SUBJECT : BOTANY

SYLLABUS

Unit I

Algae:

General account of algology. Contributions of Indian Phycologists: (M.O. Parthasarathy, V. Desikachary, V. Krishnamurthy and V.S. Sundaralingam). Classification of algae by F.E. Fritsch (1935-45). Algae of diverse habitats, Range of thallus organization in algae. Reproduction (vegetative, asexual and sexual) and life cycle patterns of algae. Cyanobacteria (blue green algae). Economic importance of algae.

Fungi:

General Characteristics, Contributions of Indian Mycologists (C.V.Subramanian). Classification of Fungi by Alexopoulos and Mims (1979). Heterothallism and para-sexuality in fungi. Sex hormones in fungi. Reproduction in fungi (asexual and sexual). Spore dispersal mechanism in fungi. Mycorrhizae. Fossil fungi, Economic importance of fungi.Mushroom cultivation.

Lichens:

Classification of lichens based on Morphology, habitat, internal structure and fungal partner. Interrelationship of phycobionts and mycobionts.Structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens. Lichens as indicators of pollution. Economic importance of lichens.

Bryophytes:

General feature, Classification of Bryophytes (Proskauer, 1957). Distribution, Morphology, Anatomy, Reproduction and Life cycle of Marchantiales, Jungermanniales, Anthocerotales and Polytrichales. Spore dispersal mechanisms and germination pattern. Evolutionary trends in Sporophytes and gametophytes of bryophytes. Fossil bryophytes. Economic importance of bryophytes.

Unit II

Pteridophytes:

Classification of Pteridophytes (Reimer, 1954). Stelar evolution. Telome theory. Sorus – Origin, types and sporangial development. Heterospory and seed habit – Alternation of generations. Apogamy, Apospory and parthenogenesis in Pteridophytes. Comparative morphology, anatomy, reproduction and evolutionary studies of the following groups: Psilopsida, Lycopsida, Sphenopsida and Pteropsida. Economic importance of Pteridophytes.

Gymnosperms:

General character, classification of gymnosperms (Sporne, 1974). Origin and Evolution of gymnosperms. Comparative study of vegetative, anatomical and reproductive characteristics of Cycadales, Ginkgoales, Coniferales, Gnetales. Economic importance of gymnosperms.

Paleobotany:

Concept of Paleobotany: Geological time scale. Contributions of Birbal Sahni, Technique for paleobotanical studies. Fossilization process, Types of fossils, the fossil records: systematic reconstruction and nomenclature of fossil plants, Determination of Age of Fossils, Fossil Pteridophytes: *Rhynia, Sphenophyllum, Lepidocarpon, Botryopteris*. Fossil Gymnosperms: *Williamsonia* and *Cordaites*.

Unit III

Morphology:

The plant body. Root: Structure and functions. Root modification. Stem: aerial and underground stem modifications. Leaf: Types, phyllotaxy, venations and leaf modifications. Inflorescence: Types. Flower: Floral whorls, sex, symmerty, Aestivation, Fusion. Ovary position, placentation. Fruits: Types. Seeds: Parts of seeds, Types, seed dispersal.

Taxonomy and Systematics:

Objectives of plant systematics, Concepts of Taxonomic hierarchy. Species concepts. Botanical nomenclature: principle, Rules and Recommendation of ICN. Systems of classification: Linnaeus, Bentham and Hooker, Engler and Prantl, Takhtajan, Angiosperm phylogeny Groups (APG systems). Modern Trends in Plant Taxonomy – DNA Bar coding and Molecular Systematics – Cladistic Methodology – Taxonomic keys, Botanical Gardens, BSI, Herbarium techniques and Application. Virtual/digital Herbarium. Systematic Position, salient features and economic importance of the following families: Nymphaeaceae, Magnoliaceae, Aristolochiaceae, Arecaceae, Orchidaceae, Commelinaceae, Zingiberaceae, Cyperaceae, Menispermaceae, Combretaceae, Lythraceae, Moraceae, Rosaceae, Meliaceae, Sapindaceae, Nyctaginaceae, Portulacaceae, Boraginaceae, Fabaceae, Rubiaceae, Bignoniaceae, Pedaliaceae and Convolvulaceae.

Economic Botany:

General account on utilization of selected crop plants: (i) Cereals and millets (ii) Pulses (iii) Vegetables, Fruits and Nuts (iv) Cosmetics plants (v) Oil seeds (vi) Sugar yielding plants, (vii) Spices and condiments, (viii) Fibre yielding Plants (ix) Timber yielding plants (x) Resins, gums and latex (xi) Essential oils (xii) Beverages, (xiii) Dyes, (xiv) Plants used as avenue trees for shade, pollution control and aesthetics and (xv) Energy plantation – uses of *Casuarina*.

Medicinal Botany:

Traditional medicinal systems in India. Importance of ethnobotany in Indian context. Active principles, biochemical properties and medicinal uses of *Phyllanthus amarus, Justicia adhatoda, Andrographis paniculata, Curcuma longa, Cannabis sativa, Glorisa superba, Cymbopogon citratus, Catharanthus roseus and Rauwolfia serpentina.*

Unit IV

Anatomy:

Classification of tissues. Theories of organization of shoot, root and floral meristems. Root and shoot transition. Cambium – Vascular cambium and cork cambium – origin, development and types. Anomalous thickening in dicot and monocot stems. Xylem: components, structure. Secondary elements, hard wood, soft wood, growth ring, heart wood and sap wood, Tyloses, Reaction wood and Tension wood. Patterns of secondary wall thickening. Phloem – components and structures. Tissue system: Types and characteristics – Secondary elements, Secretory cells and tissues: Structure, classification and significance. Nodal anatomy. Leaf: Epidermal tissue, development of stomata, Stomatal types, leaf anatomy: monocots and dicots. Plant galls: types, structure and development. Experimental anatomy – PGR and tissue differentiation.

Embryology:

Microsporangium – Microsporogenesis, Microspores: morphology, ultrastructure, Microgametogenesis. Pollen wall development, Pollen – Stigma – Incompatibility. Methods to overcome incompatibility. Megasporangium. Megagametogenesis: Female gametophyte, Monosporic, Bisporic and Tetrasporic, Nutrition of embryo sac and fertilization. Pollination: Types and pollination agents – Fertilization and post fertilization events: Endosperm: Types. Endosperm haustoria. Cytology and physiology of endosperms. functions of endosperms. Embryo development in Dicot and Monocot. Polyembryony – Causes. Apomixis, Apospory and parthenocarpy – Their role in plant improvement program. Seed development.

Microtechniques:

Microscopy – Principle and applications, Light microscope: Bright field, Dark field, Phase contrast microscopy, Fluorescence Microscope, Electron microscope (TEM & SEM). Microtome: Types, Principles and operating mechanisms. Maceration, Squashes, Smears, Whole mount and clearing techniques. Fixation and fixatives, dehydration, clearing, infiltration, Embedding, Block making and sectioning. Stains and staining techniques.

Unit V

Cell Biology:

Cell structure, organization of prokaryotic and Eukaryotic cells. Cell theory, ultrastructure and molecular organization of cell wall, Plasma membrane, cytoplasm, protoplasm, Endoplasmic reticulum, Golgi bodies, plastids, mitochondria, chloroplast, lysosomes, Ribosome, vacuoles, Nucleus. Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle and control of cell cycle. Organization of nuclear genome: DNA as genetic material – prokaryotic and eukaryotic DNA – chromatin – chromosomes – Gene –Transposon. Replication of DNA and types.

Molecular Biology:

Transcription in prokaryotes and eukaryotes (RNA synthesis – enzymology – signaling) – mechanics of initiation, elongation, termination – post–transcriptional modifications and RNA splicing – regulation of gene expression (lac and trp operons) – RNA interference (TGS and PTGS) – Translation (genetic code – redundancy and elucidation of base composition – tRNA charging – initiation, elongation and termination) – post translational modifications. Molecular Chaperones – Heat shock proteins. Bioinformatics: Concepts, scope and applications.

Unit VI

Genetics and Biostatistics:

Mendelian genetics – Mendel‘s Law of inheritance, non mendelian inheritance, Gene interactions – complementary genes, Lethal genes, Epistasis, Quantitative inheritance. Chromosomal basis of inheritance. Gene Linkage and crossing over-Kinds of linkage, types of crossing over mechanism. Sex determination in plants, theories of sex determination. Sex linked characters. Multiple alleles and pseudo alleles. Cytoplasmic inheritance, organelle heredity with reference to chloroplast and mitochondrial mutants –male sterility in plants. Population Genetics – Gene pool, Gene Frequencies, Mutation, Selection, Migration, genetic drift, Hardy – Weinberg law. Mutation: Types of Mutation. Mutagenic agents and their mode of action.

Biostatistics: principle, scope and application in biological sciences. Standard deviation and coefficient of variation (CV). Test of significance: Z test, t-test and chi square test. probablity and distributuion. Correlation and regression.

Plant Breeding:

Domestication and introduction of plants. Origin of cultivated Plants. Vavilov's center of origin. Organic Agriculture. Conventional Plant Breeding systems: introduction, Selection – Types of selection, selection in self and cross pollinated crops. Hybridization-Hybridization techniques, male sterility, self-incompatibility, heterosis and hybrid vigor. Role of polyploidy in crop improvement. Green revolution, Applications of tissue culture and molecular techniques in plant breeding.

Unit VII

Plant Physiology:

Solute transport: Properties of water, Diffusion, Osmosis and water potential, mechanism of water absorption. Translocation of water and solutes through membranes, Mechanisms of loading and unloading of photo-assimilates. Transpiration and stomatal movements. Mineral nutrition: Role of Macro and Micro nutrients. Deficiency symptoms.

Photosynthesis:

Light harvesting complexes; photosynthetic pigments, mechanisms of electron transport; photo protective mechanisms; CO_2 fixation – C_3, C_4 and CAM pathways – Factors affecting photosynthesis.

Respiration:

Types of respiration, Glycolysis, Citric acid cycle; electron transport system and ATP synthesis; photorespiration and its significance.

Nitrogen metabolism and Secondary metabolites:

Nitrogen cycle and metabolism, Biological Nitrogen fixation. Secondary metabolites: Biosynthesis of terpenes, flavonoids, phenols and alkaloids and their physiological roles.

Plant Growth Regulators:

Physiological role and mechanisms of action of auxins, gibberellins, cytokinins, Ethylene and abscisic acid. Photobiology and photo morphogenesis: Phytochromes-history and discovery, occurrence and distribution; Cryptochromes – photochemical and biochemical properties. Vernalization. Circadian rhythm in plants. Plant Movements – nastic and tropic movements. Seed dormancy: causes and methods to break seed dormancy. Physiology of seed germination. Abscission and Senescence.

Stress physiology:

Causes, mechanisms, effects of plant responses and adaptation to biotic and abiotic stresses.

Biochemistry:

Chemical bonds and their interactions. Water – structure, pH concept – buffer, Molarity, Molality and Normality. Carbohydrates: Structures and classification. Lipids: Structure, classification and properties. Biosynthesis and biological significance of major lipids. Amino acids – classification, properties of Amino acids. Amino acid metabolism, Proteins: classification, structure (primary, secondary, tertiary and quaternary), properties of protein. Enzymes – general feature, naming and classification – Factors affecting enzyme activities. Enzyme inhibition, Mechanism of enzyme action. Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids.

Unit VIII **Ecology:**

History and scope of ecology, Autecology: Characteristics of a population; population growth curves; population regulation; life history strategies (R and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured population. Synecology – Characteristics of community, composition and structure, origin and development, ecotone, edge effect, ecological niche. Ecological interdependence and interaction – positive and negative interactions. Competition – inter-specific and intra-specific. Ecological Succession: Types, mechanisms, concept of climax.

Concept and dynamics of Ecosystem:

Types of Ecosystem, components, Food chain, food webs. Concept of trophic level, Ecological pyramids, Energy flow ecosystem. Mineral cycling (C, N, P); primary production and decomposition; structure and function of terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine) ecosystems.

Environmental pollution and Management:

Types, causes, effects and control measures of air, soil, water, thermal, noise and heavy metal pollution; Bioremediation and biodegradation – Bio-mining, microbes in leaching metals. Biodiversity management; climate change and its consequences; global environmental change; greenhouse effect, Climate change conferences.- Kyoto Protocol climate agreement – Carbon trade and carbon credits. Blue carbon and IPCC. Tools to study global climate change. GIS application in Biodiversity and Environmental Impact Assessment (EIA).

Biodiversity conservation:

Need for conservation – *in-situ* conservation – sanctuaries, national parks, biosphere reserves; *ex-situ* conservation – Gene banks, seed banks, Pollen banks and Cryopreservation. Role of indigenous people in conservation of sacred species, sacred groves; Human and animal conflicts in Biodiversity conservation, Red List categories of IUCN. Forest conservation through laws – the biological diversity Act (2002) in force. National Biodiversity Authority.

Phytogeography:

Principle of plant geography – Phytogeographic regions of India, Dispersal and migration barrier hypothesis, Willis age and area hypothesis. Continuous range, cosmopolitan, circumboreal and circum austral, pantropical, Discontinuous distribution Wegner's theory continental drift hypothesis, land bridges hypothesis, Endemism. Biogeographic classification of India, Biodiversity hotspot regions of India and the World.

Unit IX

Microbiology and Plant Pathology:

Bacteria: Classification of bacteria (Bergey's Manual of Bacteriology, 1994), structural organization and reproduction of bacteria, Motility, flagella and pili – Growth and Nutrition, growth curve, kinetics of bacterial growth. Sterilization techniques, culture media, staining techniques for bacterial identification – Bacterial genetics: conjugation, transformation and transduction. Application: fermentor and types of fermentations – industrial products from bacteria, agricultural applications of bacteria, bacteria in Bioremediation. Structure and reproduction of Archaebacteria, Cyanobacteria, Mycoplasma and Actinobacteria (Actinomycetes).

Virology:

General characteristics, Classification of plant viruses (ICTV,1970), structure and multiplication of plant viruses. Bacteriophage: Structural characteristics and multiplication. Virion, viroid, virusoids and prions. Isolation and purification of plant viruses.

Plant Pathology:

Classification of plant diseases, Symptomology. Principles of plant infection: Inoculum, inoculum potential, Pathogenicity, Disease triangle. Epidemiology and forecasting of plant diseases – Host parasite inter relationships and interaction. Pathogenesis: Mechanism of penetration- Disease development of pathogen

(colonization) and dissemination of pathogens. Environment and nutrition in relation to disease development – Defence mechanism. Role of enzymes and toxins in disease development. Diseases and disease cycle – Important diseases of crop plants in India: Sheath blight of rice, leaf spot of groundnut, Black rust of wheat, Late blight of potato, Fusarium wilt of cotton, Bacterial blight of rice, Citrus canker, Bunchy top of Banana, Root knot of Brinjal, Red rust of tea. Disease Resistance mechanism in plants. Techniques adopted in plant breeding for disease resistance. Principles of plant disease management – Cultural practices, physical, chemical and biological methods, disease controlled by immunization. Plant quarantine and legislation. Integrated Pest Management System. Plant protection organizations in India.

Unit X **Introduction to Plant Tissue Culture:**

Basics of plant tissue culture – concepts in plant tissue culture. Plant tissue culture techniques. Micropropagation, organ culture, mersitem culuture, protoplast culture and haploid plant production. Callus induction, Cell suspension culture, somatic embryogenesis, synthetic seed technology. Conservation of Plant genetic resources. Application of cell culture systems in metabolic engineering. Concepts and application of nanobiotechnology: Application of nano particles in Agriculure, environment and medicine. Impact of nano-science and nano-biotechnology to society.

Genetic Engineering:

Principles of rDNA technology. Molecular tools in Genetic engineering. Cloning vectors – Plasmids – types, Mechanism of plasmids, Isolation of plasmids. Cosmids and phage vectors. Construction of Genomic library, polymerase chain reaction (PCR), Molecular Markers (RAPD, RFLP and AFLP). Blotting techniques (Southern, Northern and Western blots). Sequencing methods for DNA. Genetic transformation and development of transgenic plants for insect, herbicide and viral resistances, Golden rice, Edible vaccines, Bio-farming, bioremediation and bioprospecting, salt and drought tolerant plants, enhancement of shelf life of flowers and fruits. Socio-economic and ethical aspects of biotechnology. Environmental laws; Intellectual property rights; World Intellectual Property Organization (WIPO) GATT, TRIPS, PBR and Farmers rights and its role. Ecological impact and biosafety issues of GM crops.