Syllabus for Lecturer (10+2) Botany

VIRUSES, BACTERIA AND ALGAE

Viruses: General characteristics, origin, chemical nature, and ultrastructure. Mechanisms of viral replication, morphology of TMV and bacteriophage, economic importance of viruses. Transmission of plant viruses and control measures. Modern concepts of oncogenic plant viral diseases-cucumber mosaic virus, cauliflower mosaic virus; general concept of viroids.

Bacteria: Origin and evolution, classification criteria and diversity, bacterial growth and nutrition, ultrastructural details, and types of reproduction. Nature of virulence, toxins, and extracellular enzymes of pathogenic bacteria; ecological and economic importance.; Cyano bacteria: Salient features, biological and ecological importance

Algae: Habitat diversity, range of thallus organization, and evolutionary relationships. Cell ultrastructure including cell wall, flagella, chloroplasts, pyrenoids, and eyespots, and their importance in taxonomy. Reproduction and criteria for classification of algae; modern trends in algal classification.

Morphology and reproduction of Cyanophyta (Anabaena), Chlorophyta (Ulothrix). Charophyta (Chara), Xanthophyta (Vaucheria), Bacillariophyta (Navicula). Phaeophyta (Fucus), and Rhodophyta (Batrachospermum). Economic importance of algae.

MYCOLOGY AND PLANT PATHOLOGY

Mycology: Fungi - general characteristics, cell ultrastructure, thallus organization, cell wall composition, nutrition, reproduction, heterothallism, heterokaryosis, parasexual life cycle, and recent trends in classification of fungi (Hyde et al., 2017). Structural diversity, mode of reproduction, and life cycle of Mastigomycotina (Albugo, Peronospora), Zygomycotina (Rhizopus, Mucor), Ascomycotina (Taphrina, Morchella), Basidiomycotina (Puccinia, Agaricus), and Deuteromycotina (Fusarium, Colletotrichum).

Role of fungi in the production of wine, beer, bread, organic acids, amino acids, enzymes, and vitamins. Food spoilage caused by fungi and fungal metabolites used in medicine, including the production of antibiotics; fungi as biocontrol agents. Mycorrhiza and its role. Mushroom cultivation (Agaricus & Ganoderma)-technique and utility.

Plant Pathology: Concept and significance of plant diseases. Disease triangle, pre-penetration activities of pathogens on the host surface, direct penetration through intact plant surfaces, and penetration through wounds and natural openings. Enzymatic degradation of cell wall substances.

Symptoms, causal organisms, disease cycle, and control of paddy diseases (Blast, Brown leaf spot, and Bacterial leaf blight); wheat diseases (Black stem rust and Bunt of wheat) ; maize disease (Leaf blight); grape diseases (Downy and Powdery mildew); apple disease (Scab); bacterial disease (fire blight of apple and pear, citrus canker). Plant disease management including regulatory methods, quarantine and inspections, physical methods, chemical methods, biological control, antagonistic plant as bio control agents and Integrated Pest Management (IPM).

ARCHEOGONATEE

Bryophytes: Evolution of gametophyte and sporophyte, fossil bryophytes, and habitat diversity of bryophytes. Modern trends and criterion in bryophyte classification. Morphology, anatomy, and reproduction (excluding developmental details) of Marchantia, Anthoceros, and Funaria. Evolution of sporophyte, apogamy and apospory, alternation of generations, economic importance, and horticultural uses of bryophytes.

Pteridophytes: General characteristics, origin and evolution, telome theory. heterospory, and origin of seed habit. Stelar evolution and recent trends in classification. Fossil pteridophytes, structural features, and evolutionary significance of Psilophytales (Psilophyton), Lepidodendrales (Lepidodendron), and Calamitales (Calamites). Diversity, morphology, anatomy, and reproduction in Psilopsida (Psilotales), Lycopsida (Lycopodiales, Selaginellales, Isoetales), Sphenopsida (Equisetales), Ophioglossales, Eusporangiate ferns (Marattiales), and Leptosporangiate ferns (Filicales, Marsileales, Salviniales). Economic importance of pteridophytes.

Gymnosperms: General characteristics, origin and evolution, recent trends in classification, and economic importance. Distribution of living gymnosperms in India. Morphology and anatomy of vegetative and reproductive organs and interrelationships of Cycadales, Ginkgoales, Coniferales, Taxales, Ephedrales, Welwitschiales, and Gnetales. Fossil gymnosperms, structural features, and evolutionary significance of Pteridospermales, Cycadeoidales, and Cordaitales

ANGIOSPERM TAXONOMY, MORPHOLOGY, ECONOMIC BOTANY, ANATOMY AND EMBRYOLOGY

Plant Taxonomy: taxonomy and systematics; artificial, natural and evolutionary classification approaches; phenetics – principles and methods; cladistics – terminology and methods; angiosperm phylogeny group classification (APG-IV); role of morphology, cytology, palynology, phytochemistry and molecular biology in taxonomy; taxonomic categories and hierarchy; herbarium; botanic garden; methods of identification – dichotomous keys; cybertaxonomy; principles of International Code of Nomenclature for algae, fungi and plants; type method.

Economic Botany: origin, evolution, domestication and uses of food (maize and buckwheat), fodder (alfalfa), fibre (cotton), spices (saffron), oil-yielding plants (mustard and groundnut); general account, botany and uses of apple, pear, plum, cherry, almond and apricot; diversity, distribution and uses of important medicinal plants of Jammu and Kashmir

Morphology: general account of plant morphology; habit, habitat, life forms; root – types and modifications; stem – types and modifications; leaves: types, shapes, venation, phyllotaxis; inflorescence types; parts of flower, flower attachment and symmetry; perianth, types and aestivation; stamen type, attachment, position, number and fusion; anther types and attachment; nectaries; gynoecium – parts of carpel, fusion and number; ovary attachment and position; placentation and its types; fruit and its types; seeds and their types.

Anatomy: plant tissue types – meristematic, permanent and their sub-types; structure and function of primary meristematic tissues; secondary meristems – vascular cambium and cork cambium; periderm; lenticels; abscission; structure and function of primary and secondary xylem and phloem; general account of wood structure (heart wood and sap wood, early and late wood); development and ultrastructure of trichomes and stomata; anatomy of monocot and dicot seeds; seed appendages.

Embryology: Microsporogenesis; pollen wall, apertures-NPC system; development of male gametophyte; ovule structure and types; **Megasporogenesis;** embryo sac types (monosporic, bisporic and tetrasporic); **Pollination** – types and adaptations; agencies of pollination – abiotic and biotic. pollen germination – *in vitro* and *in vivo*; pollen viability and storage, pollen pistil interaction; **Self-incompatibility** – sporophytic and gametophytic self-incompatibility. biochemical mechanism of self-incompatibility; methods to overcome incompatibility barrier; **Double fertilization** and its significance; triple fusion; endosperm-types, development, structure and functions; **Embryogenesis** – development and structure of typical dicot and monocot embryos; seed and fruit formation; polyembryony – types and its significance; apomixis – types and its practical applications.

BIOCHEMISTRY AND PLANT PHYSOOLOGY

Biomolecules: Composition, structure and function of biomolecules- carbohydrates, lipids, proteins, nucleic acids, and vitamins. Stability of proteins and nucleic acids. Conformation of proteins: Ramachandran plot, secondary structure, domains, motifs and folds.

Enzymes: kinetics of single-substrate enzyme catalyzed reactions- Michaelis-Menton equation and its significance; enzyme inhibition and mechanism of enzyme catalysis; extraction and purification of enzymes (brief account).

Photosynthesis: photosynthesis from historical and evolutionary perspective; photosynthetic pigments; components of light reaction; light harvesting complexes; photo-oxidation of water; mechanisms of electron and proton transport; carbon assimilation, Calvin cycle (C3 cycle), C4 Cycle, CAM pathway; characteristics of C3, C4 and CAM plants; photorespiration and its energetics.

Respiration: glycolysis and citric acid cycle (overview and unique features in plants); pentose phosphate pathway; electron transport system; synthesis and release of ATP; alternative oxidase system; cyanide resistant respiration

Nitrogen and sulphur metabolism: nitrogen in environment; mechanism of nitrate uptake and assimilation; ammonium assimilation; biological nitrogen fixation; nodule formation and nod factors; photorespiratory nitrogen cycle; sulphur uptake, transport and assimilation.

Plant hormones: Biosynthesis, transport, physiological effects and mechanism of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroides, polyamines, jasmonic acid and salicylic acid.

Sensory Photobiology: light-oxygen- voltage "LOV" sensors, xanthopsins, phytochromes, blue- light sensors using flavin adenine dinucleotide "BLUF", cryptochromes and rhodopsins (A brief overview). phytochromes and cryptochromes:

discovery, structure, photochemical and biochemical properties, cellular localization and responses.

Solute transport and photoasssimilate translocation: plant water relations (water potential and its components); mechanism of water transport through xylem; phloem transport; phloem loading and unloading; membrane transporter proteins and processes.

The control of flowering: floral evocation (internal and external cues), endogenous clock and its regulation; photoperiodic control of flowering; vernalization and its significance.

ECOLOGY AND ENVIRONMENT

Population Ecology: population characteristics; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, age structured populations.

Habitat and Niche: concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Species Interactions: types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Community Ecology: nature of communities; community structure and attributes; species diversity and its measurement, richness and evenness; edges and ecotones; guilds.

Ecological Succession: temporal changes (cyclic and non-cyclic); mechanism of ecological succession (relay floristics and initial floristic composition; facilitation, tolerance and inhibition models, resource ratio hypothesis); changes in ecosystem properties, concept of climax and its characterization. diversity- disturbance, and diversity stability relationships.

Ecosystem Ecology: biotic component-food chains, food web, trophic cascades; abiotic component soil formation, soil profile development, soil horizons and soil classification. primary production (gross and net primary production, controlling factors and methods of measurement), energy flow pathways, ecological efficiencies; litter accumulation and decomposition (mechanisms, substrate quality and climatic factors). Biogeochemical cycles of C, N, P and S (pathways, processes, budgets and anthropogenic impact).

Biogeography: diversity patterns: species abundance distribution, diversity patterns (latitudinal gradient- contributory factors and explanatory theories). MacArthur and Wilson's Island biogeography theory. Biomes: types (terrestrial and aquatic), distribution and unique features.

Applied Ecology: environmental monitoring; environmental pollution and bioremediation; global environmental change, ecosystem management; Restoration Ecology: concept, concerns, strategies and planning; biodiversity- ecosystem function relationship (BEF).

Conservation Biology: biodiversity components, levels and values; major drivers of biodiversity loss; biodiversity conservation (*ex-situ* and *in-situ*); sustainable development with reference to SDGs; environmental policies (national and international). Biodiversity hotspots. IUCN threat categories.

GENETICS, CYTOGENETICS AND PLANT BREEDING

Mendelian Principles: Dominance, segregation, independent assortment

Concept of gene: Allele concept-complementation test, Multiple Alleles, split genes, overlapping genes, Pseudogenes

Extension of Mendelian Principles: Codominance, incomplete dominance, pleiotrophy, gene interaction (epistasis)

Linkage and crossing over: Types of linkage, genetic recombination, chromosome mapping (three point test cross), sex linked inheritance.

Chromosome: Structure and organization of chromosomes in prokaryotes and eukaryotes, B-chromosomes (origin and function), organization of chloroplast genome.

Structural changes in chromosomes: Deletion, duplication, inversion and translocations

Numerical changes in chromosomes: Aneuploidy- Types, origin, production and utility; Euploidy-Origin, production, meiotic behavior and utility of Autopolyploidy and Allopolyploidy.

Mutations: Spontaneous and induced mutations, molecular basis of point mutations, frame shift mutations, suppressor mutations, back mutations, Missense mutations.

Populations genetics: Hardy-Weinberg Law, factors affecting Hardy-Weinberg equilibrium.

Plant Breeding: Objectives and activities in plant breeding, mechanisms promoting self and cross pollination, pureline selection, backcross method, heterosis and inbreeding depression, production of hybrid varieties, genetic and transgenic male sterility.

CELL AND MOLECULAR BIOLOGY

Cell wall and plasma membrane: structure and functions; membrane proteins – integral and transmembrane proteins.

Cell organelles: Structure and function of chloroplast, mitochondria, golgi complex and Endoplasmic Reticulum.

DNA Structure (Watson & Crick model), Mechanism of DNA Replication, Replication apparatus -Enzymatic Machinery, DNA damage and repair mechanisms.

Transcription: Types of RNA, mechanism of transcription, transcription factors, and repressors, post transcriptional modifications (RNA editing, splicing, polyadenylation),

Translation: Ribosome structure and assembly, tRNA, aminoacylation of tRNA, aminoacyl tRNA Synthetase, Genetic code, mechanism of protein synthesis, initiation, elongation and termination factors, major differences between prokaryotes and eukaryotes (at translational level).

Regulation of gene expression: in prokaryotes (Lac operon, tryptophan operon) and eukaryotes (role of promoters, activators, repressors and DNA methylation).

BIOTECHNOLOGY

Biotechnology-concept, scope and applications

Plant Tissue Culture: Cellular totipotency, cytodifferentiation, Organogenesis, Culture techniques (Cell and suspension culture), Haploidy-methods of production of haploids, utility of haploids, Somatic Embryogenesis-mechanism of induction and utility, Somatic

hybridization-Protoplast fusion, regeneration and utility of hybrids and cybrids. **Cryopreservation**-short and long term storage.

Genetic Engineering: Principles of Gene Cloning, Restriction Enzymes-types and utility, Cloning vectors (Plasmids, Phages, Phagemids, cosmids, YAC, construction of recombinant DNA, methods of construction of Genomic and cDNA libraries and their utility.

Gene transfer in plants-Agrobacterium mediated gene transfer, Direct methods of gene transfer. Application of transgenic plants (Herbicide resistance, Insect Resistance, Edible Vaccines, Golden Rice, Flavr Savr Tomato).

Molecular Markers (RFLP, RAPD, SSR, SNP, AFLP)- concept and utility, Gene knockout concept,

DNA sequencing techniques, Human Genome Sequencing Project; Microarray technology and its utility. concept of genomics, Proteomics and metabolomics.

Gene Silencing mechanisms-RNA interference (RNAi), Antisense RNA Technology, Gene Editing (CRISPR).