II-SEM-IV

## Course Name: Fundamental of Ecology (Practical)

By the end of the practical course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Research Formulation and Planning**<br>**Course outcome:** Develop the ability to identify a relevant ecological problem and design a structured field study.<br>**Course detail:** Students will learn how to conduct a preliminary literature review regarding local ecosystems, formulate a clear hypothesis about environmental interactions, and select appropriate field sites. They will design a step-by-step methodology for investigating specific ecological questions regarding local fauna and their habitats. |
| CO2 | **Analysis of Physicochemical Abiotic Factors**<br>**Course outcome:** Gain proficiency in using analytical tools to measure and interpret the physical and chemical parameters of ecosystems.<br>**Course detail:** Students will perform practical tests to determine soil and water quality. This includes measuring pH, temperature, and turbidity, as well as chemical analysis for dissolved oxygen (Winkler's method), free carbon dioxide, and alkalinity in water samples to understand how these factors limit biological life. |
| CO3 | **Quantitative Analysis of Populations and Communities**<br>**Course outcome:** Master sampling techniques to estimate the density, frequency, and abundance of species in a given area.<br>**Course detail:** Students will apply the Quadrat and Line Transect methods to sample local plant or animal communities. They will learn to calculate the Importance Value Index (IVI) and use statistical tools to determine the Shannon-Wiener Diversity Index, providing a quantitative measure of ecosystem health and species richness. |
| CO4 | **Study of Adaptive Morphological Variations**<br>**Course outcome:** Develop the skill to correlate morphological and anatomical features of animals with their specific ecological niches.<br>**Course detail:** Through the examination of museum specimens and live observations, students will document adaptations for various environments. This includes studying aquatic adaptations (streamlining, fins), xeric/desert adaptations (water conservation features), and fossorial or volant adaptations to understand how selection pressures shape animal form. |
| CO5 | **Estimation of Ecosystem Productivity**<br>**Course outcome:** Apply experimental methods to quantify the energy fixation and oxygen production of a community.<br>**Course detail:** Students will perform experiments such as the "Light and Dark Bottle" method to estimate Primary Productivity in an aquatic ecosystem. They will learn to calculate Gross Primary Productivity (GPP) and Net Primary Productivity (NPP), providing insight into the energy budget of the ecosystem. |
| CO6 | **Field Documentation and Environmental Reporting**<br>**Course outcome:** Acquire skills in systematic field observation and the preparation of comprehensive ecological reports.<br>**Course detail:** Students will undertake a field visit to a local natural habitat (such as a wetland, forest, or grassland). They will practice identifying local fauna in situ, documenting trophic interactions (food webs), and recording human impacts on the site. The final outcome is a structured field report that synthesizes observations with ecological theory. |

# Course Outcomes

## B. Sc. II-SEM-IV

## Course Name: Ophidiology and Arachnology (Theory)

By the end of this course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Taxonomy and Evolutionary Diversity**<br>**Course outcome:** Develop the ability to identify and classify major lineages of snakes and arachnids based on morphological and phylogenetic characteristics.<br>**Course detail:** Students will study the evolutionary history and classification of Order Squamata (Suborder Serpentes) and Class Arachnida (Orders Araneae, Scorpiones, Acari). They will learn to use taxonomic keys to distinguish between venomous and non-venomous snakes and identify diverse arachnid families based on eye patterns, appendage modification, and body segmentation. |
| CO2 | **Specialized Anatomy and Physiology**<br>**Course outcome:** Understand the unique structural adaptations that allow snakes and arachnids to thrive in diverse ecological niches.<br>**Course detail:** The course covers the functional anatomy of the ophidian skeletal system (skull kinesis), the respiratory system, and specialized sensory organs like the Jacobson's organ and pit organs. For arachnids, students will investigate the anatomy of book lungs, Malpighian tubules, and the complex silk-spinning apparatus (spinnerets) in spiders. |
| CO3 | **Venom Biology and Toxinology**<br>**Course outcome:** Analyze the biochemical composition of venoms and the physiological mechanisms of toxin action in prey and humans.<br>**Course detail:** Students will explore the evolution of the venom delivery apparatus (fangs and stingers). They will study the proteomic diversity of venoms, distinguishing between neurotoxic, hemotoxic, and cytotoxic effects. The unit also covers the principles of antivenom production, the "Big Four" venomous snakes of India, and the medical management of snakebites and scorpion stings. |
| CO4 | **Ethology and Reproductive Strategies**<br>**Course outcome:** Evaluate the complex behavioral patterns related to foraging, defense, and reproduction in these specialized groups.<br>**Course detail:** This unit explores various hunting strategies such as ambush vs. active foraging and the use of silk in arachnids for prey capture. Students will study reproductive behaviors, including courtship dances in scorpions and spiders, oviparous vs. viviparous modes in snakes, and various levels of parental care observed in both groups. |
| CO5 | **Ecological Roles and Conservation Biology**<br>**Course outcome:** Assess the importance of snakes and arachnids in ecosystem stability and design conservation strategies for threatened species.<br>**Course detail:** Students will investigate the role of these predators as biological pest controllers in agricultural landscapes. The course addresses major threats including habitat loss, the illegal wildlife trade, and "ophidiophobia" (fear of snakes). Students will learn about the legal protections under the Wildlife Protection Act and the role of ex-situ conservation in serpentariums and arachnariums. |
| CO6 | **Applied Arachnology and Biotechnological Potential**<br>**Course outcome:** Explore the industrial and medical applications of arachnid products and snake venom components.<br>**Course detail:** Students will learn about the properties of spider silk as a biomaterial for textile and medical industries. The course also highlights the use of venom peptides in developing new drugs for pain management, hypertension, and cancer. Students will evaluate the economic potential of sustainable venom milking and the role of mites and ticks in veterinary and human medicine. |

# Course Outcomes

## B. Sc. II-SEM-IV

## Course Name: VSC (Practical)

By the end of the practical course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Research Formulation and Planning**<br>**Course outcome:** Develop the ability to identify a relevant genetic problem and design a structured laboratory or simulation-based study.<br>**Course detail:** Students will learn how to conduct a preliminary literature review on model organisms and hereditary disorders, formulate a clear hypothesis regarding inheritance patterns, and select appropriate experimental protocols. They will design a step-by-step methodology for investigating specific genetic questions, ranging from classical Mendelian crosses to modern molecular diagnostics. |
| CO2 | **Model Organism Handling and Phenotypic Characterization**<br>**Course outcome:** Develop proficiency in identifying genetic variations and managing biological models for research.<br>**Course detail:** Students will gain hands-on experience with *Drosophila melanogaster*, learning to differentiate between wild-type and various mutants (eye color, wing shape, and body color). They will master the skill of sexing flies and utilize ICT tools for virtual mounting and observation, providing a foundation for understanding how mutations manifest physically in a laboratory setting. |
| CO3 | **Human Pedigree Reconstruction and Linkage Analysis**<br>**Course outcome:** Master the ability to trace and interpret the transmission of hereditary traits through multiple generations.<br>**Course detail:** Students will learn the standardized symbols and nomenclature used in medical genetics to draw family trees. They will perform pedigree analysis to identify and interpret different modes of inheritance, including autosomal dominant, autosomal recessive, and X-linked traits, enabling them to predict the probability of trait recurrence in future generations. |
| CO4 | **Clinical Cytogenetics and Chromosomal Assessment**<br>**Course outcome:** Acquire the technical skills to visualize sex chromatin and analyze chromosomal constitutions for clinical diagnosis.<br>**Course detail:** This unit involves the preparation of buccal smears to demonstrate Barr bodies (sex chromatin) for sex determination. Students will also perform karyotyping using printed photomicrographs to identify homologous chromosomes and detect numerical abnormalities such as Down's (Trisomy 21), Turner's (XO), and Klinefelter's (XXY) syndromes, bridging the gap between cytology and clinical health. |
| CO5 | **Molecular Extraction and Genomic Amplification Techniques**<br>**Course outcome:** Demonstrate proficiency in the isolation of genetic material and understand the principles of modern DNA amplification.<br>**Course detail:** Students will perform the laboratory procedure for DNA extraction from plant (onion/spinach) or animal (saliva/cheek cells) sources. They will be introduced to the workflow of Polymerase Chain Reaction (PCR) and Gel Electrophoresis through demonstrations or virtual simulations, learning how specific DNA fragments are amplified and visualized based on their molecular weight. |
| CO6 | **Quantitative Genetics and Complex Gene Interactions**<br>**Course outcome:** Develop advanced problem-solving skills to analyze non-Mendelian inheritance and epistatic interactions.<br>**Course detail:** Students will master the mathematical and statistical approaches required to solve complex genetic problems. They will analyze various types of epistasis, including complementary, duplicate, and dominant gene interactions, to understand how multiple genes coordinate to determine a single phenotypic trait, moving beyond simple monohybrid and dihybrid ratios. |

# Course Outcomes

## B. Sc. II-SEM-IV

## Course Name: SEC (Practical)

By the end of the practical course, the student will be able to:

| CO No. | Title of CO |
|---|---|
| CO1 | **Research Formulation and Planning**<br>**Course outcome:** Develop the ability to identify a relevant ichthyological problem and design a structured field or laboratory study.<br>**Course detail:** Students will learn how to conduct a preliminary literature review on local fish diversity, formulate a clear hypothesis regarding fish distribution or health, and select appropriate sampling sites. They will design a step-by-step methodology for investigating specific ecological, behavioral, or physiological questions regarding local aquatic fauna. |
| CO2 | **Taxonomic Identification and Morphological Characterization**<br>**Course outcome:** Master the use of taxonomic keys and external traits to classify and identify diverse fish species.<br>**Course detail:** Students will perform detailed studies of external morphology, including body shapes, fin types, and coloration patterns. They will use specialized taxonomic keys to identify local and commercially important fishes up to the genus and species level. Additionally, they will study various scale types (placoid, cycloid, ctenoid) to understand their role in both identification and age determination. |
| CO3 | **Anatomical Visualization and ICT-Based Systems Analysis**<br>**Course outcome:** Gain proficiency in analyzing the internal systems and specialized adaptations of fishes using modern digital tools.<br>**Course detail:** Utilizing ICT-based virtual dissection tools, students will observe and document the internal anatomy of fishes, focusing on the digestive, circulatory, and reproductive systems. They will also investigate specialized adaptations such as the swim bladder and the lateral line system to understand how different species maintain buoyancy and perceive their environment. |
| CO4 | **Biometric Analysis and Meristic Quantification**<br>**Course outcome:** Develop technical skills in collecting and analyzing quantitative data for population and stock assessment.<br>**Course detail:** Students will perform morphometric measurements (total length, head length, etc.) and meristic counts (fin rays, scale counts) on various specimens. They will learn to analyze this data statistically to identify variations between species and populations, which is a fundamental skill in fisheries management and evolutionary biology. |
| CO5 | **Physiological Monitoring and Environmental Assessment**<br>**Course outcome:** Acquire the ability to evaluate the relationship between fish health and the physicochemical parameters of their habitat.<br>**Course detail:** This unit involves the practical examination of respiratory structures by mounting and studying gill lamellae under a microscope. Students will also perform water quality analysis, testing for pH, temperature, and dissolved oxygen, to understand how environmental stressors influence fish behavior, physiology, and overall survival. |
| CO6 | **Industrial Exposure, Preservation, and Professional Documentation**<br>**Course outcome:** Evaluate the practical aspects of fisheries management, specimen preservation, and commercial marketing.<br>**Course detail:** Students will learn standardized wet and dry preservation techniques and labeling practices for maintaining a museum collection. Through field visits to fish markets and hatcheries, they will gain exposure to the economic aspects of ichthyology, including breeding protocols and market chains. The final outcome is the preparation of a comprehensive field report documenting observations on fish reproduction, behavior, and industry practices. |

# Course Outcomes

## B. Sc. II-SEM-IV

## Course Name: Field Project (Practical)

| CO No. | Title of CO |
|---|---|
| CO1 | **Research Formulation and Planning**<br>**Course outcome:** Develop the ability to identify a relevant zoological problem and design a structured field study.<br>**Course detail:** Students will learn how to conduct a preliminary literature review, formulate a clear hypothesis, and select appropriate field sites. They will design a step-by-step methodology for investigating specific ecological, behavioral, or physiological questions regarding local fauna. |
| CO2 | **Application of Field Techniques**<br>**Course outcome:** Master the use of specialized tools and methods for collecting biological data in various ecosystems.<br>**Course detail:** Students will gain hands-on experience in using field equipment such as GPS, binoculars, quadrats, transects, and collection nets. They will learn various sampling techniques, including point counts for birds, sweep netting for insects, and water quality sampling for aquatic life. |
| CO3 | **Biodiversity Documentation and Taxonomy**<br>**Course outcome:** Identify and document local faunal diversity within a specific geographical area.<br>**Course detail:** Through direct observation and the use of field guides or digital identification apps, students will learn to classify animals in their natural habitats. They will maintain field diaries to record species richness, population abundance, and seasonal variations in diverse environments. |
| CO4 | **Quantitative Data Analysis**<br>**Course outcome:** Organize, analyze, and interpret raw field data using statistical and graphical tools.<br>**Course detail:** Students will learn to compile field observations into structured datasets. They will apply basic statistical tests (such as mean, standard deviation, or diversity indices) and create visual representations like graphs and charts to interpret their findings and draw scientifically valid conclusions. |
| CO5 | **Scientific Reporting and Documentation**<br>**Course outcome:** Communicate research findings through a professionally structured technical report.<br>**Course detail:** Students will learn the standard format of a scientific project report, including an Abstract, Introduction, Materials and Methods, Results, Discussion, and Bibliography. This outcome also includes developing the skills to present findings orally or through poster presentations. |
| CO6 | **Field Ethics and Environmental Stewardship**<br>**Course outcome:** Conduct field studies with high ethical standards and minimal impact on the environment.<br>**Course detail:** Students will be sensitized to the ethical treatment of animals during field observations. They will follow "Leave No Trace" principles, ensuring their presence does not disrupt the ecosystem, cause stress to wildlife, or violate local conservation laws and regulations. |
| CO7 | **Professional Skill Development and Career Readiness**<br>**Course outcome:** Enhance employability through the acquisition of practical, real-world zoological skills.<br>**Course detail:** The field project fosters essential soft skills such as teamwork, leadership, time management, and problem-solving in unpredictable outdoor conditions. These experiences prepare students for careers in wildlife conservation, environmental consultancy, NGO work, and advanced academic research. |