BOTANY

1. MOLECULES AND THEIR INTERACTION RELAVANT TO BIOLOGY

A. Composition, structure and function of biomolecules (carbohydrates, proteins, nucleic acids and vitamins

B. Bioenergetics, glycolysis, energy transducers. oxidative phosphorylation, coupled reaction, group transfer, biological

C. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.

D. Conformation of nucleic acids (A-B-Z-DNA), t-RNA, micro-RNA).

E. Stability of protein and nucleic acid structures.

F. Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins

2. CELLULARORGANIZATION

A. **Membrane structure and function:** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

B. Structural organization **and function of intracellular organelles:** Cell wall, nucleus mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility

C. **Organization of genes and chromosomes:** Operon, interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons.

D. **Cell division and cell cycle:** Mitosis and meiosis, their regulation, steps in cell cycle, and control ofcell cycle.

E. **Microbial Physiology:** Growth, yield and characteristics, strategies of cell division, stress response

3. FUNDAMENTALPROCESSES

A. **DNA replication, repair and recombination:** Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extra chromosomal replicons, DNA damage and repair mechanisms.

B. **RNA synthesis and processing**: Transcription factors and machinery, formation of initiation complex. Transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport.

C. **Protein synthesis and processing**: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation and elongation factors, termination, genetic code, amino acylation of tRNA, tRNA identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post-translational modification of proteins.

D. **Control of gene expression at transcription and translation level** : Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing

4. CELL COMMUNICATION AND CELL SIGNALING

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

B. **Innate and adaptive immune system:** Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity, B and T cell epitopes, structure and function of antibody molecules, generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen antibody interaction, MHC molecules, antigen processing and presentation, activation and differentiation of B and T Cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system. Toll-like receptors, cell mediated effector functions, inflammation, hypersensitivity and autoimmunity, Immune response during bacterial (tuberculosis), parasitic (Malaria) and viral (HIV) infections, Congenital and acquired immune deficiencies, vaccines

5. DEVELOPMENTAL BIOLOGY

A. **Basic concepts of developmen**t: Potency, commitment, specification, induction, competence, determination and differentiation, morphogenetic gradients, cell fate and cell lineages, stem cells equivalence and analysis of development. The cytoplasmic determinants, imprinting, mutants and transgenics

B. **Gametogenesis, fertilization and early development:** Production of gametes, embryo sac development and double fertilization in plants; zygote formation, embryogenesis, establishment of symmetry in plants, sees formation and germination.

C. **Morphogenesis and organogenesis in plants: Organization** of shoot and root apical meristem, shoot and root development, leaf development and phyllotaxy, transition to flowering, floral meristems and floral development in ***Arabidopsis*** and ***Antirrhinum***.

D. Programmed cell death, aging and senescence.

6. SYSTEM PHYSIOLOGY PLANT:

A. **Photosynthesis:** Light harvesting complexes, mechanisms of electron transport, Photo protective mechanisms, CO_2 fixation-C3, C4 and CAM pathways.

B. **Respiration and photorespiration:** Citric acid cycle, plant mitochondrial electron transport and ATP synthesis, alternate oxidase photo respiratory pathway.

C. **Nitrogen Metabolism:** Nitrate and ammonium assimilation, amino acid biosynthesis.

D. **Plant hormones:** Biosynthesis, storage, breakdown and transport, physiological effects and mechanisms of action.

E. **Sensory photobiology:** Structure, function and mechanisms of action of phytochromes, Cryptochromes and phototropins, stomatal movement, photoperiodism and biological clocks.

F. **Solute transport and photo assimilate translocation:** Uptake, transport and translocation of water, ions solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem, transpiration, mechanisms of loading and unloading of photoassimilates.

G. **Secondary metabolites:** biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

H. **Stress physiology**: Responses of plants to biotic (pathogens and insects) and abiotic (water Temperature and salt) stresses, mechanisms of resistance to biotic stress and tolerance to abiotic stress

7. INHERITANCEBIOLOGY

A. **Mendelian principles**: Mendelian inheritance Dominance, segregation, independent assortment, deviation from Mendelian genetics

B. **Concept of gene:** Allele, multiple alleles, pseudoallele, complementation tests.

C. **Extensions of Mendelian principles**: Codominance, incomplete dominance, gene interactions, pleiotropy genomic imprinting penetrance and expressivity, phenocopy, linkage and crossing over sex linkage sex limited and sex influenced characters.

D. **Gene mapping methods:** Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

E. **Extra-chromosomal inheritance**: Inheritance of mitochondria land chloroplast genes, maternal inheritance.

F. **Microbial genetics**: Methods of genetic transfers- transformation, conjugation, transduction and sex deduction, mapping genes by interrupted mating, fine structure analysis of genes.

G. **Quantitative genetics:** Polygenic inheritance, heritability and its measurements, QTl mapping.

H. **Mutation:** Types, causes and detection, mutant types-lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis

I. **Structural and numerical alterations of chromosomes:** Deletion, translocation, ploidy and their genetic implications duplication, inversion.

J. **Recombination:** Homologous and non-homologous recombination, including transposition, site-specific recombination

8. DIVERSITY OF LIFE FORMS

A. Principles and methods**:** of taxonomy, concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of plants and microorganisms.

B. **Levels of structural organization:** Unicellular, colonial and multicellular forms, levels of organization of tissues, organs and systems, comparative anatomy.

C. **Outline classification of plants and microorganisms**: Important criteria used for classification in each taxon, classification of plants and microorganisms, evolutionary relationships among taxa.

D. **Natural history of Indian subcontinent**: Major habitat types of the subcontinent, geographic origins and migrations of species

9. ECOLOGICAL PRINCIPLES

A. **The environment**: Physical environment, biotic environment, biotic and abiotic interactions.

B. **Habitat and niche:** Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement.

C. **Population ecology**: Characteristics of population, population growth curves, population regulation,life history strategies (r and K selection), concept of metapopulation demes and dispersal, interdemic extinctions, age structured populations.

D. **Species interactions**: Types of interactions, interspecific competition, herbivory, carnvory, pollination, symbiosis.

E. **Community ecology:** Nature of communities, community structure and attributes, levels of species diversity and its measurement, edges and ecotones.

F. **Ecological succession**: Types, mechanisms, changes involved in succession, concept of climax.

G. **Ecosystem**: Structure and function, energy flow and mineral cycling (CNP) primary production and composition, structure and function of some Indian ecosystems, terrestrial (forest, grassland) and aquatic (freshwater, marine, estuarine).

H. **Biogeography:** Major terrestrial biomes, theory of island biogeography, biogeographical zones of India.

I. **Applied ecology**: Environmental pollution, global environmental change, biodiversity-status, monitoring and documentation, major drivers of biodiversity change, biodiversity management approaches.

J. **Conservation biology**: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

10. METHODS IN BIOLOGY

A. **Molecular biology and recombinant DNA methods:** Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods, analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing gels molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems, expression of recombinant proteins using bacterial, animal and plant vectors, isolation of specific nucleic acid sequences, generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAG and YAC vectors, in vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms, protein sequencing methods, detection of post-translation modification of proteins, DNA sequencing methods, strategies for genome sequencing, methods for analysis of gene expression at RNA and analysis of carbohydrate and lipid molecules, RFLP, RAPD and AFLP techniques.

B. **Histochemical and immunotechniques** Antibody generation, detection of molecules using ELISA, RIA, western blot, immune precipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, localization by techniques such as FISH and GISH.

C. Biophysical methods: Analysis of biomolecules using UV/visible fluorescence, circular dichorism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR analysis using light scattering different types of mass spectrometry and surface plasma resonance methods.

A. **Statistical Methods**: Measures of central tendency and dispersal, probability distributions (Binomial, Poisson and normal), sampling distribution, difference between parametric and non- parametric statistics, confidence interval, errors, levels of significance, regression and test, basic introduction to 2% correlation, t-test, analysis of variance, Muetro variate statistics,etc.

B. **Radiolabeling techniques**: Properties of different types of radioisotopes normally used in biology, their detection and measurement, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

C. **Microscopic techniques**: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.

D. **Methods in field biology:** Methods of estimating population density of plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior habitat characterization-ground and remote sensing methods.

E. **Plant tissue culture:**The sub-titles/topics would be: sterilization methods, nutrient medium, micropropagation, Types of plant tissue culture, role of plant growth regulators, significance of plant tissue culture, cryopreservation, gene bank.

F. **Biofertilizers:** Plant growth promoting rhizobacteria (PGPR), Phosphate solubilizing microorganisms,Zinc-solubilizing microorganisms, Iron-solubilizing microorganisms, Biological nitrogen fixation, Nodule formation, Selection, isolation and multiplication of beneficial microorganisms