

**MSc. CBCS SYLLABUS IN ZOOLOGY-2021-22  
SEMESTER-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 OR	40	6	100
	A 6 credit SWAYAM course as per availability and relevance			
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-305	Practical related to theory papers	60	6	100

**C. ALLIED ELECTIVE COURSE \***

Course No.	Course Title Environment,	Lectures	Credits	Marks
ZOO-303	Environmental Biology and Wildlife Conservation	40	6	100
ZOO-304	Animal Physiology and Developmental Biology	40	6	100

**Total Credits-30, Marks-500**

\* Open for students of allied Department

**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	-	12	200

**Total Credits-30, Marks-500**

**Grand Total Marks= 2000**

**Credits-120**

**b) Organismic Biology**

Course No	Course Title	Lectures	Credits	Marks
Zoo-401B	Structure and Function of Vertebrates	40	6	100
Z00-402B	Population Genetics and Evolution	40	6	100
Zoo-403B	Environmental Biology and Toxicology	40	6	100
Z00-404B	Project work	40	6	100
Z00-405B	Practical related to theory papers	60	6	100

**c) Cell Biology**

Course No	Course Title	Lectures	Credits	Marks
Zoo-401C	Molecular Biology and Genetic Engineering	40	6	100
Z00-402C	Cellular and Integrative Neurobiology, Environmental Biotechnology	40	6	100
Zoo-403C	Animal Development and Vertebrate Immune System	40	6	100
Z00-404C	Project work	40	6	100
Z00-405C	Practical related to theory papers	60	6	100

**d) Medical Entomology** (This paper is proposed to run at RMRC, Bhubaneswar subject to willingness and approval by Director, RMRC)

Course No	Course Title	Lectures	Credits	Marks
Zoo-401D	Morphology, Taxonomy and Biodiversity of Vectors	40	6	100
Z00-402D	Arthropods of Public Health Importance	40	6	100
Zoo-403D	Control of Vector of Public Health Importance & Biostatistics	40	6	100
Z00-404D	Project work	40	6	100
Z00-405D	Practical related to theory papers	60	6	100

**Total Credits-30, Marks-500**

**Grand Total Marks= 2000**  
**Credits-120**

**Zoo - 101 BIOSYSTEMATICS, BIOINFORMATICS AND NON-CHORDATES**

**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, Curation, 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 indices.

**Bioinformatics**

**Unit-III**

Introduction to genomics and proteomics databases- Nucleic acid sequence databases: Genbank, EMBL, DDBJ, protein sequence databases: Swiss-prot, Uniprot, PDB, BLAST, PSI- BLAST (steps involved in use and interpretation of results) and BLAST vs FASTA, file formats- FASTA, GCG and ClustalW; 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., Protein structure prediction; Homology modelling.

**Non-Chordates**

**Unit-IV**

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**

**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, oncogenes and tumor suppressor genes.

**Unit-III** 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**

### **Physiology**

#### **Unit-I**

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

#### **Unit-II**

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

#### **Unit-III**

#### **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**

**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**

**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-II:**

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-III:**

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, 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**

**Microbiology**

**Unit-I**

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 animals, alterations 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-III**

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**

**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-III**

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 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**

**Evolutionary Biology**

**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 assortative 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**

**Chordates**

**Unit-I**

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

**Unit-II**

Origin and evolution of amphibians, reptiles and 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; Single cell protein.

**Zoo - 302 DEVELOPMENTAL BIOLOGY**

**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 and 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-III**

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**

**Unit-I: Environmental Biology**

Ecosystem: Ecological niche, Resource partitioning, population growth curves, life history statistics (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-III**

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).

**ANIMAL PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY**

**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 and 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 (Action potential; Synaptic transmission), 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**

**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**

**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

#### 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 cycle; 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 footprinting 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.

### Zoo - 402A MICROBIAL ECOLOGY AND BIOTECHNOLOGY, AND NANOBIOLOGY

#### 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 NEUROBIOLOGY**

**Unit-I**

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-III**

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**

**Unit-I**

Outline classification and evolution of 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-III**

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**

**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-II** Genetic variability: Genetics 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**

**Unit-I**

Energy flow in ecosystem, Food chains Population and its characteristics

**Unit-II**

Environmental pollution Green house effect Biotic community and Conservation of natural resources.

**Unit-III**

Toxicology : Definition and classification 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**

**Unit-I**

Basic concepts on genes and genome, Regulation of gene expression in prokaryotes, Structure of prokaryote 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**

**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 cloning other than *E. coli*, Downstream processing operations, Production of microbial insecticides and mycoherbicides.

**Unit-V**

Bioconversion, Waste control, Biogas production and Bioleaching, Plant-microbe interactions and Bio fertilizers, Mushroom production technology.

**Zoo- 403C ANIMAL DEVELOPMENT AND VERTEBRATE IMMUNE SYSTEM**

**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-III**

Equipments 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 (Monolayer, 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 their application in research and therapeutics, Hybridoma technology.

**Vertebrate immune system**

**Unit-IV**

Organization and expression Ig 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**

**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, Dictyoptera.

**Unit IV**

Collection and preservation techniques and Biodiversity, Mosquitoes, sandflies, fleas, lice, 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**

**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**

**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.**

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