MSc CBCS SYLLABUS IN ZOOLOGY
DEPARTMENT OF ZOOLOGY
w.e.f. 2020-21

Colour codes: **Red** : **Employability**
Green : **Entrepreneurship**
Blue : **Skill development**

Department of Zoology, Utkal University
Vani Vihar, Bhubaneswar-751 004, Odisha

Website www.utkaluniversity.ac.in

EMESTER-I (ODD)

A. CORE COURSES

Course No	Course Title	Lectures	Credits	Marks
ZOO-101	Biosystematics, Bioinformatics and Non-Chordates	40	6	100
ZOO-102	Cell Biology and Genetics	40	6	100
ZOO-103	Physiology, Histology and Histochemistry	40	6	100
ZOO-104	Instrumentation and Biostatistics	40	6	100
ZOO-105	Practical related to theory papers	60	6	100

Total Credits-30, Marks-500

SEMESTER-II (EVEN)

A. CORE COURSES

Course No	Course Title	Lectures	Credits	Marks
ZOO-201	Biophysics and Biochemistry	40	6	100
ZOO-202	Microbiology and Immunology	40	6	100
ZOO-203	Endocrinology and Reproductive Physiology	40	6	100
ZOO-204	Evolutionary Biology and Animal Behaviour	40	6	100
ZOO-205	Practical related to theory papers	60	6	100

Total Credits-30, Marks-500

SEMESTER-III (ODD)

B. CORE COURSES

Course No	Course Title	Lectures	Credits	Marks
ZOO-301	Chordates, Comparative Anatomy and Economic Zoology	40	6	100
ZOO-302	Developmental Biology	40	6	100
ZOO-303	Environmental Biology and Wildlife Conservation	40	6	100
ZOO-305	Practical related to theory papers	60	6	100

C. ALLIED ELECTIVE COURSE

Course No.	Course Title Environment,	Lectures	Credits	Marks
ZOO-304	Animal Physiology and Developmental Biology	40	6	100

Total Credits-30, Marks-500

D. FREE ELECTIVE COURSE (Open to students of all Post Graduate Departments)

Course No.	Course Title	Lectures	Credits	Marks
ZFC-1	Wildlife	40	-	-
ZFC-2	Conservation Biology and Biodiversity	40	-	-

Credits-0

E. CORE ELECTIVE COURSES (If more than one of these courses are offered in a year, a student is required to choose only **one,** i.e., '**A**' or '**B**' or '**C**' or '**D**')

Semester-IV (EVEN)

a. Molecular Biology

Course No	Course Title	Lectures	Credits	Marks
ZOO-401A	Molecular Biology, Genetic Engineering and Applications	40	6	100
ZOO-402A	Microbial Ecology and Biotechnology, and Nanobiology	40	6	100
ZOO-403A	Animal development and Neurobiology	40	6	100
ZOO-404A	Project work	-	6	100
ZOO-405A	Practical related to theory papers	40	6	100

Grand Total Marks= 2000
Credits-120

Zoo - 101 BIOSYSTEMATICS, BIOINFORMATICS AND NON-CHORDATES

Course Objectives

1. To provide basic idea about classical and modern taxonomic approaches.
2. To provides methodological background and quantitative skills in morphology-based taxonomy and systematics
3. To provide basic ideas about different databases, and usability of available data for predicting molecular phylogeny and protein structure.
4. To have an understanding of different parasite causing human diseases
5. To obtain a thorough understanding of the processes in invertebrates.

Learning Outcomes:

The students will be able to gain basic taxonomic and computational skills of systematics and phylogeny. Besides, fundamental processes in variety of invertebrates can be ascertained.

Biosystematics

Unit-I

Concepts of Biosystematics; Importance and applications of biosystematics; Trends in biosystematics: conventional and newer aspects of taxonomy; Dimensions of speciation and taxonomic characters; Species concepts: species category, different species concepts, sub-species and other intraspecific categories; Theories of biological classification.

Unit-II

Taxonomic procedures: Taxonomic collections, Preservation, Curetting, Taxidermy; International Code of Zoological Nomenclature (ICZN): Operative principles, Interpretation and application of important rules; Evaluation of biodiversity indices: Shannon-Winner index, Dominance index, Similarity and Dissimilarity index, and Association index.

Bioinformatics

Unit-III

Introduction to genomics and proteomics databases; Nucleic acid sequence databases: Genbank, EMBL, DDBJ, protein sequence databases: Swiss-prot, Uniport, PDB, TrEMBL; Introduction to sequence alignment, Needleman and Wunsch algorithm; Local alignment of sequences, Smith and Waterman algorithm; Basic Local alignment Search Tool, Multiple Sequence alignment and Molecular Phylogenetics., BLAST, PSI- BLAST (steps involved in use and interpretation of results) and HMMER, BLAST vs FASTA, file formats- FASTA, GCG and ClustalW; Protein structure prediction; Homology modeling.

Non-Chordates

Unit-lV

Protozoan diseases in man; Biology of Foraminifera; Reproduction in sponges; Polymorphism in Coelenterates; Helminth parasites and human diseases; Soil nematodes; Metamerism and Segmentation in Annelids.

Unit-V

Crustacean parasites; Vision in insects; Mouthparts in insects; Biology of locusts; Biology of termites; Horseshoe crabs and their importance; structure and affinities of Trilobites; Shell in molluscs; Larval forms in echinoderms and origin of chordates.

Zoo - 102 CELL BIOLOGY AND GENETICS

Course Objectives

1. To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.
2. To get thorough understanding of structure and function of cellular cytoskeleton, cell cycle regulation, apoptosis and cancer.
3. To be familiar with recombinant technology and its application.
4. To be familiar with the various genetic and molecular changes occur in a normal cell during malignant transformation.
5. To provide the fundamental knowledge on classical genetics, genetic disorders and the methods of gene transfer.

Learning Outcome:

At the end of this course, Students will be acquainted with the membrane structure and functions, the cytoskeleton, cell division and their regulation through different check points. The association between defect in cell cycle, apoptosis, signal transduction and cancer will help in understanding cell physiology. Students will learn working of genes in a complex manner in biological system.

Cell Biology

Unit-I

Cell concept; Biomembranes: Experimental evidences, Molecular composition and arrangement; Transport across cell membrane: Diffusion, Active transport, Uniports, Symports and Antiports; Extra Cellular Matrix; Cell matrix adhesion: Membrane modifications (Zonula occludens, Zonula adherens, Macula adherens and Gap junction); Mechanism of protein sorting and regulation of intracellular transport; Nuclear membrane transport and its regulation.

Unit-II Cytoskeleton: Structure and dynamics of microfilaments and microtubules; Microtubules and Mitosis; Structure and function of cilia and flagella; Structure, orientation and behaviour of chromosomes (chromosome segregation); Cell cycle: steps and regulation during mitosis and meiosis; Cell-cell signaling; Programmed cell death; Biology of Cancer: development and causes of cancer, oncogenes and tumor suppressor genes.

Unit-Ill Cell cloning and its application; Genetic analyses in cell biology; Testing of genetic toxicity; Methods of harvesting of cells (testes, bone marrow); Karyotype and banding pattern of chromosomes.

Genetics

Unit-IV

Laws of heredity; Co-and incomplete dominance; Linkage and linkage maps; Varieties of Gene expression: lethal genes, multiple alleles, pleiotropic genes, gene interactions, epistasis; Structural and numerical alterations of chromosomes and meiotic consequences; Extrachromosomal inheritance: mitochondrial, maternal inheritance; Sex-chromosome systems, different mechanisms of sex determination in animals and their molecular mechanism.

Unit-V

Chromosomal disorders and common human syndromes; Amniocentesis and its application; Biology of twins; Polyembryony; Free Martin; Genetic counseling; Polygenic inheritance: heritability and its

measurements; Pedigree analysis; C value paradox; Lod score for linkage testing; Homologous and non-homologous recombination.

Zoo - 103 PHYSIOLOGY, HISTOLOGY AND HISTOCHEMISTRY

Course Objectives:

1. To learn and understand the fundamental scientific concepts relating to a broad range of topics in animal physiology and their interactions to maintain body homeostasis.
2. To understand several processes essential for maintaining the body's biochemical balance for normal functioning.
3. To improve the student's perspective of health and biology through in-depth study of human physiology
4. To have a basic understanding of different tissues and a detailed method of histology.
5. To understand the basics of histochemistry.

Learning Outcomes:

The students will be able to explore an original query in animal physiology. Influence of the environmental factors in respective niches can be established. Students after completion of this course are expected to learn basic histological features of important tissues and organs.

Physiology

Unit-I

Mechanism of digestion and absorption; Pulmonary ventilation: respiratory surface and gas exchange, regulation of respiration, transport of gases; Composition of blood, haemopoeisis, blood groups; Cardiac cycle and blood pressure.

Unit-Il

Mechanism of muscle contraction; Secretory system: urine formation, glomerular filtration, tubular function, renal mechanism of concentrating and diluting urine; Acid-base balance.

Unit-Ill

Adaptive physiology

Mechanism of adaptation; Adaptations in fresh water and marine environment; Osmoregulation in marine and terrestrial invertebrates and vertebrates; Acclimation and acclimatization; Mechanism of cell volume regulation; Adaptation in extremophiles.

Histology

Unit-IV

Histological preparation methods; Classification and structure of epithelial, connective, muscle and nervous tissue.

Histochemistry

Unit-V

Basic requirements of a histochemical test: general principles and demonstration of carbohydrates, lipids, protein and nucleic acids; Enzyme histochemistry: principles and demonstration (dehydrogenases, esterases and phosphatases); Affinity histochemistry; Fixatives and stains.

Zoo - 104 INSTRUMENTATION AND BIOSTATISTICS

Course Objectives:

1. To provide a basic idea about the working principles of different microscopes and their application in biological sciences.
2. To provide a detailed account of different separation techniques and their application in biological research.
3. To give basic knowledge about different techniques pertaining to protein from quantification, and identification to structure elucidation.
4. To provide a detailed understanding of several diagnostic techniques and their applications including several in vitro immunoassay techniques and several hybrid imaging techniques.
5. To equip the learner to use the tools, techniques and statistical methods for project work/ research in biology.

Learning outcome:

The course enables the students learn applications of statistical methods in solving biological problems. Students after completion of this course are expected to handle and operate basic instruments for their experimental purposes and interpret the data through appropriate statistics.

Instrumentation

Unit-I

Microscopy: principle of operation and instrumentation of light, Fluorescent, Electron, Atomic force and Confocal microscopy; Flow cytometry.

Unit-II

Centrifugation: Principle of sedimentation, different types of centrifugation, differential and density gradient Centrifugation; Principle and application of chromatography (Molecular exclusion, Ion exchange, Affinity, Gas-liquid and HPLC); Principle and application of electrophoresis (Paper, Cellulose acetate, Starch, Agarose, PAGE, SDS-PAGE, Isoelectric focusing and Two Dimensional).

Unit III

Spectrophotometry: principle and application of ultraviolet and visible spectrophotometry; Spectrofluorimetry; Mass spectrometry: MALDITOF; X-ray diffraction crystallography; Radioisotopic techniques: Nature of radioactivity, application of radioactivity in biology (carbon dating, liquid scintillation counting, autoradiography).

Unit-IV

ELISA; RIA (Radio-immuno assay); PET (Positron Electron Tomography); MRI (Magnetic Resonance Imaging), CAT (Computer Aided Tomography); Polymerase Chain reaction (including Real Time PCR), Microarray.

Biostatistics

Unit-V

Sampling techniques; Measures of central tendency (Mean, Median, Mode); Measures of dispersion; Coefficient of variation; Correlation and Regression; Measure of Probability; Normal, Poisson and Binomial distribution; Tests of significance (t- and chi-square tests); Simple correlation and regression; Analysis of variance (single factor design); Nonparametric test: Wilcoxon Rank test, Mann-Whitney test; Principal component analysis.

Z00 - 201 BIOPHYSICS AND BIOCHEMISTRY

Course Objectives

1. To understand the biophysical properties and chemical foundation of life processes.
2. To have a basic idea of cellular nutrients, and energy production process.
3. To understand the structure and metabolism of biologically significant molecules.
4. To have a basic understanding of protein building blocks and their synthesis.
5. To explain the role of catabolic and anabolic pathways in cellular metabolism.

Learning Outcomes:

At the end of the course, the student will be able to demonstrate knowledge of the fundamental concepts in physics and chemistry that underlie biological processes. On completion of the course, the students will understand the fundamental energetic of biochemical processes and chemical logic of metabolic pathways.

Biophysics

Unit-I:

Concept of biomolecules; Chemical composition and bonding; Weak interactions in aqueous system; ionization of water; weak acids; weak bases; buffers and buffering capacity; Principle of bioenergetics: Bioenergetics and thermodynamics; Phosphoryl group transfers and ATP; Biological oxidation-reduction reactions.

Biochemistry

Unit-Il:

Carbohydrates: Structure and classification; Glycoconjugates (Proteoglycans, Glycoproteins and Glycolipids); Metabolism of carbohydrates: Glycolysis, Fermentation; Pentose-phosphate pathway, TCA cycle, Gluconeogenesis, Glycogen metabolism: Oxidative phosphorylation; Electron transport chain and ATP synthesis; Regulation of carbohydrate metabolism.

Unit-Ill:

Amino acids: Types of amino acids and their properties; The Peptide bond; Biologically active peptides; Analysis of amino acids; Metabolism of amino acids: Transamination and oxidative deamination;
Proteins: Properties of proteins; Sequence of amino acids in proteins and its importance; Three dimensional structure of proteins (secondary, tertiary and quaternary structure); Ramachandran plot; Urea cycle.

Unit-IV:

Lipids: Structure and classification; Biosynthesis of fatty acids; Metabolism of lipids: beta-oxidation of fatty acids; Storage lipids; Structural lipids in membranes; Lipids as signals, cofactors and pigments, coenzymes and vitamins.
Nucleic acids: Structure; Synthesis and degradation of nucleic acids; Importance of free nucleotides.

Unit-V

Enzymes: Classification and properties; Kinetics and mechanism of action; Enzyme inhibition and repression; Coenzymes; Regulation of enzymes (allosteric, phosphorylation and proteolytic cleavage).

Zoo - 202 MICROBIOLOGY AND IMMUNOLOGY

Course Objectives:

1. To help students develop skills necessary for critical analysis of microbes and microbial processes.
2. To have a better understanding of microbial diseases including host-parasite interaction.
3. To learn the organization, malfunctioning and disorders of the immune system.
4. To learn the regulation and processing of immune responses.
5. To get a broad understanding of antigens, antibodies and vaccines.

Learning Outcomes:

At the end of the course, the students should be able to understand the role of microbes in human health and diseases. They will be able to identify the cellular and molecular basis of immune responsiveness and understand how the innate and adaptive immune responses coordinate to fight invading pathogens.

Microbiology

Unit-l

History of microbiology; Structural organization and multiplication of bacteria and virus; Microbial genetics: concept of genetic recombination of bacteria, transformation, transduction and sexduction (Conjugation); Microbial culture, pure culture, subculture, stains for microbes.

Unit-II

Microbial diseases: Bacterial diseases of man (Airborne, Foodborne, Waterborne, Soil borne, Sexually-transmitted and contact diseases); Viral diseases of man (AIDS, Hepatitis, SARS group); Zoonotic diseases.

Host parasite interaction**:** Recognition and entry processes of different pathogens into animal, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals, cell-cell fusion in both normal and abnormal cells.

Immunology

Unit-Ill

Innate and adaptive Immunity; Organization and Structure of lymphoid organs; Antigens; Structure and function of immunoglobulins; Monoclonal and polyclonal antibodies; Antigen-antibody reaction.

Unit-IV

Humoral and cell mediated immunity; Regulation of immune response; Major histocompatibility complex and HLA system; Antigen processing and presentation; Complement and its action.

Unit-V

Immunological aspects of transplantation; Autoimmunity; Immuno-tolerance; Hypersensitivity concept, Vaccines; Interferons and Episomes.

Zoo - 203 ENDOCRINOLOGY AND REPRODUCTIVE PHYSIOLOGY

Course Objectives:

1. To impart knowledge on structure, function and regulation of different endocrine glands of vertebrates.
2. To have a better understanding of the anatomy of glands and synthesis of different hormones.
3. To give the basic concepts on hormone signaling and role of endocrine organs in different reproductive phases of animals.
4. To provide basic idea about structure, function and physiological role of endocrine system.
5. To give a better idea about the endocrine system during reproduction and different aspects of fertility and contraception.

Learning Outcomes:

The role of endocrine glands in different physiological processes and regulation of body homeostasis can be better understood by the students.

Endocrinology

Unit-I

Hormones of invertebrates and vertebrates; Mechanisms of hormone action; Hormones and their feedback systems; Hypothalamic control of adenohypophysial hormones; Chemistry and biological action of adenohypophysial and neurohypophysial hormones; Pituitary pathophysiology.

Unit-II

Neuroendocrine system and neurosecretion; Anatomy of thyroid and parathyroid glands; Biosynthesis, function and regulation of thyroid and parathyroid hormones; Hormones of Pineal gland; Gastrointestinal hormones.

Unit-Ill

Endocrine pancreas: Anatomy, regulation of secretion, chemistry and functions of insulin and glucagon; Pancreatic pathophysiology; Adrenal gland: anatomy, biosynthesis, function of cortical and medullary hormones and regulation of their secretion; Role of hormones in carbohydrate, protein and lipid metabolism.

Reproductive Physiology

Unit-IV

Structure of male reproductive system, testicular events and biosynthesis of testosterone; Biochemistry of semen; Capacitation of spermatozoa; Structure of female reproductive system; Folliculogenesis; Ovulation, Luteinization; Estrous cycle; Menstrual cycle; Menopause; Endocrine disorders related to reproduction; Endocrinology of implantation, pregnancy, parturition and lactation.

Unit-V

Steroids and their biosynthesis; Steroid hormones and brain differentiation; Transport of steroid hormones in blood; Metabolism and excretion of steroid hormones; Sterility: causes and control; Artificial insemination; *In vitro* fertilization and embryo transfer; Fertility control; Contraception: Natural and chemical methods; Contraceptives of the future.

Zoo- 204 EVOLUTIONARY BIOLOGY AND ANIMAL BEHAVIOUR

Course Objectives

1. To understand the evidence that living species share descent from common ancestry.
2. To have an understanding of genetic variation in a population and its influence on social behaviour and human health.
3. To gain a basic idea about the adaptability influenced and gradual change in the appearances and characteristics of organisms.
4. To provide a basic idea about different aspects of animal behaviour and different means to study them.
5. To have a better understanding of the regulatory basis of animal behaviour.

Learning Outcomes:

The students are expected to develop a solid foundation on processes of evolutionary processes responsible for bringing about variation in gene frequency. They would be able to suggest beneficial alterations in agricultural crops and livestock through variability studies. Study of animal behavior will enable the students to understand the physiological processes for beneficiation processes.

Unit-I

Geological time scale; Origin of life; Formation and types of fossils; Evolutionary evidences and theories; Variation, natural selection, genetic drift, isolation and mutation as underlying mechanisms of evolution; Evolutionary analysis of form and function.

Unit II

Hardy-Weinberg equilibrium: principle, derivation, conditions and applications; Molecular basis of variation and inheritance; Genotype-environment interactions; Inbreeding and assertive mating; Depression and heterosis; Evolution of Social Behavior; Evolution of human health.

Unit-III

Evolutionary trends (micro, macro and mega patterns of evolution); Patterns of speciation; Molecular and genomic evolution: gene flow, gene duplication, gene divergence and evolution of gene families; Protein and nucleotide sequence analysis; Concepts of neutral evolution and molecular clocks.

Animal behavior

Unit-IV

Classification and analysis of behavior patterns; Methods of behavioral study; Altruism and kin selection; Neural basis of learning, memory, cognition, sleep and arousal; Biological clock; Bioluminescence.

Unit-V

Hormones and behavior; Social communication in honey bee and termites; Parental care in fish and amphibia; Migration in fish and bird; Mating systems; Habitat selection and optimality in foraging.

Zoo - 301 CHORDATES, COMPARATIVE ANATOMY AND ECONOMIC ZOOLOGY

Course Objectives:

1. To be familiar with the anatomical design and evolutionary affinities of primitive chordates phyla with their general and distinguishing characteristics.
2. To have a better understanding of the origin and evolution of advanced chordates.
3. To learn different anatomical structures across chordates phyla.
4. To understand the biology and culture of various insects of economic importance.
5. To understand the basic biology, common diseases and culturing techniques for animals of economic importance.

Learning Outcomes:

The students can be entrepreneurs by utilizing the skills of economic zoology.

Chordates

Unit-I

Affinities of hemichordates, urochodates and cephalochordates; Structure and affinities of cyclostomes; Air breathing fishes; Structure and affinities of lungfishes.

Unit-II

Origin and evolution of amphibians, reptiles, birds; Evolution of primates; Systematic position of prototherians and metatherians; Diversity of aquatic mammals; Mechanism of dentition in mammals.

Comparative anatomy of vertebrates

Unit III

Integuments; Digestive tracts; Renal system; Modifications of venous system in vertebrates**;** Variation in eyes and photoreceptors among vertebrates.

Economic Zoology

Unit-IV

Earthworm and vermicomposting; Silk moth and sericulture; Honey bee and apiculture; Lac insects and lac culture; Insect vectors of medical and veterinary importance with special reference to mosquitoes and flies; Termites as pests; Economic importance of molluscs.

Unit V

Economic importance of Coral reefs; Prawn and shrimp farming; Induced breeding; Composite fish culture; Ornamental fish culture; Diseases of fishes; Bio fouling and predation.

Zoo - 302 DEVELOPMENTAL BIOLOGY

Course Objectives:

1. To understand the basic concept and experimental aspect of developmental biology using model organisms.
2. To have a thorough understanding of sex cell development and fertilization.
3. To study the developmental aspects including metamorphosis.
4. To have an understanding of the early embryonic precursor process and organogenesis.
5. To elucidate the interaction of genes and environment during development.

Learning Outcome:

The course will provide an in depth information on developmental biology starting from molecular aspects of gametogenesis to regeneration.

Unit-I

History of developmental biology (Contributions of Spemann, Hilde Mangold, Holtfreter, Needham, Waddington, Spratt, Briggs and King, Patric Steptoe and Robert Edwards); Model organisms in developmental biology (*Caenorhabditis elegans*, *Drosophila*, Zebra fish, amphibians, chick, mouse).

Unit-II

Molecular aspects of spermatogenesis and oogenesis; Fertilization: morphological aspects and biochemical events; Nucleo-cytoplasmic interactions; Nuclear transplantation in vertebrate embryos; parthenogenesis.

Unit-Ill

Organogenesis: Nieuwkoop Centre and Primary Organizer; Embryonic induction; Movement of cells over long distance (Neural crest and primordial germ cells); Embryonic adaptations: Placentation and implantation in mammals.

Unit-IV

Growth: Growth at cellular and intracellular level, Growth at organismic level and Growth curves; Regeneration in invertebrates and vertebrates; Biochemical aspects of metamorphosis in insects and amphibians; Homeotic genes and homeotic transformation in anuran tadpoles.

Unit-V

Late embryonic development: Vulva formation in *Caenorhabditis elegans*, Formation of neural tube and patterning in vertebrates; Vertebrate limb development; Biotic, abiotic and symbiotic regulation of development.

ZOO-303

ENVIRONMENTAL BIOLOGY AND WILDLIFE CONSERVATION

Course Objectives:

1. To provide a holistic idea of populations, their interactions and communities.
2. To understand the processes associated with climate change, carbon budget and related environmental processes.
3. To generate ideas on the ecological concept of conservation.
4. To have an understanding of wildlife, its conservation and related laws.
5. To have understanding of modern conservation techniques and patent filing procedures.

Learning Outcomes:

Students will be exposed to the fundamental aspects of ecology, climate change and related aspects. They are expected to know wildlife laws and various technological developments for their conservation.

Unit-I: Environmental Biology

Ecosystem: Ecological niche, Resource partitioning, population growth curves, life history strategies (R & K selection); Metapopulations; Community Ecology: Nature of communities, community structure and attributes; Edges and ecotones; Species interaction: competition (Lotka-Volterra equations), predation, herbivory, disease and parasitism.

Unit-II

Global warming and Climate change; Fate of carbon in the atmosphere: carbon emission, carbon footprint, carbon sequestration and carbon trading; Water footprint; Water harvesting and sustainable use; Ozone layer depletion; Acid rains; Greenhouse effect; Wastewater treatment; Solid waste management; Bioremediation; Bioleaching; Biosensors.

Wildlife

Unit-Ill

Zoogeographic realms; Theory of island biogeography; Biogeographic zones of India; Rare and Endangered species concept; Wildlife of Odisha; Sea turtle conservation; Project crocodile; Project Tiger; Project Elephant; General methods of wildlife census; Human-wildlife conflict.

Unit-IV

Environment Protection Act (1986); Forest Conservation Act (1980); Wildlife (Protection) Act (1972); Organizations associated with conservation; International conventions and treaties; Conventions on Biodiversity.

Unit-V

Remote sensing and its application, Intellectual property rights and Patents; Biodiversity conservation (*in situ* and *ex situ* methods); Biodiversity hotspots; Keystone species; Cryopreservation (Germplasm conservation, Gene bank, frozen zoo).

ZOO-304 ALLIED ELECTIVE COURSE

ANIMAL PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY

Course Objective:

1. To study the mechanism of working of different organs and their role in the maintenance of body homeostasis.
2. To learn the mechanism of development of animal embryos.

Learning Outcomes:

Students will be familiarized with physiological processes of animals and basic concepts on development of animals.

Unit I Animal physiology (I)

Blood groups, Blood cells, hematopoiesis; Cardiac cycle: blood pressure, neural and chemical regulation of cardiac cycle.

Unit II Animal physiology (II)

Mechanism of breathing; Transport & exchange of gases; Neural and chemical regulation of respiration; Structural organization of kidney, urine formation; Regulation of water & electrolyte and acid-base balance.

Unit III Animal physiology (III)

Nervous system and sense organs: Neurons, action potential, Central Nervous System and Peripheral nervous system; Vision; Hearing and tactile response.

Unit IV Developmental Biology (I)

Pioneering experiments in Developmental biology; Gametogenesis, fertilization, gastrulation; Extra embryonic membranes.

Unit V Developmental Biology (II)

Axis formation in *Drosophila*, eye-lens induction; Regeneration and metamorphosis.

FREE ELECTIVE COURSE (ZFC-1)

WILDLIFE

Course Objective:

1. To familiarize with the wild resources of the land.
2. To familiarize the students with different guidelines, rules and regulations of the country to protect the nature and its inhabitants.

Learning Outcomes:

The students will be able to understand the importance of wildlife and their sustenance.

Unit I Biology of Indian Wildlife
- Distribution of Wildlife in India
- Rare and endangered species of Odisha (Mammals, Birds, Reptiles)
- Conservation education on wildlife
- Ethics and wildlife conservation

Unit II Conservation of Wildlife in Odisha.
- Crocodile
- Sea turtle
- Tiger
- Elephant

Unit III Anima, laws and policies in India
- Wildlife (Protection) Act, 1972; Wild life (Protection) Amendment Act, 2002
- Wildlife (Transaction and Taxidermy) Rules, 1974
- Forest conservation Act, 1980 and Rules, 2003
- Major International Agreements (CITES, CBE, ITTA, UNFCCC, etc.)

Unit IV Protected areas and wildlife.
- Keystone species
- Biodiversity Hot Spots in India, Wetland Biodiversity
- Zoos, wild life sanctuaries of Odisha. National parks and biosphere reserves
- Organizations in wildlife conservation (BNHS, IUCN, WWF, SITES etc.)

Unit V Wildlife health and Ecotourism
- Management of wildlife health programme
- Zoonoses
- Ecotourism – a world wide view
- Ecotourism in Indian context (case studies)

FREE ELECTIVE COURSE (ZFC-2)
CONSERVATION BIOLOGY AND BIODIVERSITY

Course Objectives:

1. To study the science of biological diversity and its conservation.
2. To study the importance of community participation in sustainable conservation.

Learning Outcomes:

Students will contribute to mobilize the community in conservation movements.

Unit I Conservation Biology and Biodiversity: a prologue
- Role of Science in conservation Biology
- Species and speciation
- Extinct Species
- Ethics and conservation

Unit II Threats to Biological Diversity

Biodiversity Distribution
Over exploitation
Habitat destruction
Alien species

Unit III **Protected areas.**
Wild life sanctuaries
National parks
Biosphere reserves
Wildlife corridors

Unit IV **Restoration Biology**
Ecological restoration
Conservation strategies (*in situ* and *ex situ*)
Single species conservation
Conservation Laws

Unit V **Community based conservation**
Community conservation partnership
Community conservation conflict
Conservation management, Case studies
Bio- adoption

Core elective (Special Paper)

Zoo - 401A MOLECULAR BIOLOGY

Course Objectives:

1. To study the central dogma of molecular biology in modern perspectives.
2. To have an idea on different molecular markers and their usefulness in taxonomy and detection of diseases.
3. To study the regulation of genes, and manipulation of genes for the production of transgenic animals.
4. To understand several modern molecular tools, principle and their application in biological sciences.
5. To have an understanding of rectification of defects in genes using different advanced molecular techniques.

Learning Outcome:

The course will acquaint the students with versatile tools and techniques employed in genetic engineering and allow them for innovative application of these in basic and applied fields of biological research. The course may be deemed as a foundation course serving as a platform for introduction of more advanced cutting-edge technologies.

Unit-I
Molecular markers in genome analysis (SNP, microsatellites, CNV, RFLP, RAPD and AFLP); Mapping of genome: Genetic and physical maps; Transposon and transposition; DNA replication; DNA damage and repair; Types of noncoding RNAs; Synthesis and processing of mRNA and microRNA; RNA dependent DNA synthesis; Genetic code; Protein synthesis; Post-transcriptional and post-translational modifications.

Unit-II
Regulation of gene expression in Prokaryotes: Operon concept (*lac*-operon and *trp*-operon); Transcription attenuation; Gene regulation of lytic and lysogenic cycles; Gene regulation by riboswitches.

Regulation of gene expression in eukaryotes: combinational control in yeast GAL Genes and yeast mating type switching; Insulators, activators and repressors of transcription; Gene silencing; Gene imprinting; RNA interference; DNA methylation and acetylation; Signal transduction.

Unit-III

DNA foot printing analysis; Methods for measuring transcript levels: nucleic acid hybridization, FRET, nuclear run-off assays, subtractive hybridization; Amplified differential gene expression; Serial analysis of gene expression; Reporter gene assay (Beta-galactosidase, Luciferase assay, Chloramphenicol acetyl transferase).

Unit-IV

Blotting techniques (Southern, Northern and Western); Genome sequencing approaches (Shot gun and Clone contig strategies); DNA and RNA sequencing, Next generation sequencing; CRISPR-Cas; Transgenic and Knockout animals.

Unit-V

Tools of genetic engineering: enzymes, cloning vectors, host cells; Gene library and cDNA library; Molecular diagnosis of diseases; Production of pharmaceuticals (hormones); DNA fingerprinting.

After successful completion of the course the student should be able to design and comprehend experimental strategies for whole genome, transcriptome and proteome analysis. The student should be able to appropriately access and utilize various online and offline tools and databases related to genomic analysis.

Zoo - 402A MICROBIAL ECOLOGY AND BIOTECHNOLOGY, AND NANOBIOLOGY

Course Objectives:

1. To study the ecosystem of microbes in varied habitats.
2. To study different microbes caused pathogenicity.
3. To understand the use of microbes in the production of biofuels, antibiotics, and the decomposition of waste products.
4. To have a better understanding of the application of microbes for the synthesis of insecticides, biogas and biofertilizers.
5. To apply the concept of nanoscience in biological research.

Learning Outcomes:

The learners will be familiarized about the application of nanotechnology in biological research.

Microbial Ecology

Unit-I

Human micro biome; Microbes in metal containing habitat; Bioleaching of metals; Microbial adaptation to contaminated environment; The problems and prospects of bio mining; Biofuel production with reference to microbes; Role of microbes in decomposition process and waste utilization.

Unit-II

Epidemiology; Microbial mechanisms of pathogenicity; Antimicrobial drugs; Biology of SARS group of viruses; Biology of HIV; Biological warfare; Gut microbiota and brain activity.

Microbial Biotechnology

Unit-III

Bioprocess technology; Isolation and screening of industrially important microbes; Strain improvement; Production of antibiotics, beverages, enzymes, milk product; Food microbiology; Biomaterials; Microbial degradation of xenobiotics; Electronic waste management.

Unit-IV

Principles of bioreactor engineering; Bacterial cloning other than *E. coli*; Downstream processing; Production of microbial insecticides; Bioconversion; Biogas production; Bio fertilizers; Mushroom production technology.

Nanobiology

Unit-V

Basic concept; nanoparticles; Applications: Nanobiomechanics, nanoparticle–biomolecule conjugate, nanomedicines, nanosubmarine and nanozymes.

Zoo - 403A ANIMAL DEVELOPMENT AND NEUROBILOGY

Course Objectives:

1. To study the molecular mechanism of embryonic development.
2. Understand the causes and mechanism of abnormalities during the developmental process.
3. To learn the application of stem cells.
4. To know the working mechanism of the nervous system
5. Learn several diseases associated with abnormal function of the nervous system.

Learning Outcomes:

Enhancement of knowledge on modern techniques used to manage embryonic development.

Unit-l

Morphogenetic determinants in egg cytoplasm and Role of maternal contribution in early embryonic development, Differential gene expression during development, Application of Developmental Biology in medicine, Regeneration therapy, *in vitro* fertilization (IVF).

Unit-II

Teratogenesis, teratogenic agents and mechanism of teratogenesis; Ageing: maximum life span, mechanisms and models.

Unit-Ill

Stem cells: embryonic, adult, induced pluripotent and transgenic; Stem cell therapy; Gene therapy (somatic cell gene therapy and germ line gene therapy).

Unit-IV

General features of neurons, Cellular organization of neurons, Dendrites and Axon, Glial cells, Schwann cells, Nerve cells as signaling units, Cytoskeleton of the neuron - Microtubule, Microfilament, Neuro filament, Synthesis of macromolecules by nerve cells, Synthesis and trafficking of neuronal proteins: Cytosolic protein, Nuclear and Mitochondrial protein, Cell membrane and Secretory proteins; Synaptic transmission: types and structure of the synapse, transmission across the synapse, Pre- and post-synaptic events; Excitatory and inhibitory transmission.

Unit-V

Neurotransmitters: Synthesis, Storage, Release, Neuropeptides: Mode of action, Role of neuropeptides and coexistence of neuropeptides with other neurotransmitters, Learning and Memory, CSF and Blood brain barrier, Neurodegenerative Disorders: Parkinson's and Alzheimer's diseases, Senile dementia, Myasthenia Gravis.

Zoo - 404A PROJECT AND PROJECT DISSERTATION

Each student has to carry out a project (either an experiment or a review), submit a dissertation and make a PowerPoint presentation of the work before the examiners.

b) Organismic Biology

Zoo - 401B STRUCTURE AND FUNCTION OF VERTEBRATES

Course Objective:

1. To get the idea on structural modification of integuments, endoskeleton, nervous system and urogenital system.

Learning Outcomes:

Basic information on the structure of a organ will help students to understand the working principle of the organs and its system in animals.

Unit-I

Outline classification and evolution in Chordates, Integument and its derivatives, Development, Structure and function of skin and its derivatives, Glands, Scales, Horns, Claws, Nails, Hoofs, Feathers and Hairs.

Unit-II

Endoskeleton - Axial and appendicular, Feeding and nutrition - Functional modification of digestive tract in relation to feeding.

Unit-Ill

General plan of blood circulation in various groups: Blood, Evolution of heart, Aortic arches and Portal systems, Respiratory system: Cutaneous, Gill and Lung respiration, Air sacs in birds, characters of respiratory tissue.

Unit-IV

Nervous system and sense organs: General plan of brain structure, Evolution of cerebral hemispheres and cerebellum, Comparative anatomy of brain and spinal cord, Peripheral nervous system.

Unit-V

Structural modification of urinogenital system in vertebrates, Ultrastructure of kidney, Evolution of reproductive passages.

Zoo - 402B POPULATION GENETICS AND EVOLUTION

Course Objectives:

1. To familiarize the students with the concept of evolutionary forces and their role in the cause of genetic variations in a population.
2. To analyze the role of genetic factors in speciation.

Learning Outcomes:

Knowledge of genetic variation in a population will enable to study the quantitative and qualitative traits of the organism which, in turn, will enhance the adaptability the organism in their habitat.

Unit-I
Theories of organic evolution (Darwinism) Neo-Darwinism, Hardy-Weinberg law of genetic equilibrium and destabilizing forces of evolution (Mutation, Genetic drift, Migration, Natural selection)

Unit-Il Genetic variability: Genetic structure of a population, Phenotypic variation, Factors affecting human diseases. Population genetics: Patterns of change in nucleotides and Amino acids, Molecular variation, Emergence of New-Darwinism

Unit-III
Genetics of quantitative traits in populations, Estimation of heritability, Genotype-environment interactions, Inbreeding depression, Phenotypic plasticity, Analysis of quantitative traits.

Unit-IV
Genetics of speciation: Models of speciation, Reproductive isolation, Phylogenetic and biological concept of species. Molecular evolution: Gene evolution, Assessment of molecular variation.

Unit-V
Origin of higher forms: Phylogenetic gradualism and Punctuated equilibrium, Macro and Mega evolution, Population genetics and ecology: Monitoring natural populations, Loss of genetic variation, Conservation of genetic resources in diverse taxa.

Zoo - 403B ENVIRONMENTAL BIOLOGY AND TOXICOLOGY

Course Objectives:

1. To study the science of environment and to find out the cause of environment toxicity.

Learning Outcomes:

Sustainable management of the environment can be done if basic information on toxicants and its effect on environment is known to the stakeholders.

Unit-I
Energy flow in ecosystem, Food chains, Food web; Population and its characteristics

Unit-II
Environmental pollution Greenhouse effect, Biotic community and Conservation of natural resources.

Unit-Ill

Toxicology: Definition and classification of toxic agents and their mode of action, Pesticides, Solvents, Metals, Carcinogens, Xenobiotics.

Unit-IV

Environmental Toxicology, Food additives, air, water and soil pollutants, Principles of systemic toxicology, Genotoxicology.

Unit-V

Statistical methods in toxicology, Environmental policy and Environmental impact assessment (EIA), Regulatory toxicology, Residue analysis, Human toxicology and Medical ethics.

Zoo - 404B PROJECT AND PROJECT DISSERTATION

Each student has to carry out a project (either an experiment or a review), submit a dissertation and make a PowerPoint presentation of the work before the examiners.

c) Cell Biology

Zoo - 401C MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Course Objectives:

1. To study the functional regulation of genes, the basic concepts of genetic engineering and its application to study the function of gene.

Learning Outcomes:

Prior knowledge of function regulation of genes and genetic engineering techniques will enable us to carry out different laboratory approaches to change the function of a gene either for beneficial product formation or rectification of defect in the gene.

Unit-I

Basic concepts on genes and genome, Regulation of gene expression in prokaryotes, Structure of prokaryotic gene, DNA - binding domains and protein to protein binding domains of regulatory proteins, Operon concept, Lac-operon, *trp*-operon, *ara*-operon, Transcription attenuation, Lytic and Lysogenic cascades.

Unit-II

Regulation of gene expression in eukaryotes: Types of eukaryotic genes, Eukaryotic promoters, Transcription factors, Transcription activators, Regulation of galactose metabolism in yeast, Intracellular and intracellular signals that regulate eukaryotic gene expression.

Unit-III

Basic concepts of genetic engineering: Enzymes, Vectors, Host, Cloning, Gene Library, cDNA expression.

Unit-IV

Molecular techniques in genetic engineering: Isolation of DNA and RNA from animal tissues and blood, Probes, Polymerase chain reaction, Restriction Fragment Length Polymorphism, Blotting techniques

(Southern, Northern and Western), Genome sequencing (Shotgun and paired-end strategies and comparative genome analysis).

Unit-V

Application of biotechnology in Medicine and Health, Diagnosis of diseases such as AIDS, Tuberculosis and genetic defects such as Cystic fibrosis, Cancer, Muscular dystrophy, Production of pharmaceuticals: Hormones (Insulin, Growth hormone), Recombinant vaccines, Gene therapy, Forensic Science: DNA fingerprinting for criminal identity and Paternity testing.
Disease-resistant and Transgenic plants Study of gene expression: Transgenes and Knockout animals, Gene silencing, Human genome project, Enzyme and whole cell immobilization and its industrial application.

Zoo. 402-C MICROBIAL ECOLOGY AND MICROBIAL BIOTECHNOLOGY

Course Objectives:

1. To study the ecosystem of microbes.
2. To familiarize with the concepts of bioreactor, bioprocessing, bioleaching and commercial production of biofules, antibiotics, decomposition of waste products using microbes.

Learning Outcomes:

Knowledge of microbial biotechnology will help in harvesting of the microbial products in a cost effective way

Learning Outcomes:

Microbial Ecology

Unit-I

Distribution of microbes in soil, water, air, milk, food; Microorganisms of the body; Microbes in metal containing habitat; Metal-microbe interactions, Microbial immobilization and transformation of metals, Microbial application of metal removal.

Unit-II

Microbial adaptation to contaminated environment; Microbe-petroleum (Fuels) interactions; Problems and prospects of biomining; Biofuel production with reference to microbes; Role of microbes in decomposition process and waste utilization.

Microbial Biotechnology

Unit-III Bioprocess technology: Isolation and screening of industrially important microbes, Strain improvement, Production of antibiotics, Beverages, enzymes, Milk products, Vaccines, Fermentation.

Unit-IV

Principles of bioreactor engineering; Bacterial closing other than *E, coli;* Downstream processing operations; Production of microbial insecticides and mycoherbicides.

Unit-V

Bioconversion; Waste control; Biogas production and Bioleacting; Plant-microbe interactions and Bio fertilizers; Mushroom production technology.

Zoo- 403C ANIMAL DEVELOPMENT AND VERTEBRATE IMMUNE SYSTEM

Course Objectives:

1. To study the factors regulating the embryonic development.
2. To understand the axis development in amphibia and chicks.
3. To learn the detailed procedures and components of cell culture.
4. To study the structural and functional organization of the immune system in the body.
5. To understand the molecular mechanism of immune response to infectious diseases.

Learning Outcomes:

Knowledge of body pattern formation can tell us the roles played by different genes. Management of diseases to enhance the survivability of the organism can be done if we know the response mechanism of immune system of the body to infectious agents.

Unit-I

Morphogenetic determinants in egg cytoplasm and Role of maternal contributions in early embryonic development, Differential gene expression during development.

Unit-II

Organization of multicellular Embryo: Axis formation in amphibia and chick; Cellular basis of animal morphogenesis, Cytoplasmic fiber system, Cellular shape changes and epithelial folds, Mesenchyme shape change and cell mortality, Intercellular adhesion, Organogenesis : The vertebrate lens and Vertebrate limb.

Animal cell culture

Unit-Ill

Equipment and material for animal cell culture technology, Importance of culture media. Natural and defined media, Development and maintenance of primary cultures and established cell lines, Large scale cultivation (Monolaycr, Suspension and Microcarrier cultures, Fermentation Technology for growth of animal cells and their products), Use of embryonic tissues and embryo culture, Stem cells (embryonic and adult): their culture and application in research and therapeutics, Hybridoma technology.

Vertebrate immune system

Unit-IV

Organization and expression of immunoglobulin Gene structure, Models of Ig gene structure, Multigene organization, DNA rearrangements and mechanism, Generation of antibody diversity, Differential expression of Ig genes, BCR and TCR regeneration and diversity.

Unit-V

Immune response to infectious diseases, AIDS and other immunodeficiencies, Application of immunological techniques.

Zoo - 404C PROJECT AND PROJECT DISSERTATION

Each student has to carry out a project (either an experiment or a review), submit a dissertation and make a PowerPoint presentation of the work before the examiners.

d) Medical Entomology

Zoo-401D MORPHOLOGY TAXONOMY AND BIO-DIVERSITY OF VECTORS

Course Objectives:

1. To study the morphology, characteristics features of insect vectors spreading diseases.
2. To learn the techniques of preserving biodiversity using both traditional and modern molecular tools.

Learning Outcomes:

The title shall help in gaining the knowledge on diversity of insects and their role in spreading diseases. This will help ultimately to control the spread of diseases by these vectors.

Unit I

Morphology of medically important insects and other arthropods, Head: antenna, mouth parts, Thorax: wings, wing venation, legs, general structure, abdomen: Appendages, cerci, external genitalia.

Unit II

Taxonomic concepts and Classification of Arthropoda, Type concept, Population concept, Levels of Taxonomy: Taxonomic hierarchy; Species concept: species, infraspecific categories, sibling species, subspecies, variants within populations.

Unit III

Characteristics of different classes of Arthropoda. Classification of insect, Characteristics of orders: Diptera, Siphonaptera, Anoplura, Hemiptera, Dictyyoptera.

Unit IV

Collection and preservation techniques: Mosquitoes, sandflies, fleas, lices, ticks, flies; Characteristics of biodiversity, Biodiversity hotspots, biosphere species documentation, Diversity indices, invasive species, Relationship between anthropogenic stressors, vector biodiversity.

Unit V.

Theory and practice of molecular taxonomy, Molecular techniques in mosquito taxonomy, RFLP-RAPD, Microsatellites, SNPs, Microarrays and DNA bar coding.

Zoo- 402D ARTHROPODS OF PUBLIC HEALTH IMPORTANCE

Course Objectives:

1. To study the role of arthropods in cause of different diseases in human, its impact and management.

Learning Outcomes:

Knowledge of arthropods causing health problems in human can enable us to eradicate the carriers of diseases.

Unit I

Introduction to arthropods of public health importance Arthropods, diseases and epidemiological triad, vectors, pests, transmission, cyclic and secular trend of diseases.

Unit II

Arthropods as vectors of human diseases, Modes of disease transmission: vertical and horizontal transmission, biological, mechanical and contact transmission cycle, interseasonal maintenance.

Unit III

Anthroponotic diseases Malaria, filariasis, visceral leishmaniasis, onchocerciasis, trypanosomiasis, chagas diseases, scrub typhus, thck typhus, Disease vectors, distribution and transmission, socio-economic impact on human population.

Unit IV

Zoonotic diseases Cutaneous leishmaniasis, schistosomiasis, plague, Kyasanur Forest Disease(KFD), leptospirosis, dracunculiasis, Disease vectors, distribution and transmission, socio-economic impact on human population.

Unit V

Arthropods of public health nuisance and their management. Houseflies, cockroaches, lice, bugs, scorpions, centipede, millipede, wasps, bees, beetles, spiders, ants, distribution and impact on human health, toxins, venoms, allergy, asthma.

Zoo - 403D EPIDEMIOLOGY AND BIOSTATISTICS

Course Objectives:

1. To learn different approaches of studying epidemiology.
2. To learn the objective of using different statistical methods in solving biological problems related to epidemiology.

Learning Outcomes:

Different aspects of health related data can be analyzed by use of biostatistics. Adoption of a particular study approach in health sector can be carried out if we know the basic understanding of statistical methods.

Unit I

Principles of Epidemiology and epidemiological studies, Definition, aim and scope of epidemiology, target population, sampled population, Descriptive studies, Case reports, Case series – ecological and cross sectional studies. Analytical studies, observational (case-control, cohort), experimental (clinical/community trials), Surveillance concepts, tools and methods for vectors and disease, epidemic outbreak investigations.

Unit II

Epidemiological measures Rates, ratio, proportions (incidence, prevalence, risk difference, relative risk, odds ratio, attributable risk), Standardization of rates (direct/indirect), Association and causation (spurious, direct/indirect), Screening for disease (types and uses, sensitivity, specificity, positive and negative predictive values)

Unit III

Sampling methods, Data types: qualitative, quantitative, Tables, Graphs, Averages (mean, median, mode), Dispersions: range, mean deviation, variance, standard deviation, standard error, Coefficient of dispersion.

Unit IV.

Descriptive statistics, Population, sample, parameter statistic, Sampling frame, sampling unit, Methods of sampling: simple random, systematic, stratified, cluster, Determination of sample size, Binomial, Poisson, negative binomial, normal distribution.

Unit V

Applied statistics, Level of significance: type I, type II errors, Null and alternative hypotheses, Chi-square tests, t-tests. ANOVA (one and two way), Correlation and Regression, Scatter diagram, Pearson's correlation coefficient rank correlation, least square regression, Profit analysis, Calculation of Lc50/Lc90 values.

Zoo - 404D PROJECT AND PROJECT DISSERTATION

Each student has to carry out a project (either an experiment or a review), submit a dissertation and make a PowerPoint presentation of the work before the examiners.