MPAT – Botany

Appendix – I

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Syllabus Botany

UNIRAJ MPAT 2016 – 17

Section A

Phycology : Algae in diversified habitats (terrestrial, freshwater, marine), thallus organization, cell ultra structure, reproduction. (Vegetative, asexual, sexual), criteria for classification of algae: pigments, reserve food, flagella, classification; salient features of Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta. Phaeophyta and Rhodophyta: with special reference to *Microcystis, Hydrodictyon, Drapernaldiopsis, Cosmarium,* algal blooms, algal biofertilizers: algae as food, feed and usesin industry.

Mycology: General characters of fungi, substrate relationship in fungi, cell ultrastructure, unicellular and multicellular organization, cell wall composition, nutrition (saprobic, biotrophic, symbiotic), reproduction (vegetative, asexual, sexual), heterothallism, heterokaryosis, parasexuality, recent trends in classification. Phylogeny of fungi, general account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina, with special reference to *Pilobolus, Chaetomium, Morchella, Melampsora. Polyporus, Drechslera & Phoma,* fungi in industry, medicine and as food, fungal diseases in plants and humans, Mycorrhizae, fungi as biocontrol agents.

Bryophyta : Morphology, structure, reproduction and life history, distribution, classification, general account of Marchantiales, Junger-maniales, Anthocerotales, Sphagnales, Funariales and Polytrichales, with special reference to Plagiochasma, Notothylus and Polytrichum, economic and ecological importance.

Pteridophyta : Morphology, anatomy and reproduction, classification, evolution of stele, heterospory and origin of seed habit, general account of fossil pteriodophyta, introduction to Psilposida, Lycopsida, Sphenopsida and Pteropsida, with special reference to *Lycopodium, Gleichenia, Pteris, Isoetes & Ophioglossum.*

GYMNOSPERMS

Introduction : Gymnosperms, the vessel-less and fruitless seed plants varying in the structure of their sperms, pollen grains, pollen germination and the complexity of their female gametophyte, evolution of gymnosperms. Classification of Gymnosperms and their Distribution in India Brief account of the families of Pteridospermales (Lyginopteridaceae, Medullosaceae, Caytoniaceae and Glossopteridaceae). General Account of Cycadeoidales and Cordaitales Structure and reproduction in Cycadales, Ginkgoales, Coniferales, Ephedrales, Welwitschiales and Gnetales.

TAXONOMY OF ANGIOSPERMS

Origin of intrapopulation variation: Population and the environment, ecads and ecotypes, evolution and differentiation of species - various models. The species concept: Taxonomic hierarchy, species, genus, family and other categories, principles used in assessing relationship, delimitation of taxa and

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attribution of rank. Salient features of the International Code of Botanical nomenclature. Taxonomic evidence: Morphology, anatomy, palynology, embryology, cytology, phytochemistry, genome analysis and nucleic acid hybridization. Taxonomic tools : Herbarium, floras, histological, cytological, phytochemical, serological, biochemical and molecular techniques, computers and GIS. Systems of angiosperm classification: Phenetic versus phylogenetic systems, cladistics in taxonomy, relative merits and demerits of major systems of classification, relevance of taxonomy to conservation, sustainable utilization of bio-resources and ecosystem research.

Concepts of phytogeography : Endemism, hotspots and hottest hotspots, plant explorations, invasions and introductions, local plant diversity and its socio-economic importance.

Phylogeny of Angiosperms : Ancestors of Angiosperms, time and place of origin of Angiosperms, Habit of Angiosperm, Primitive living Angiosperms, Inter relationship among the major groups of Angiosperms.

1. Important landmarks in the history of microbiology Archaebacteria and eubacteria: General account, ultra structure, nutrition and reproduction, biology and economic importance, cyanobacteria - salient features and biological importance.

2. Viruses: Classification, characteristics and ultra structure of virions, isolation and purification of viruses, chemical nature, replication, transmission of viruses, cyanophages, economic importance.

3. Phytoplasma: General characteristics and role in causing plant diseases. Scope and application of microbes in agriculture, industry, food, pollution and biological control of pests.

4. General account of immunity, allergy, properties of antigens and antibodies. Antibody structure and function, affinity and antibody specificity. Monoclonal antibodies and their uses, antibody engineering, serology, types of vaccines. Preliminary account of Biofilms, biochips, biosensors and biosurfactants.

5. History and scope of plant pathology: General account of diseases caused by plant pathogens.

Pathogen attack and defense mechanisms: Physical, physiological, biochemical and molecular aspects.

Plant disease management: Chemical, biological, IPM systems, development of Transgenics, biopesticides, plant disease clinics. Preliminary account of application of information technology in plant pathology.

Symptomology, identification and control of following plant diseases. Fungal diseases: Wheat (Rust, Smut, Bunt); Bajra (Green ear, ergot and smut), crucifer (rust).

Paddy (Paddy blast), Cotton (Wilt), Grapes (Downy mildew and powdery mildew). Bacterial disease: Wheat (Tundu), Citrus canker. Viral disease: Tobacco mosaic, Bhindi yellow mosaic. Phytoplasma disease: Little leaf of brinjal. Nematode disease: Root-knot of vegetables.

Section B

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Section - B

Introduction: Unique features of plant development, differences between animal and plant development.

Seed germination and seedling growth: Metabolism of nucleic acids, proteins and mobilization of food reserves, tropisms, hormonal control of seedling growth, gene expression, use of mutants in understanding seedling development.

Shoot development: Organization of the shoot apical meristem (SAM), cytological and molecular analysis of SAM, control of cell division and cell to cell communication, control of tissue differentiation, especially xylem and phloem, secretory ducts and laticifers, wood development in relation to environmental factors.

Leaf growth and differentiation: Determination, phyllotaxy, control of leaf form, differentiation of epidemis (with special reference to stomata and trichomes) and mesophyll.

Root development: Organization of root apical meristem (RAM), cell fates and lineages, vascular tissue differentiation, lateral roots, root hairs, root-microbe interactions.

Reproduction: Vegetative options and sexual reproduction, flower development, genetics of floral organ differentiation, homeotic mutants in *Arabidopsis* and *Antirhinum*, sex determination.

Male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development and gene expression, male sterility, sperm dimorphism and hybrid seed Production, pollen germination, pollen tube growth and guidance, pollen storage, pollen allergy, pollen embryos.

Female gametophyte: Ovule development, megasporogenesis, organization of the embryo sac, structure of the embryo sac cells.

Pollination, pollen-pistil interaction and fertilization : Floral characteristics, pollination mechanisms and vectors, breeding systems, commercial considerations, structure of the pistil, pollen-stigma interactions, sporophytic and gametophytic self-incompatibility (cytological, biochemical and molecular aspects), double fertilization, in vitro fertilization.

Seed development and fruit growth: Endosperm development during early maturation and desiccation stages, embryogenesis, ultra structure and nuclear cytology, cell lineages during late embryo development, storage proteins of endosperm and embryo, polyembryony, apomixis, embryo culture, dynamics of fruit growth, biochemistry and molecular biology of fruit maturation.

Latent life - dormancy: Importance and types of dormancy, seed dormancy, overcoming seed dormancy, bud dormancy.

Senescence and programmed cell death (PCD): Basic concepts, types of cell death, PCD in the life cycle of plants, metabolic changes, associated with senescence and its regulation, influence of hormones and environmental factors on senescence.

Plant Biodiversity: Concept, status in India, utilization and concerns

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Sustainable development: Basic Concepts. Origins of agriculture.

World centers of primary diversity of domesticated plants: The Indo-Barnase centre, plant introductions and secondary centers.

Origin, evolution, botany, cultivation and uses of (i) Food, forage and fodder crops, (ii) fiber crops, (iii) medicinal and aromatic plants and (iv) vegetable oil-yielding crops.

Important fire-wood and timber-yielding plants and non-wood forest products (NWFPs) such as bamboos, rattans. raw materials for paper making, gums, tannins, dyes, resins and fruits.

Green revolution : Benefits and adverse consequences. Innovations for meeting world food demands. Plants used as avenue trees for shade, pollution control and aesthetics. Plants used as avenue trees for shade, pollution control and aesthetics. Principles of conservation, extinctions, environmental status of plants based on International Union for Conservation of Nature.

Strategies for conservation - in situ conservation : International efforts and Indian initiatives, protected areas in India -sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs conservation of wild biodiversity.

Strategies for conservation - ex situ conservation: Principles and practices, botanical gardens. field gene banks, Seed banks, in vitro repositories, cryobanks, general account of the activities of Botanical Survey of India (BSI), National Bureau of plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR), and the Department of Biotechnology (DBT) for conservation, non formal conservation efforts.

Climate, soil and vegetation patterns of the World: Life zones, major biomes and major vegetation and soil types of the world..

Vegetation organization: Concepts of community and continuum, analysis of communities (analytical and synthetical characters), community coefficients. interspecific associations, ordination, concept of ecological niche.

Vegetation development: Temporal changes (cyclic and non-cyclic), mechanism of ecological succession (relay floristic and initial floristic composition, facilitation, tolerance and inhibition models), changes in ecosystem, properties during succession.

Ecosystem organization : Structure and functions, primary production (methods of measurement, global pattern, controlling factors), energy dynamics (trophic organization, energy flow pathways, ecological efficiencies), litter fall and decomposition (mechanism, substrate quality and Climatic factors), global biogeochemical cycles of C,N,P and S, mineral cycles (pathways, processes, budgets) in terrestrial and aquatic ecosystems.

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Biological diversity: Concept and levels, role of biodiversity in ecosystem functions and stability, speciation and extinction, IUCN categories of threat, distribution and global patterns, terrestrial biodiversity hot spots, inventory.

Air, water and soil pollution: Kinds, sources, quality parameters, effects on plants and ecosystems.

Climate change: Greenhouse gases (CO_2, CH_4, N_2O, CFCs: sources, trends and role), ozone layer and ozone hole, consequence of climate change (CO_2 fertilization, global warming, sea level rise, UV radiation).

Ecosystem stability: Concept (resistance and resilence), ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems, ecology of plant invasion, environmental impact assessment, ecosystem restoration.

Ecological management: Concepts, sustainable development, sustainability indicators.

Section C

Water relation of plants : Unique physicochemical properties of water, chemical potential, water potential, apparent free space, bulk movement of water, Soil Plant Atmosphere Continuum (SPAC), stomatal regulation of transpiration, signal transduction in guard cell.

Membrane Transport : Passive - non-mediated transport and Nernst equation, Passive-mediated transport, ATP-driven active transport, Uniport, Symport, Antiport Ion channels.

Amino acids, Proteins and Enzymes : Nod factor, root nodulation and nitrogen fixation. Structure of amino acids, stereo-isomers, Amphoteric properties, synthesis of amino acids by reductive amination, GS-GOGAT system and transamination, Structure of proteins: primary, secondary, tertiary, quaternary and domain structure, reverse turn and Ramchandran Plot, protein stability : electrostatic forces, hydrogen bonding, disulfide bonding and hydrophobic interaction. Enzymes: Structure and properties, substrate specificity, classification and mechanism of enzyme action.

Carbohydrates: Classification, structure and function of monosaccharides, Polysaccharides and glycoproteins including starch, cellulose and pectins. Photosynthesis : Photosynthetic pigments, absorption and transformation of radiant energy, photo-oxidation, four complexes of thylakoid membranes : photosystem I, cytochrome b6-f complex, photosystem II and coupling factors, photolysis of water and O_2 evolution, non-cyclic and cyclic transportation of electrons, water-water cycle, proton gradient and photophosphorylation, Calvin cycle, regulation of RUBISCO activity, control of Calvin cycle, C4 pathway and its, adaptive significance, CAM pathway, differences between C3 and C4 plants, glycolate pathway and photorespiration, chlororespiration and CO_2 concentrating mechanism in microorganism.

Respiration : Anaerobic and aerobic respiration, amphibolic nature of TCA cycle, pentose phosphate pathway, glyoxylate pathway, oxidative phosphorylation, gluconeogenesis, high energy compounds : their synthesis and utilization. Fat metabolism : Synthesis of long chain fatty acids, lipid biosynthesis, ...

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and β-oxidation. **Secondary metabolites:** Biosynthesis and function of secondary metabolites with special reference to tannins, alkaloids and steroids. **Plant growth regulators:** Auxins - chemical nature, bioassay, physiological effects and mode of action. Gibberellins - chemical nature, bioassay, physiological effects and mode of action. Cytokinins - chemical nature, bioassay, physiological effects and mode of action. Abscisic acid - chemical nature, bioassay, physiological effects and mode of action. Ethylene - chemical nature, bioassay, physiological effects and mode of action. **Physiology of flowering:** Photoperiodism and Vernalization.

CYTOLOGY

Chromatin organization : Chromosome structure and packaging of DNA, molecular organization of centromere and telomere, nucleolus and ribosomal RNA genes, euchromatin and heterochromatin, karyotype analysis, banding patterns, karyotype evolution, specialized types of chromosomes, polytene, lampbrush, B-chromosomes and sex chromosomes, molecular basis of chromosome pairing. **Structural and numerical alterations in chromosomes :** Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes, Origin, occurrence, production and meiosis of haploids, aneuploids and euploids, origin and production, of autopolyploids, chromosome and chromatid segregation, allopolyploids, types, genome constitution and analysis,

evolution of major crop plants, induction and characterization of trisomics and monosomics. **GENETICS**

Genetics of prokaryotes and eukaryotic organelles : Mapping the bacteriophage genome, phage phenotypes, genetic recombination in phage, genetic transformation, conjugation and transduction in bacteria, genetics of mitochondria and chloroplasts, cytoplasmic male sterility.

Gene Structure and expression : Genetic fine structure, cis-trans test, fine structure analysis of eukaryotes, introns and their significance, RNA splicing, regulation of gene expression in prokaryotes and eukaryotes. Panoply of operon, catabolite repression, attenuation and antitermination.

Genetic recombination and genetic mapping : Recombination, independent assortment and crossing over, molecular mechanism of recombination, role of RecA and RecBCD enzymes, site-specific recombination, chromosome mapping, linkage groups, genetic markers, construction of molecular maps, correlation of genetic and physical maps, somatic cell genetics - an alternative approach to gene mapping. **Mutations :** Spontaneous and induced mutations, physical and chemical mutagens, molecular basis of gene mutation, transposable elements in prokaryotes and eukaryotes, mutation induced by transposons, site-directed mutagenesis, DNA damage and repair mechanisms, inherited diseases and defects in DNA repair, initiation of cancer at cellular level, protooncogenes and oncogenes. Sex determination, sex, linked inheritance, sex limited characters and sex reversal, multiple allele's and blood groups in man.

CYTOGENETICS

Cytogenetics of aneuploids and structural heterozygotes : Effect of aneuploidy on phenotype in plants, transmission of monosomics and trisomics and their use in

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chromosome mapping of diploid and polyploid species, breeding behavior and genetics of structural heterozygotes, complex translocation heterozygotes, translocation tester sets, Robertsonian translocations, B-A translocations. **Molecular cytogenetics :** Nuclear DNA content, C-value, paradox, cot curve and its significance, restriction mapping - concept and techniques, multigene families and their evolution, in situ hybridization - concept and techniques, physical mapping of genes of chromosomes, computer assisted chromosome analysis, chromosome microdissection and microcloning, flow cytometry and confocal microscopy in karyotype analysis.

Alien gene transfer through chromosome manipulations : Transfer of whole genome, examples from wheat, Arachis and Brassica, transfer of individual chromosomes and chromosome segments methods for detecting alien chromatin, production, characterization and utility of alien addition and substitution lines, genetic basis of inbreeding and heterosis, exploitation of hybrid vigour.

The dynamic cell: Structural organization of the plant cell, specialized plant cell types, chemical foundation, biochemical energetics. **Cell wall:** Structure and functions, biogenesis, growth. **Plasma membrane:** Structure, models and functions, sites for ATPases, ion carriers, channels and pumps, receptors. **Plasmodesmata:** Structure, role in movement of molecules and macromolecules, comparison with gap junctions. **Chloroplast:** Structure, genome organization, gene expression, RNA editing, nucleochloroplastic interactions.

Mitochondria: Structure, genome organization, biogenesis. **Plant vacuole :** Tonoplast membrane, ATPase, transporters, as storage organelle. **Nucleus :** Structure, nuclear pores, nucleosome organization, DNA structure, A, B and Z forms, replication, damage and repair, transcription, plant promoters and transcription factors, splicing, mRNA transport, nucleolous, rRNA biosynthesis. **Restriction enzymes :** Cleavage of DNA into specific fragments, construction of a restriction map from the fragments, restriction sites, as genetic markers, RFLP and their use in plant breeding.

Ribosomes: Structure, site of protein synthesis, mechanism of translation, initiation, elongation and termination, structure and role of tRNA. **Protein sorting:** Targeting of proteins to organelles. **Cell shape and motility:** The cytoskeleton, organization and role of microtubules and microfilaments, motor movements, implications in flagellar and other movements. **Cell cycle and apoptosis:** Control mechanisms, role of cyclins and cyclin-dependent kinases, retinoblastoma and E2F proteins, cytokinesis and cell plate formation, mechanisms of programmed cell death. **Other Cellular organelles:** Structure and functions of microbodies, Golgi apparatus, lysosomes, endoplasmic reticulum.

Techniques in cell biology: Immuno-techniques, in situ hybridization to locate transcripts in cell types, FISH, GISH, confocal microscopy

Biotechnology: Basic concepts, principles and scope.

Plant Cell and tissue culture: General introduction, history, scope, concept of cellular differentiation, totipotency.

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Organognesis and adventive embryogenesis: Fundamental aspects of morphogenesis: somatic embryogenesis and androgesis, mechanisms, techniques, and utility.

Somatic hybridization: Protoplast isolation, Fusion and culture, hybrid selection and regeneration, possibilities, achievements and limitations of protoplasts research.

Applications of plant tissue culture: Clonal propagation, artificial seed, production of hybrids and somaclones, production of secondary metabolites/ natural products, cryopreservation and germplasm storage.

Recombinant DNA technology: Gene cloning principles and techniques, construction of genomic/cDNA libraries, choice of vectors, DNA synthesis and sequencing, polymerase chain reaction, DNA fingerprinting.

Genetic engineering of plants : Aims, strategies for development of transgenics (with suitable examples), *Agrobacterium* - the natural genetic engineer, T-DNA and transposon mediated gene tagging, chloroplast transformation and its utility, intellectual property rights, possible ecological risks and ethical concerns.

Microbial genetic manipulation: Bacterial transformation, selection of recombinants and transformants, genetic improvement of industrial microbes and nitrogen fixers, fermentation technology.

Genomics and proteomics: Genetic and physical mapping of genes, molecular markers for introgression of useful traits, artificial chromosomes, high throughput sequencing, genome projects, bioinformatics, functional genomics, microarrays, protein profiling and its significance.

Bioactive Compounds: Alkaloid, antioxidants, flavonoid, proteins and terpenoids.

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