Syllabus

PHYCOLOGY

Overview of Algal Division: Glaucophyta, Rhodophyta, Chlorophyta, Dinophyta and Bacillariophyta.

Cyanophyta: Phycobilisome chemistry, Heterocyst - Ultrastructure, biochemistry, *nif*- gene regulation, ecology.

Ultrastructure of algal cell: Flagellar motor and nuclear division.

Phytoplankton ecology: Types of Phytoplankton, Primary production, Nutrient uptake model - Michelies-Menton and Monod and Droope model.

MICROBIOLOGY

Methods in Microbiology: Methods for isolating pure cultures, types of culture media, enrichment culture techniques, maintenance and preservation of pure cultures.

Growth and Nutrition: Bacterial growth: definition, growth parameters, measurement of growth, synchronous growth, growth kinetics, factors affecting growth. Batch and continuous culture. Control of microbial growth: physical and chemical methods. Nutritional requirements and nutritional classification of bacteria.

Microbial Metabolism: Metabolic pathways of energy production. Fermentation and fermentative pathways. Regulatory mechanisms in bacteria- induction, repression, feed back inhibition, catabolite repression and attenuation. Nitrogen metabolism: ammonification, nitrification, denitrification and nitrogen fixation.

Bacterial Genetics: Organization and replication of genetic material in bacteria: chromosome and plasmid, Gene transfer mechanisms: conjugation, transformation and transduction. Recombination in bacteria.

Medical Microbiology: Host defense mechanisms, Pathogenic properties of bacteria: toxins and extracellular enzymes; brief account of major human disease and their bacterial pathogens. Principles of chemotherapy, chemotheraputic agents: sulpha drugs and antibiotics -chemistry and mode of action.

Viruses and acellular microbes: Nomenclature and classification, distinctive properties of virus, morphology and ultrastrucutre, capsid and their arrangements, types of envelope and their composition, viral genome, their types and structure, virus related agents (viriods and prions). Viral replication: lytic and lysogenic.

CELL BIOLOGY AND BIOMOLECULES

Macro-molecules: Carbohydrates- mono, di- and polysaccharides; amino acids and peptides; lipids, classification, structure and function, their roles in biological membranes. Primary, Secondary, Tertiary and Quaternary structure of proteins; α-helix, β-sheet and collagen structure; Nucleic acid classification, physical and chemical properties.

Biomembranes: Structural models; Composition and dynamics; Biogenesis and assembly, Dynamic, aspects of cell wall during growth and differentiation; Transport of ions and

macromolecules; Pumps, carriers and channels; Endo- and exocytosis.

Ribosomes and Protein Synthesis: Organization and biogenesis of ribosomes; Ribosome structure and its significance in protein synthesis; translation of prokaryotes and eukaryotes.

Cell cycle: Introduction, phases, cell cycle control in yeast.

Deoxyribonucleic acid: Structure and properties of DNA, aberrant structures; Melting and reassociation of DNA, Cot curves, repetitive and unique sequences, Rot curves and gene expression.

DNA replication: Mode of replication of circular and linear DNA molecules, machinery of DNA replication in prokaryotes and eukaryotes; replication of nucleosomes.

Transcription in prokaryotes and eukaryotes: Promoters, enhancers, transcription factors; initiation, elongation and termination of transcription in prokaryotes and eukaryotes

RNA and DNA polymerases: Types, structure and function; polymerase chain reaction: theory, applications and modifications.

MYCOLOGY AND PLANT PATHOLOGY

Mycology : 1. Dormancy, germination and growth; 2. Carbohydrate metabolism; 3. Cell cycle in Yeast; 4. Biotechnological approaches in mushroom production.

Plant Pathology: 1. Mechanism of penetration and the process of disease development; 2. Mechanism of disease resistance; 3. Genetics of host pathogen interaction; 4. Biotechnological approaches for diseases resistance.

TAXONOMY OF ANGIOSPERMS

Tools of Taxonomy: Functions of field, herbarium, botanic gardens, floras/literature, GIS (geographic information system).

Nomenclature: History of ICBN, aims and principles, rules (incl. fossils and cultivated plants) and recommendations, proposed bio and phylocodes.

Concepts and Principles of Assessing Relationship: Phenetic numerical taxonomy-principles, philosophies, methods, merits and demerits.

Biodiversity: Concepts, levels, hotspots, megadiversity centers, status (with special reference to India); Concerns- extinction and threats (IUCN categories), conservation-needs and methods.

PALAEOBOTANY AND PALYNOLOGY

Basic geological information related to palaeobotany: Sedimentary rocks; Taphonomy; dating the pages of earth history; nomenclature and reconstruction of fossil plants; Stratigraphy; Basic concepts of continental drift and plate tectonics.

Origin and evolution of plant life forms: The earliest environments; Brief idea of Origin of life; first prokaryotes; evolution of eukaryotes; geological records of algae (stromatolites, diatoms, dinoflagellates), fungi (endomycorrhiza and epiphyllous fungi), bryophytes and their ecological significance.

Palynology: Branches of palynology; Spore, pre-pollen and pollen morphology, wall chemistry, evolution of aperture types.

Applied palaeobotany and palynology: i) Fundamentals of palaeofloristics, palaeogeography, palaeoecology and palaeoclimatology; Application of neopalynology and palaeopalynology. ii) Ancient DNA and other fossil biomolecules and their potential in evolutionary research; stable isotopes and tree ring in reconstruction of palaeoclimate.

GENETICS AND GENOMICS

Introduction and importance of Plant Genetics: Basic discoveries in classical and molecular genetics; Extension of mendelism: Allelism; gene function to produce polypeptides; interaction with environment; penetrance and expressibility; gene interaction- epistasis, pleiotropy, continuous variations Model organisms for genetic studies: Life cycle of *Neurospora*, *Arabidopsis* and Corn.

Linkage, crossing over and chromosome mapping: Crossing over as the physical basis of recombination; chromosome mapping; three-point test cross. Construction of genetic and physical map; molecular polymorphism.

Genome organization in Eukaryotes: Types of genomes, genetic features of eukaryotic nuclear genomes; development of gene concept, gene replication, organization of structural and functional elements of chromosome:- centromere, telomere heterochromatin and telomerase, sex chromosomes in plants; special chromosomes in different eukaryotes; genome duplication and alterations and their role in evolution; Genes and gene number; Law of constancy and C-value paradox.

Gene expression: Control of gene expression; Control of gene expression in bacteriophage lambda, T -phages; RNA phages; Regulation of prokaryotic gene expression (lac, his, trp operons and catabolite repression); Regulation of gene expression in eukaryotes, heterochromatin in gene silencing.

Genetic Integrity and Diversity: Physical and chemical basis of equational separation of chromosomes; Recombination, Mechanism of recombination; Evolutionary significance of recombination; genetic control of recombination. Mutagenesis: Molecular basis of spontaneous and induced mutations; Transposon mutagenesis, *In vitro* mutagenesis, Site-directed mutagenesis, Environmental mutagenesis; Repair and retrieval systems; Mobile genetic elements: Structure and function of transposable elements and their role in evolution, Extranuclear genetics.

PLANT PHYSIOLOGY AND BIOCHEMISTRY

1. The atom and chemical bonds, reaction orders, pH, buffer, indicator, physico-chemical properties of water.
2. Plant water relationship.
3. Photosynthesis: complexes of electron transport in chloroplast, mechanism of electron transport, generation of proton gradient and ATP generation, bioenergetics of light reaction,

$C0_2$ concentrating mechanism in plants, regulation of C3- C4 and CAM cycles.
4. Structure, biosynthesis, role and mechanism of action of auxin, gibberellins, cytokines, ethylene and abscisic acid.
5. Bio-energetics: an overview.
6. Protein: primary, secondary, tertiary and quaternary structure of proteins, biosynthesis, purification and characterization, Ramachandran plot.
7. Mechanism of enzyme action, enzyme kinetics, enzyme inhibition.

PHYTOCHEMISTRY AND PHARMACOGNOSY

1. Classification and pharmacological action of plant drugs.
2. Carbohydrates - starch, cellulose derivatives, gums.
3. Alkaloids, definition, properties, classification, alkaloidal drugs - *Datura stramonium, Atropa belladona,* opium, *Cinchona,* tea, ergot, *Rauvolfia, Holarrhena, Catharanthus* alkaloidal constituents, uses, allied drugs.
4. Phenolic compounds produced by plants, types, biological activity, drugs - Senna, Aloe, Hypericum, Capsicum.
5. Steroidal compounds, different types, biological activity and pharmaceutical importance
6. Volatile oils, composition, drugs- clove, *Mentha, Eucalyptus, Foeniculum, Cinnamomum,* citronella

PLANT MOLECULAR BIOLOGY AND BIOTECHNOLOGY

1.**Recombinant DNA technology:** Principles and methods of recombinant DNA technology-expression of cloned genes in *E. coli,* cloning in yeast: transformation in yeast, yeast artificial chromosome (YAC), retrovirus like vector (Ty) in yeast/shuttle vector.
2. **Plant tissue culture:** Organogenesis, Embryogenesis, *in vitro* fertilization, Apomixis and application of haploidy and DH populations in transgenic breeding and crop improvement; Molecular and Biochemical markers of in vitro regenerability of plants.

3. **Genetic transformation:** Vector construction, Protoplast system (electroporation and PEG), *Agrobacterium* system, *en-planta* transformation and Biolistic system; Screenable and selectable markers and their use; Chloroplast transformation; Marker-free methodologies; Gene stability, Inheritance and Differential expression of trans genes in plants.

4. Pest management in crop plants, Biopesticides, Built-in plant protection (Bt technology) safety and environmental issues

5. Molecular breeeding for abiotic stress tolerance (stress regulated genes expression, osmotic stress signalling, application in salt, cold and drought tolerance in plants)

6. Biofortified crops (improvement of micronutrients in food crops; e.g. Iron and pro-vitamin A enriched rice, Vitamin E-maize, Protein improvement in rice and potato etc.)