SYLLABUS

for

M.Sc. (Botany)

(Previous & Final)

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School of Science

OPJS UNIVERSITY, CHURU(RAJASTHAN)

2014-15

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M.Sc. (Botany)

FIRST YEAR

COURSE I. MSB-101  CELL AND MOLECULAR BIOLOGY OF PLANTS
COURSE II. MSB-102  CYTOLOGY, GENETICS AND CYTOGENETICS
COURSE III. MSB-103  BIOLOGY AND DIVERSITY OF LOWER PLANTS: CRYPTOGRAMS
COURSE IV. MSB-104  TAXAONOMY AND DIVERSITY OF SEED PLANTS
COURSE V. MSB-105  PLANT PHYSIOLOGY AND METABOLISM

SECOND YEAR

COURSE VI. MSB-201  PLANT DEVELOPMENT AND REPRODUCTION
COURSE VII. MSB-202  PLANT ECOLOGY
COURSE VIII. MSB-203  PLANT RESOURCE UTILIZATION AND CONSERVATION
COURSE IX. MSB-204  BIOTECHNOLOGY AND GENETIC ENGINEERING OF PLANTS AND MICROBES
COURSE X. MSB-205  ELECTIVE/ PROJECT.

LIST OF ELECTIVE SUBJECTS:-

1.  STRESS BIOLOGY
2.  CROP GENETICS AND PLANT BREEDING
3.  PLANTS AND SOCIETY
4.  ETHNOBOTANY
5.  PLANT PROTECTION
6.  MOLECULAR BIOLOGY AND BIOTECHNOLOGY

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Details of Syllabus

FIRST YEAR

I. Cell And Molecular Biology of Plants

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 of 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; ATPases; transporters; as storage organelle.

NUCLEUS: Structure; nuclear pores; nucleosome organization; DNA structure; A,B & Z forms; replication, damage and repair; transcription; plant promoters and transcription factors; splicing; mRNA transport; nucleolus; rRNA biosynthesis.

RIBOSOMES: Structure; site of protein synthesis; mechanism of translation; initiation, elongation and termination; structure and role of tRNA.

OTHER CELLULAR ORGANELLES: Structure and functions of microbodies, golgi apparatus, lysosomes, endoplasmic reticulum.

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; mechanism of programmed cell death.

PROTEIN SORTING: Targeting of proteins to organelles.

TECHNIQUES IN CELL BIOLOGY: Immunotechniques; in situ hybridization to locate transcripts in cell types; FISH, GISH; confocal microscopy.

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II. Cytology, Genetics And Cytogenetics

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 ALTERCATIONS IN CHROMOSOMES: Origin, meiosis and breeding behavior 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.

GENETIC RECOMBINATION AND GENE MAPPING: Recombination; independent assortment and crossing over; molecular mechanism of recombination; role of RecA & 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 mutations; transposable elements in prokaryotes and eukaryotes; mutations induced by transposons; site directed mutagenesis; DNA damage and repair mechanisms; inherited human diseases and defects in DNA repair; initiation of cancer at cellular level; protooncogenes and oncogenes.

CYTOGENETICS:

CYTOGENETICS OF ANEUPLOIDS AND STRUCTURAL HETEROZYGOTES: Effect of aneuploidy on phenotype in plants; transmission of monosomics and trisomics and their use in chromosome mapping of diploid and polyploidy species; breeding behavior and genetics of structural heterozygotes; complex translocation heterozygotes; translocation tester sets; Robertsonians 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 on 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.

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III. Biology And Diversity Of Lower Plants: Cryptogams

MICROBIOLOGY:

ARCHAEBACTERIA AND EUBACTERIA: General account; ultrastructure, nutrition and reproduction; biology and economic importance; cyanobacteria - salient features and biological importance.

VIRUSES: Characteristics and ultrastructure of virions; isolation and purification of viruses; chemical nature, replication, transmission of viruses; economic importance.

PHYTOPLASMA: General characteristics and role in causing plant diseases.

PHYCOLOGY:

Algae in diversified habitats (terrestrial, freshwater, marine); thallus organization; cell ultrastructure; unicellular and multicellular organization; cell wall composition; nutrition (saprobic, biotrophic, symbiotic); thallus organization; cell ultrastructure; 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; algal blooms, algal biofertilizers, algae as food, feed and uses in 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, sexual and asexual); heterothallism; heterokaryosis; parasexuality; recent trends in classification.

Phylogeny of Fungi; general account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina; 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, Anthoceratales, Sphagnales, Funariales and Polytrichales; economic and ecological importance.

PTERIDOPHYTA:

Morphology, anatomy and reproduction; classification; evolution stele; heterospory and origin of seed habit; general account of fossil pteridophyta; introduction to Psilopsida, Lycopsida, Sphenopsida and Pteropsida.

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IV. Taxonomy and Diversity Of Seed Plants

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 gameto phyte; evolution of gymnosperms.

CLASSIFICATION OF GYMNOSPERMS AND THEIR DISTRIBUTION IN INDIA:

BRIEF ACCOUNT OF THE FAMILIES OF PTERIDOSPERMALES: Lyginopteridaceae, Medullosaceae, Caytoniaceae and Glossopteridaceae.


TAXONOMY OF ANGIOSPERMS:

ORIGIN OF INTRAPOPULATION VARIATION: Population and 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 attribution of rank. Salient features of ICBN.

TAXONOMIC EVIDENCE: 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.

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V. Plant Physiology and Metabolism

ENERGY FLOW: Principles of thermodynamics, free energy and chemical potential, redox reactions, structure and functions of ATP.

FUNDAMENTALS OF ENZYMOLOGY: General aspects, allosteric mechanism, regulatory and active sites, isozymes, kinetics of enzymatic catalysis, Michaelis-Menten equation and its significance.

MEMBRANE TRANSPORT AND TRANSLOCATION OF WATER AND SOLUTES: Plant-water relations, mechanism of water transport through xylem, root-microbe interactions in facilitating nutrient uptake, comparison of xylem and phloem transport, phloem loading and unloading, passive and active solute transport, membrane transport proteins.

SIGNAL TRANSDUCTION: Overview, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity in protein kinases and phosphatases, specific signal mechanisms, e.g. two component sensor regulator system in bacteria and plants, sucrose sensing mechanism.

PHOTOCHEMISTRY & PHOTOSYNTHESIS: General concepts and historical background, evolution of photosynthetic apparatus, photosynthetic pigments and light harvesting complexes, photo-oxidation of water, mechanisms of electron and proton transport, carbon assimilation- the Calvin cycle, photorespiration and its significance, the C4 cycle, the CAM pathway, biosynthesis of starch and sucrose, physiological and ecological considerations.

RESPIRATION & LIPID METABOLISM: Overview of plant respiration, glycolysis, the TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, alternative oxidase system, structure and function of lipids, fatty acid biosynthesis, synthesis of membrane lipids, structural lipids and storage lipids, and their catabolism.

NITROGEN FIXATION, NITROGEN AND SULPHUR METABOLISM: Overview, biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation, sulfate uptake, transport and assimilation.

PLANT GROWTH REGULATORS & ELICITORS: Physiological effects & mechanism of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids, polyamines, jasmonic acid & salicylic acid, hormone receptors, signal transduction and gene expression.

THE FLOWERING PROCESS: Photoperiodism and its significance, endogenous clock and its regulation, floral induction and development- genetic and molecular analysis role of vernalization.

STRESS PHYSIOLOGY: Plant responses to biotic and abiotic stress, mechanisms of biotic and abiotic stress tolerance, HR & SAR, water deficit and drought resistance, salinity stress, metal toxicity, freezing and heat stress, oxidative stress.

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SECOND YEAR

VI. Plant Development & Reproduction

INTRODUCTION. Unique features of plant development; differences between animal & plant development

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

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

Leaf growth & Differentiation: determination; phyllotaxy, control of leaf form; differentiation of epidermis (with special reference to stomata & trichomes) & mesophyll.

Root Development: organization of Root apical Developmentn (RAM); cell fates & lineages; vascular tissue differentiation; lateral roots; root hairs; root microbe interactions.

Reproduction: Vegetative options & sexual reproduction; flower development; genetics of floral organ differentiation; homeotic mutants in Arabidopsis & Antirrhinum; sex determination

Male gametophyte: Structure of Anthers; microsporogenesis, role of tapetum; pollen development & gene expression; male sterility, sperm dimorphism & hybrid seed production; pollen germination, pollen tube growth & 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 & fertilization: Floral characteristics, pollination mechanisms & vectors; breeding systems; commercial considerations; structure of the pistil; pollen-stigma interactions, sporophytic & gametophytic self-incompatibility (cytological, biochemical & molecular aspects); double fertilization; in vitro fertilization.

Seed development & fruit growth: Endosperm development during early, maturation & dessication stages; embryogenesis, ultrastructure & nuclear cytology; cell lineages during late embryo development; storage proteins of endosperm & embryo; polyembryony; apomixes; embryo culture; dynamics of fruit growth; biochemistry & molecular biology of fruit maturation.

Latent life- Dormancy: Importance & types of dormancy; seed dormancy; overcoming seed dormancy; bud dormancy.

Senescence & Programmed Cell Death (PCD): basic concepts, types of cell death, PCD in the life-cycle of plants, metabolic changes associated with senescence & its regulation; influence of hormones & environmental factors on senescence.

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VII. Plant Ecology

Climate, soil & vegetation patterns of the world: Life zones; major biomes & major vegetation & soil types of the world.

VEGETATION ORGANIZATION: concepts of community & continuum; analysis of communities (analytical & synthetic characters); community coefficients; interspecific associations, ordination; concept of ecological niche.

VEGETATION DEVELOPMENT: temporal changes (cyclic & non-cyclic); mechanism of ecological succession.

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

BIOLOGICAL DIVERSITY: Concept & levels; role of biodiversity in ecosystem functions & stability; speciation & extinction; IUCN categories of threat; distribution & global patterns; terrestrial biodiversity hot spots.

AIR, WATER & SOIL POLLUTION: Kinds; sources; quality parameters; effects on plants & ecosystems.

CLIMATE CHANGE: greenhouse gases (CO$_2$,CH$_4$,N$_2$O,CFCs: sources, trends & role); ozone layer & ozone hole; consequences of climate change(CO$_2$ fertilization, global warming, sea-level rise,
UV radiation).

ECOSYSTEM STABILITY: Concept (resistance & resilience); ecological perturbations (natural & anthropogenic) & their impact on plants & ecosystems; ecology of plant invasion; environmental impact assessment; ecosystem restoration.
ECOLOGICAL MANAGEMENT: Concepts; sustainable development; sustainability indicators.

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VIII. Plant Resource Utilization & Conservation

PLANT BIODIVERSITY: Concept, status in India, utilization & concerns.

SUSTAINABLE DEVELOPMENT: basic concepts

ORIGINS OF AGRICULTURE

WORLD CENTRES OF PRIMARY DIVERSITY OF DOMESTICATED PLANTS: the Indo-Burmese centre; plant introductions & secondary centres.

ORIGIN, EVOLUTION, BOTANY, CULTIVATION & USES OF:
  - Food, forage & fodder crops
  - Fibre crops
  - Medicinal & aromatic plants
  - Vegetable yielding crops

IMPORTANT FIRE-WOOD & TIMBER-YIELDING PLANTS & NON-WOOD FOREST PRODUCTS (NWFPs)
Such as bamboos, rattans, raw materials for paper making, gums, tannins, dyes, resins & fruits.

GREEN REVOLUTION: Benefits & adverse consequences.

INNOVATIONS FOR MEETING WORLD FOOD DEMANDS

PLANTS USED AS AVENUE TREES for shade, pollution control & 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 initiatives; protected areas in India- sanctuaries, national parks, biosphere reserves, wetlands, mangroves & coral reefs for conservation of wild biodiversity.

STRATEGIES FOR CONSERVATION: ex situ conservation: principles & 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 & Industrial
Research (CSIR), & Department of Biotechnology (DBT) for conservation, non formal conservation efforts.

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IX. Biotechnology & Genetic Engineering of Plants & Microbes

BIOTECHNOLOGY: Basic concepts, principles & scope.
PLANT CELL & TISSUE CULTURE: General introduction, history scope, concept of cellular differentiation, totipotency.
SOMATIC HYBRIDIZATION: Protoplast isolation, fusion & culture, hybrid selection & regeneration, possibilities, achievements & limitations of protoplast research.
APPLICATIONS OF PLANT TISSUE CULTURE: Clonal propagation, artificial seed, production of hybrids & somaclones, production of secondary metabolites/ natural products, cryopreservation & germplasm storage.
RECOMBINANT DNA TECHNOLOGY: gene cloning principles & techniques, construction of genomic/cDNA libraries, choice of vectors, DNA synthesis& 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 & transposon mediated gene tagging, chloroplast transformation & its utility, intellectual property rights, possible ecological risks & ethical concerns.
MICROBIAL GENETIC MANIPULATION: Bacterial transformation, selection of recombinants & transformants, genetic improvement of industrial microbes 7 nitrogen fixers, fermentation technology.
GENOMICS & PROTEOMICS: genetic & physical mapping of genes, molecular markers for introgression of useful traits, artificial chromosomes, high throughput sequencing, genome projects, bioinformatics, functional genomics, microarrays, protein profiling & its significance.

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