

DEPARTMENT OF ZOOLOGY

Programme Outcomes (POs), Course Outcomes (COs) & PO-CO MAPPING from SEMESTER 1 TO SEMESTER 7(4-Year Honors / Research Track)

Under the **National Education Policy (NEP) Curriculum and Credit Framework for Undergraduate Programmes (CCF)** and **UGC guidelines**, a 4-Year B.Sc. (Major) in Zoology is structured across 8 semesters.

Aligned with NEP 2020, under the **University of Calcutta's Curriculum and Credit Framework for Undergraduate Programmes (CCF)**, the 4-year B.Sc. (Major) in Zoology is structured across 8 semesters. The **Programme Outcomes (POs)** build progressively—from core cellular, systematic, and anatomical foundations in early semesters, to molecular biology, ecological conservation, skill enrichment, and advanced research methodologies in the final semesters.

Curriculum and Credit Framework for Undergraduate Programmes aligned with NEP 2020, the **Course Outcomes (COs)** reflect specific knowledge and practical abilities gained upon completing the major core courses, skill enhancement courses, and dissertation components across Semesters 1 to 8.

Overarching Programme Outcomes (POs)

Upon completing the 8-semester B.Sc. Major in Zoology, graduates will demonstrate:

Semester 1

(4-Year Honors / Research Track)

DSCC-1 / Core Course 1: Cell Biology

Course Outcome:COs:

CO1: Comprehend Cellular Architecture, Organelles, and Membrane Dynamics: Explain the structural organization and physiological functions of eukaryotic sub-cellular organelles, alongside the fluid mosaic model, transport mechanisms (active, passive, vesicular), and membrane potential across biological membranes.

CO2: Analyze Cytoskeletal Networks, Extracellular Matrix, and Junctions: Critically evaluate the structural assembly and dynamic roles of microfilaments, microtubules, and intermediate filaments in cell motility, shape, organelle transport, and cell-to-cell/cell-matrix adhesion systems. Comprehend cytoplasmic organelles: Knowledge of UR of ER, Golgi, Lysosome, Mitochondria, cytoskeleton etc.

CO3: Development of understanding about nucleus, nucleic acids, DNA replication and technical know-how about cell biology.

CO4: Perform micrometry for cell size measurement, conduct cell viability assays (Trypan blue exclusion), and execute Giemsa staining of bone marrow cells

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PO 3. Analytical Reasoning - Use appropriate information with a critical understanding

PO 4. Research Skills - Design and conduct experiments to test a hypothesis, Understand and interpret data to reach a conclusion

PO 5. Teamwork

PO 6. Problem solving

PO 7. Moral and Ethical Awareness - Accept the legal restrictions & ethical considerations placed for animal welfare.

PO 8. Demonstrate competence in handling and statistical analysis of data gained from practical.

PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	√	X
PO 2	√	√	√	√
PO 3	√	√	√	√
PO 4	√	√	√	X
PO 5	√	√	√	√
PO 6	√	√	√	X
PO 7	√	√	√	√
PO 8	√	√	√	√

Semester 1

SEC-1: Applied Entomology

COURSE OUTCOMES:COs:

CO1:Comprehend Insect Biology and Morphological Diversity: Explain the structural organization, head/antennae variants, thoracic appendages, and physiological adaptations across major insect orders (Orthoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera, Hymenoptera)

CO2: Analyze Vectors of Public Health Significance and Disease Transmission: Evaluate the biology, life cycles, mode of disease transmission, and control measures of key insect vectors, including mosquitoes (*Anopheles*, *Aedes*, *Culex*), sandflies (*Phlebotomus*), and ticks/mites responsible for diseases like malaria, dengue, filariasis, and leishmaniasis.

CO3: Assess Agricultural Pests and Integrated Pest Management (IPM): Identify major agricultural and stored-grain pests (*Scirpophaga incertulus*, *Leucinodes orbonalis*, *Sitophilus oryzae*),

analyze their nature of damage, determine Economic Injury Level (EIL) and Economic Threshold Level (ETL), and evaluate biological, chemical, and IPM strategies.

CO4: Development of knowledge, control of diseases and prospects about sericulture, apiculture.

CO5: **Apply Sericulture, Apiculture, and Entomological Diagnostic Techniques:** Demonstrate practical skills in silkworm rearing (*Bombyx mori*), honeybee caste identification (*Apis* sp.), modern hive management (Newton Box), temporary mouthpart/antennae slide preparations, and insect pest collection, preservation, and identification protocols.

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PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4	CO5
PO 1	√	X	X	√	√
PO 2	√	√	√	√	X
PO 3	√	√	√	√	√
PO 4	√	√	√	√	X
PO 5	√	√	√	√	√
PO 6	√	X	√	√	X
PO 7	X	X	√	√	√
PO 8	X	X	X	√	X

Semester 2

(4-Year Honors / Research Track)

DSCC-2 / Core Course 2: Biochemistry

Course Outcome:COs:

CO1:Comprehend Structural Chemistry of Biomolecules: Demonstrate a comprehensive understanding of the classification, chemical structures, stereochemistry, and physiological significance of key biological macromolecules, including carbohydrates, proteins, lipids, and nucleic acids.

CO2:Analyze Enzyme Kinetics, Catalytic Mechanisms, and Regulation: Critically evaluate the principles of enzyme action, active site dynamics, Michaelis-Menten kinetics (K_m and V_{max} parameters), coenzymes, and modes of enzymatic inhibition (competitive, non-competitive,

CO3: Evaluate Major Metabolic Pathways and Bioenergetics: Assess key catabolic and anabolic pathways (such as glycolysis, the citric acid cycle, β -oxidation of fatty acids, and oxidative phosphorylation), along with the high-energy intermediate exchanges that drive cellular bioenergetics.

CO4:Apply Bio-analytical Estimation and Spectrophotometric Techniques:Develop hands-on laboratory proficiency in buffer preparation, quantitative estimation of carbohydrates, proteins, and lipids using colorimetric/spectrophotometric assays, and qualitative biochemical identification tests.

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PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	√	√
PO 2	√	√	√	√
PO 3	√	√	√	√
PO 4	√	√	√	√
PO 5	√	√	√	√
PO 6	√	√	√	X
PO 7	X	X	√	√
PO 8	X	X	√	√

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Semester 2

SEC-2: Aquaculture

COURSE OUTCOMES: COs:

CO1: Comprehend Principles of Cultivable Species and Fish Biology: Explain the biological characteristics, selection criteria, and economic significance of indigenous and exotic cultivable finfish and shellfish species, alongside basic aquarium maintenance principles.

CO2: Analyze Sustainable Aquaculture Systems and Pond Management: Evaluate extensive, semi-intensive, and intensive culture practices (including raceways, biofloc, cage/pen culture, and sewage-fed fisheries), along with critical water quality dynamics and pond preparation techniques.

CO3: Assess Induced Breeding and Hatchery Management Practices: Assess hypophysation protocols using synthetic hormones, induced breeding mechanisms of Indian Major Carps, and operational strategies for modern finfish hatcheries (such as Chinese and glass jar hatcheries)

CO4: Apply Taxonomic, Meristic, and Field Diagnostic Techniques: Demonstrate practical proficiency in identifying fish species using meristic characters, evaluating market economics through field surveys, and conducting morphometric analyses of economically important aquaculture species.

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PO 1	√	√	√	√
PO 2	√	√	√	√

PO 3	√	√	√	√
PO 4	√	√	√	√
PO 5	√	√	√	√
PO 6	X	√	√	√
PO 7	√	√	√	√
PO 8	X	X	X	

Semester 3

(4-Year Honors / Research Track)

DSCC-3 / Core Course 3: Genetics

Course Outcomes: COs:

CO1: Comprehend Mendelian Inheritance and Chromosomal Basis of Heredity: Demonstrate a clear understanding of Mendelian principles, extensions of Mendelian inheritance (co-dominance, incomplete dominance, multiple alleles, pleiotropy, lethality), gene interactions, and sex-linked, sex-influenced, and sex-limited inheritance patterns.

CO2: Analyze Linkage, Recombination, and Chromosomal Mapping: Critically evaluate the processes of crossing over, linkage analysis, construction of genetic maps using two-point and three-point test crosses, and the mechanisms of chromosomal aberrations (structural and numerical variations).

CO3: Evaluate Molecular Genetics, Gene Regulation, and Mutations: Assess gene structure and fine structure analysis, DNA damage and repair mechanisms, types of gene mutations (spontaneous and induced), and regulatory mechanisms of gene expression in prokaryotes (e.g., *Lac* and *Trp* operons) and eukaryotes.

CO4: Apply Cytogenetic Protocols and Statistical Genetic Tools: Develop practical proficiency in preparing polytene and mitotic/meiotic chromosome squashes, identifying genetic mutants in model organisms (*Drosophila*), and applying Chi-square (χ^2) goodness-of-fit tests to analyze genetic segregation data, chromosomal aberrations and pedigree analysis.

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PO-CO MAPPING

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PO 1	√	√	√	√
PO 2	√	√	√	√
PO 3	√	√	√	√
PO 4	√	√	√	X
PO 5	√	√	√	X
PO 6	√	√	√	√
PO 7	√	√	√	√
PO 8	√	X	X	√

Semester-3

DSCC-4 / Core Course 4: Cells & Tissue Structure

COURSE OUTCOMES: COs:

CO1: Comprehend Structural Organization of Animal Tissues and Histology: Explain the classification, microscopic features, structural characteristics, and physiological roles of fundamental animal tissues, including epithelial, connective (bone, cartilage, ECM), muscular, and nervous tissues.

CO2: Analyze Cell Culture Techniques and Cellular Dynamics: Critically evaluate the principles of primary cell culture, established cell lines, extracellular matrix interaction, cell growth dynamics, and the behavioral parameters distinguishing normal cells from transformed/cancerous cells.

CO3: Evaluate Advanced Cytological and Histochemical Markers: Assess the molecular organization of tissue surfaces, biochemical composition of the extracellular matrix (glycosaminoglycans, collagen types), and the principles of histochemical staining methods used to localize cellular components.

CO4: (Practical): Apply Microtechnique, Histological Staining, and Tissue Assays: Demonstrate practical proficiency in tissue fixation, microtomy, paraffin block sectioning, histological staining (e.g., Hematoxylin-Eosin), and performing cell viability assays (such as Trypan Blue exclusion).

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PO 1	√	√	√	√
PO 2	√	√	√	√
PO 3	√	√	√	√
PO 4	√	√	√	√
PO 5	X	X	√	√
PO 6	√	X	√	√
PO 7	√	X	√	√
PO 8	X	X	X	X

Semester-3

SEC-3: Poultry Farming & Animal Husbandry

COURSE OUTCOMES: COs:

CO1: Comprehend Breeds, Housing Systems, and Animal Management Principles: Explain the breed classification of indigenous and exotic livestock and poultry (broilers and layers), alongside housing systems, environmental regulation, brooding management, and welfare standards.

CO2: Analyze Animal Nutrition, Feed Formulation, and Breeding Strategies: Critically evaluate livestock and poultry nutrient requirements, balanced ration formulation, feed additives, artificial insemination practices, selective breeding principles, and reproductive management.

CO3: Evaluate Disease Dynamics, Bio-security, and Health Management: Assess common viral, bacterial, fungal, and parasitic diseases affecting livestock and poultry (e.g., Ranikhet, Marek's disease, Mastitis), including vaccination schedules, biosecurity protocols, and disease prevention strategies.

CO4: Apply Practical Diagnostic Protocols, Hatchery Operations, and Farm Economics: Demonstrate practical skills in egg candling and grading, feed quality assessment, brooding setup management, vaccination administration techniques, and financial record-keeping for small-scale and commercial livestock ventures. Practical based identification of poultry and cattle breeds and visit farm or animal husbandry to get hands-on experience.

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PO 1	√	√	√	√
PO 2	√	√	√	√
PO 3	√	√	√	√
PO 4	√	√	√	√
PO 5	√	X	X	√
PO 6	√	X	√	√
PO 7	√	X	√	X
PO 8	X	X	X	X

Semester 4**(4-Year Honors / Research Track)****DSCC-5 / Core Course 5: Non-Chordate Structure & Function****COURSE OUTCOMES: COs:**

CO1: Understanding taxonomy and their features of all the non-chordates phyla.

CO2: Trace structural evolutionary trends across invertebrate phyla (asexual reproduction, conjugation, body cavities, canal system, water-vascular system, locomotion, respiration, excretion).

CO3: Development of knowledge about coral reefs & its importance, and type study of *Fasciola hepatica*, *Ascaris lumbricoides*.

CO4 (Practical): Identify non-chordate specimens, mounted microscopic preparations, anatomical study, and field sampling techniques

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PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	X	X
PO 2	√	√	√	X
PO 3	X	√	√	X
PO 4	√	√	√	X
PO 5	√	√	√	√
PO 6	√	X	√	√
PO 7	√	√	√	X
PO 8	X	X	X	X

Semester 4

DSCC-6 / Core Course 6: Parasitology

COURSE OUTCOMES: COs:

CO1: Comprehend Fundamental Concepts of Host-Parasite Biology: Explain the basic terminology of parasitology, including parasite types (ectoparasites, endoparasites, obligate, facultative), host categories (definitive, intermediate, reservoir, paratenic), parasite specificity, vector transmission pathways, and host-parasite interactions.

CO2: Analyze Biology and Life Cycles of Pathogenic Protozoans: Critically evaluate the morphology, mode of infection, detailed life cycles, pathogenesis, clinical features, and control

measures of major human protozoan parasites, such as *Entamoeba histolytica*, *Giardia intestinalis*, *Leishmania donovani*, *Plasmodium* spp., and *Trypanosoma gambiense*.

CO3: Assess Helminthic Parasites and Parasitic Adaptations: Assess the structural, physiological, and reproductive adaptations of parasitic platyhelminthes (*Fasciola hepatica*, *Taenia solium*) and nematodes (*Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti*), alongside their pathology and epidemiological prevention.

Access the importance of incidence, prevalence and epidemiology in microbiological diagnostic activities.

CO4: Apply Parasitological Diagnostic Techniques and Microscopic Identification: Demonstrate practical proficiency in collecting, preserving, staining, and identifying pathogenic protozoans and helminths through permanent slide examination, stool sample concentration techniques for ova/cysts, and blood smear analysis for hemoparasites. Develop awareness about the causative agents and control measures of many commonly occurring diseases.

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PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	√	√
PO 2	√	√	√	√
PO 3	√	√	√	√
PO 4	√	√	√	√
PO 5	X	X	X	√
PO 6	√	√	√	√
PO 7	X	X	X	X
PO 8	X	X	X	X

Semester 4

DSCC-7 / Core Course: Molecular Biology

COURSE OUTCOMES: COs:

CO1: Comprehend Nucleic Acid Structure, Organization, and DNA Replication: Explain the chemical architecture of DNA and RNA, genome organization (prokaryotic chromosome, eukaryotic chromatin/nucleosomes), and the semi-conservative molecular mechanisms of DNA replication, including enzyme machinery, origin firing, and end-replication strategies.

CO2: Analyze Mechanisms of Transcription and Post-Transcriptional Processing: Critically evaluate transcription initiation, elongation, and termination in prokaryotes and eukaryotes, RNA polymerase holoenzyme dynamics, promoter structures, and post-transcriptional modifications including 5' capping, polyadenylation, splicing (introns/exons), and RNA editing.

CO3: Evaluate Translation, Genetic Code Properties, , Gene Regulation & Cell signalling: Assess the structural features and degeneracy of the genetic code, aminoacyl-tRNA synthetase fidelity, ribosome assembly, stage-specific translation (initiation, elongation, termination), post-translational modifications, and transcriptomic regulation via non-coding RNAs (miRNA, siRNA). Understanding of Cell signalling and modes, types and receptors.

CO4: Apply Molecular Biology Quantifications and Diagnostic Protocols: Demonstrate practical proficiency in genomic DNA and RNA extraction, spectrophotometric quantification (A_{260}/A_{280} purity ratios), agarose gel electrophoresis, qualitative DNA damage/repair assays, and basic primer design concepts.

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PO 1	√	√	√	√
PO 2	√	√	√	√
PO 3	√	√	√	√

PO 4	√	√	√	√
PO 5	√	√	√	X
PO 6	√	√	√	X
PO 7	√	√	√	√
PO 8	X	X	X	X

Semester 4

DSCC-8 / Core Course 8: Ecology

COURSE OUTCOMES: COs:

CO1: Understanding of knowledge about ecology, various laws of limiting factors, and rules in ecology etc.

CO2: Development of knowledge about niche, competition, population biology and community ecology.

CO3: Analyze ecosystem energetics, population growth models (*r* and *k* selection), community dynamics, ecological succession, and biogeochemical cycles.

CO4: Practical based experience of quantitative estimation of various edaphic factors, identifications of various zooplanktons and soil arthropods.

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PO-CO MAPPING

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PO 1	√	√	√	√
PO 2	√	√	√	X
PO 3	√	√	√	√

PO 4	X	X	√	√
PO 5	X	√	X	X
PO 6	√	√	√	√
PO 7	√	√	√	√
PO 8	X	X	X	√

Semester 5

(4-Year Honors / Research Track)

DSCC-9 / Core Course 9: Chordate Structure & Function

COURSE OUTCOMES: COs:

CO1: Comprehend Diagnostic Features and Classification of Chordates: Demonstrate a clear understanding of fundamental chordate hall marks (notochord, dorsal hollow nerve cord, pharyngeal gill slits, post-anal tail), alongside the classification, affinities, and evolutionary significance of Protochordates (Hemichordata, Urochordata, Cephalochordata) and Agnatha.

CO2: Analyze Comparative Anatomy of Vertebrate Organ Systems: Critically evaluate structural modifications and evolutionary transitions across vertebrate classes (Piscinae, Amphibia, Reptilia, Aves, Mammalia) focusing on integumentary derivatives, skeletal support, digestive tracks, circulatory modifications (aortic arches and heart structure), and urinogenital systems.

CO3: Evaluate Respiratory, Nervous, and Sensory Adaptations: Assess structural variations in respiratory mechanisms (gills, swim bladders, lungs, air sacs), brain regionalization, cranial nerve distribution, and specialized sensory/receptor structures (lateral line system, electroreceptors, pit organs) across diverse aquatic and terrestrial vertebrates.

CO4 (Practical): Apply Osteological Identification and Dissection Protocols: Develop practical skills in identifying comparative skeletal elements (skull types, pectoral/pelvic girdles, vertebrae types), mounting placoid/cycloid/ctenoid scales, dissecting system pathways in representative vertebrate specimens, and interpreting morphological variations via diagnostic keys.

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PO 1	√	√	√	√
PO 2	√	√	√	√
PO 3	X	X	X	√
PO 4	√	√	√	√
PO 5	√	√	√	X
PO 6	√	√	√	X
PO 7	X	X	X	X
PO 8	√	√	X	X

Semester 5

DSCC-10 / Core Course 10: Endocrinology & Reproductive Biology

COURSE OUTCOMES:COs:

CO1:Comprehend Endocrine Architecture and Hormone Signaling Mechanisms: Explain the histological structure, biosynthesis, storage, and secretion mechanisms of classic endocrine glands (hypophysis, thyroid, parathyroid, adrenal, endocrine pancreas, and pineal), alongside membrane-bound and intracellular hormone receptor signaling cascades.

CO2: Analyze Neuroendocrine Axes and Metabolic Regulation: Critically evaluate feedback control systems within the hypothalamo-hypophyseal-adrenal (HHA), hypothalamo-hypophyseal-thyroid (HHT), and hypothalamo-hypophyseal-gonadal (HHG) axes, including hormonal integration in calcium homeostatic mechanisms and carbohydrate/protein metabolism.

CO3:Evaluate Reproductive Physiology, Gametogenesis, and Endocrinopathies: Assess male and female reproductive endocrinology, regulatory pathways governing spermatogenesis, folliculogenesis, menstrual/estrous cycles, implantation, pregnancy, lactation, and clinical pathologies resulting from hypo- and hyper-hormonal dysfunctions.

CO4: Apply Histological Staining and Endocrine Diagnostic Assays: Demonstrate practical proficiency in micro-dissection, tissue fixation, microtomy, and histological identification of mammalian endocrine and reproductive tissues (pituitary, thyroid, adrenal, testis, ovary, uterus), alongside evaluating hormone bioassays and estrous cycle phase determination using vaginal smear techniques.

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PO-CO MAPPING

PROGRAMM E OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	√	√
PO 2	√	√	√	√
PO 3	X	X	X	X
PO 4	√	√	√	√
PO 5	√	√	√	√
PO 6	√	√	√	√
PO 7	√	√	√	√
PO 8	X	X	X	X

Semester 5

DSCC-11 / Core Course 11: Animal Physiology

COURSE OUTCOMES: COs:

CO1: Comprehend Mechanisms of Digestion, Circulation, and Respiration: Explain the physiological processes of mechanical and chemical digestion, nutrient absorption, blood composition and hemostasis, cardiac cycle dynamics, oxygen/carbon dioxide transport curves, and respiratory gas exchange mechanisms across biological membranes.

CO2: Analyze Excretory Functions, Osmoregulation, and Homeostasis: Critically evaluate nephron micro-anatomy, urine formation processes (ultrafiltration, selective reabsorption, tubular secretion), the counter-current multiplier system, and homeostatic mechanisms regulating water-electrolyte balance and acid-base equilibrium.

CO3: Evaluate Muscle Contraction and Neuro-Muscular Transmission: Assess the ultrastructure of skeletal, cardiac, and smooth muscle fibers, the sliding filament theory of muscle contraction, excitation-contraction coupling mechanisms, and the energetics of muscle action.

CO4: Apply Physiological Assays and Hematological Diagnostic Techniques: Demonstrate practical proficiency in determining hemoglobin concentration, total erythrocyte (RBC) and leukocyte (WBC) counts, differential leukocyte counting (DLC), blood grouping (ABO/Rh), measuring blood pressure, and performing physiological tissue preparations.

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PO 3. Analytical Reasoning - Use appropriate information with a critical understanding

PO 4. Research Skills - Design and conduct experiments to test a hypothesis, Understand and interpret data to reach a conclusion

PO 5. Teamwork

PO 6. Problem solving

PO 7. Moral and Ethical Awareness - Accept the legal restrictions & ethical considerations placed for animal welfare.

PO 8. Demonstrate competence in handling and statistical analysis of data gained from practical.

PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	√	X
PO 2	√	√	X	X
PO 3	√	X	√	X
PO 4	√	√	√	√
PO 5	√	√	√	√
PO 6	√	√	√	√
PO 7	√	√	√	√
PO 8	X	X	X	X

Semester 5

DSCC-12 / Core Course 12: Biodiversity & Conservation Biology

COURSE OUTCOMES: COs:

CO1: Assess global biodiversity hotspots, in-situ and ex-situ conservation strategies, IUCN threat categories, and Indian Wildlife Protection acts.

Gather knowledge about diversity of organisms categorically and the importance of diversity in food and resource security.

CO2: Learn different techniques of conservation of organisms to secure continuity of different organisms under the category of endangered and threatened etc

CO3: Engage in field-based research activities to understand well the theoretical aspects taught besides learning techniques for gathering data in the field.

CO4: Analyse a biological problem, derive testable hypotheses and then design experiments and put the tests into practice.

CO5: Solve the environmental problems involving interaction of human and natural systems at local or global level

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PO-CO Mapping

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO-1	-	-		√	-	√	√	-
CO-2	-	-	√	√	-	-	-	√
CO-3	-	√	-	-	-	√	-	-
CO-4	-	-	-	√	-	-	-	-
CO-5	-	-	-	-	-	-	√	-

Semester 6

(4-Year Honors / Research Track)
DSCC-13 / Core Course 13: Developmental Biology

COURSE OUTCOMES:COs:

CO1: Comprehend Early Embryonic Development and Gametogenesis: Explain the cellular and molecular mechanisms of spermatogenesis, oogenesis, fertilization, cleavage patterns, blastulation, and gastrulation across major model organisms (e.g., amphibians, birds, and mammals).

CO2:Analyse Embryonic Induction, Pattern Formation, and Morphogenesis: Critically evaluate the role of primary organizers, morphogen gradients, cell specification, axis determination, and Homeobox (Hox) genes in governing tissue differentiation and body plan establishment.

CO3: Evaluate Post-Embryonic Development, Metamorphosis, and Regeneration: Assess the hormonal and cellular signaling pathways involved in insect and amphibian metamorphosis, stem cell potency, tissue regeneration, and the biology of aging (senescence).

CO4:Apply Embryological Techniques and Experimental Protocols: Demonstrate practical proficiency in identifying various embryonic developmental stages via chick/frog embryo mounts, performing vital staining, and conducting histological analysis of reproductive tissues.

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PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	√	√
PO 2	√	X	√	√
PO 3	√	√	√	√
PO 4	X	√	√	X
PO 5	√	√	√	√
PO 6	√	√	√	√

PO 7	√	√	X	√
PO 8	√	X	X	√

Semester 6

DSCC-14 / Core Course 14: Taxonomy, Evolution & Adaptation

COURSE OUTCOMES: COs:

CO1: Understand Principles of Systematics and Zoological Nomenclature: Demonstrate a clear understanding of the core concepts of animal taxonomy, classification, and the rules of the International Code of Zoological Nomenclature (ICZN), including modern phylogenetic approaches and cladistics.

CO2: Analyze Evolutionary Mechanisms and Speciation Patterns: Critically evaluate evolutionary theories, genetic drift, natural selection, micro- and macro-evolutionary processes, and the mechanisms governing species formation and reproductive isolation.

CO3: Evaluate Physiological, Anatomical, and Behavioral Adaptations: Explain the functional modifications and adaptive strategies of animals across diverse environmental niches, including aquatic, terrestrial, fossorial, flying, and extreme/desert habitats.

CO4: Apply Taxonomic Tools and Evolutionary Analysis in Practical Contexts: Develop hands-on proficiency in constructing and interpreting taxonomic keys, analyzing morphological variants, evaluating fossil records, and constructing phylogenetic trees using qualitative and quantitative data.

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PO 6. Problem solving

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PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	√	√

PO 2	√	√	√	√
PO 3	√	√	√	X
PO 4	X	X	√	√
PO 5	√	√	√	√
PO 6	√	√	√	√
PO 7	√	√	X	√
PO 8	X	X	√	X

Semester 6

DSCC-15 / Core Course 15: Animal Behaviour

COURSE OUTCOMES: COs:

CO1:Comprehend Fundamental Concepts and Patterns of Animal Behavior: Explain the physiological, genetic, and neural bases of behavior, distinguishing clearly between innate (instinctive) and learned behavioral responses across various animal groups.

CO2:Analyze Social Organization and Communication Systems: Critically evaluate the mechanics of social living, dominance hierarchies, territoriality, altruism, kin selection, and diverse modes of animal communication (visual, acoustic, chemical, and tactile).

CO3: Evaluate Adaptive Strategies for Survival and Reproduction: Assess foraging behavior, predator avoidance mechanisms, mating systems, sexual selection, and parental investment strategies from an evolutionary and eco-ethological perspective.

CO4:Apply Ethological Methods and Quantify Behavioral Patterns: Demonstrate practical skills in designing behavioral experiments, constructing ethograms, applying sampling methodologies, and analyzing animal movements and orientation patterns in lab and field conditions.

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PO 5. Teamwork

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PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4	CO5
PO 1	√	√	√	√	√
PO 2	√	√	√	√	√
PO 3	√	√	√	√	√
PO 4	√	√	√	√	√
PO 5	√	√	√	√	√
PO 6	√	√	√	√	√
PO 7	√	√	√	√	√
PO 8	√	√	√	√	√

Semester 7

(4-Year Honors / Research Track)

DSCC-16 / Core Course 16: Biotechnology & Its Application

COURSE OUTCOMES: COs:

CO1: Master Recombinant DNA Technology and Molecular Tools: Demonstrate a comprehensive understanding of core genetic engineering concepts, including restriction enzymes, cloning vectors, PCR variants, molecular markers, and gene transfer methodologies.

CO2:Analyze Industrial and Environmental Biotechnology Applications: Evaluate upstream and downstream processing techniques in microbial fermentation, bioreactor design, bioprocess optimization, and environmental applications such as bioremediation and waste treatment.

CO3:Evaluate Medical and Agricultural Advances in Biotechnology: Assess the mechanisms and applications of transgenic crops, gene therapy, monoclonal antibodies, recombinant vaccines, CRISPR-Cas9 genome editing, and stem cell technology in health and agriculture.

CO4:Apply Bio-analytical Protocols, Bioinformatics, and Biosafety Standards: Develop practical proficiency in nucleic acid and protein isolation/electrophoresis, basic sequence analysis via bioinformatics databases, and the adherence to biosafety levels, bioethics, and Intellectual Property Rights (IPR).

Programme Outcome:

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PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	√	X
PO 2	√	√	√	√
PO 3	√	X	√	√
PO 4	√	√	√	√
PO 5	√	√	X	X
PO 6	X	√	√	√
PO 7	√	√	√	√
PO 8	X	X	X	X

Semester 7

DSCC-17 / Core Course 17: Neurobiology

COURSE OUTCOMES: COs:

CO1:Comprehend Cellular Architecture and Electrophysiology of the Nervous System: Explain the structural organization of neurons and glial cells, resting membrane potential generation, ion channel dynamics, and the molecular mechanisms underlying action potential propagation along myelinated and unmyelinated axons.

CO2: Analyze Synaptic Transmission and Neurochemical Signalling Pathways: Critically evaluate chemical and electrical synaptic transmission, neurotransmitter synthesis and release mechanisms, post-synaptic receptor activation (ionotropic and metabotropic), and second messenger cascade pathways.

CO3: Evaluate Neural Integration, Sensory-Motor Systems, and Higher Brain Functions:

Assess neural processing mechanisms governing sensory perception (visual, auditory, tactile), motor control circuits, reflex arcs, neuroendocrine regulation, and the cellular substrates of learning, memory, and synaptic plasticity (LTP/LTD).

CO4: Apply Neuroanatomical, Histological, and Behavioral Methodologies: Demonstrate practical proficiency in neuroanatomical mapping, histological staining of brain/spinal cord sections, electrophysiological recording principles, and quantitative ethological models used to assess neurological functions and behavior.

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PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	√	√
PO 2	√	√	√	X
PO 3	X		√	√
PO 4	√	√	√	√
PO 5	√	√	X	√
PO 6	√	√	√	√
PO 7	√	√	X	√
PO 8	X	X	√	X

Semester 7**DSCC-18 / Core Course 18: Toxicology**

COURSE OUTCOMES: COs:**CO1: Comprehend Fundamental Concepts of Toxicokinetics and Xenobiotic Metabolism:**

Explain the principles of toxicology, including dose-response relationships (\$LD_{50}\$, \$LC_{50}\$, \$NOAEL\$), routes of exposure, absorption, distribution, excretion (ADME), and Phase I/Phase II biotransformation pathways in animal systems.

CO2: Analyze Organ-Specific Toxicities and Mechanisms of Action: Critically evaluate the cellular, molecular, and biochemical mechanisms by which chemical toxins, heavy metals, pesticides, and biological venoms induce hepatotoxicity, nephrotoxicity, neurotoxicity, and oxidative stress

CO3: Evaluate Mutagenic, Carcinogenic, and Teratogenic Hazards: Assess the long-term cellular impacts of environmental toxicant exposures, focusing on DNA damage mechanisms, chemical carcinogenesis, endocrine disruption, and developmental toxicity (teratogenesis).

CO4: Apply Ecotoxicological Assays, Bioassays, and Risk Assessment Protocols: Demonstrate practical proficiency in designing toxicological bioassays, evaluating acute and chronic toxicity parameters, interpreting histological lesions in target tissues, and applying environmental risk assessment methodologies.

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PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	√	√
PO 2	√	√	√	√
PO 3	X	√	√	√
PO 4	√	√	√	X
PO 5	√	√	X	√
PO 6	√	√	√	X
PO 7	√	√	√	√

PO 8	X	X	√	X
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Semester 7

DSCC-19 / Core Course 19: Immunology

COURSE OUTCOMES: COs:

CO1: Comprehend Cellular Architecture and Innate/Adaptive Immune Mechanics: Explain the organization of primary and secondary lymphoid organs, cell lineages, and the physiological mechanisms distinguishing non-specific innate defenses (barriers, phagocytosis, complement system) from antigen-specific adaptive immune responses.

CO2: Analyze Antigen-Antibody Interactions, MHC, and Signaling Pathways: Critically evaluate immunogen properties, structural/functional diversity of immunoglobulin classes, Major Histocompatibility Complex (MHC I & II) antigen processing/presentation pathways, and cytokine-mediated cell signaling networks.

CO3: Evaluate Hypersensitivity, Autoimmunity, Immunodeficiency, and Vaccines: Assess the immunological bases of Type I-IV hypersensitivity reactions, autoimmune pathogenesis, primary/secondary immunodeficiencies, tumor immunology, transplantation rejection mechanisms, and principles of modern vaccine design.

CO4: Apply Diagnostic Serological Assays and Immunological Protocols: Demonstrate practical proficiency in performing and interpreting immunodiagnostic techniques, including ABO/Rh blood grouping, gel precipitation assays (Ouchterlony double diffusion), radial immunodiffusion, ELISA, and immune cell isolation/quantification methodologies.

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PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	√	√
PO 2	√	√	√	√

PO 3	√	√	X	√
PO 4	√	√	√	√
PO 5	X	√	√	√
PO 6	√	√	√	√
PO 7	√	√	√	√
PO 8	√	X	X	X

Semester 7

DSCC 20/ CORE COURSE-20: ANIMAL MODELS IN RESEARCH

COURSE OUTCOMES: COs:

CO1: Comprehend Principles of Model Organism Selection and Bioethics: Explain the physiological, genetic, and evolutionary rationale for selecting specific invertebrate (e.g., *Drosophila*, *C. elegans*) and vertebrate (e.g., zebrafish, mice, rats, rabbits) animal models, while adhering to the 3Rs principles (Replacement, Reduction, Refinement) and CPCSEA/Institutional Animal Ethics Committee (IAEC) guidelines.

CO2: Analyze Disease Modeling, Genetic Modifications, and Transgenics: Critically evaluate the strategies used to develop knockout, knock-in, and transgenic animal models to mimic human metabolic, neurodegenerative, immunological, and oncological disorders for biomedical screening.

CO3: Evaluate Animal Handling, Dosing Methods, and Experimental Surgery Protocols: Assess standard laboratory housing parameters, husbandry standards, administration routes (oral, IV, IP, SC), blood sampling techniques, non-invasive imaging, and surgical/anaesthetic practices essential for in vivo experimental studies.

CO4: Apply In Vivo Assays, Physiological Measurements, and Histopathological Evaluation: Demonstrate practical proficiency in handling model organisms, executing behavioral and physiological assays, dissecting target tissues, performing bone marrow cell isolation/histopathological staining, and interpreting experimental quantitative data.

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PO-CO MAPPING

PROGRAMME OUTCOME	CO1	CO2	CO3	CO4
PO 1	√	√	√	√
PO 2	√	√	√	√
PO 3	X	√	√	√
PO 4	√	√	X	√
PO 5	√	√	√	√
PO 6	√	√	√	√
PO 7	√	X	√	√
PO 8	√	√	√	√
