BOTANY SYLLABUS (for reference)

Unit-1 (Biology and Diversity of Plants (Microbes, Algae and Fungi)

Archaebacteria and Eubacteria: General characters, distribution, ultra-structure, nutrition, multiplication. Methods of genetic recombination and their significance.
Viruses: Physical and chemical characteristics, ultra-structure, multiplication, isolation and purification and economic importance. Plant virus transmission.
Mycoplasma, phytoplasma, L-forms, viroids, rickettsias and prions: A general account, economic and evolutionary importance.
Algae: General account, thallus organisation, cell structure, reproduction, life cycle pattern, classification schemes. Salient features of Cyanophyceae, Chlorophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae.
Algae: Salient features of Prochlorophyceae, Glaucophyceae, Eustigmatophyceae. Economic and evolutionary importance of algae.
Fungi: General characters, life cycle patterns, ultra-structure, mycelial growth, cell composition, nutrition (necrotrophs, biotrophs and symbionts), methods of reproduction. Economic importance of Fungi, Mycorrhizae and Lichens.

Unit-2 (Biology and Diversity of Archegoniate)

Bryophytes: Origin of Bryophytes. General characters and classification. Evolution of gametophyte and sporophyte. Economic and Ecological importance of Bryophytes.
Pteridophyta: Evolution of stelar system; Evolution of Prothallus; soral evolution; Heterospory and seed habit; Cytological evolution of ferns; Apogamy and Apospory. Telome theory.
Palaeobotany: Geological time scale, types and nomenclature of fossils, fossilization, methods of study of fossils. Study of fossil archegoniates.
Gymnosperms: General account of present and past distribution of gymnosperms with special reference to India, Economic importance of gymnosperms.
Gymnosperms: Study of structure, reproduction, evolution, classification, life history with special reference to Cycadopsida, Coniferopsida, Gnetopsida. Evolution of the female strobilus in Coniferales.

Unit-3 (Cell Biology and Biochemistry)

Cell: Types, Intracellular compartments; Signal hypothesis, protein sorting to mitochondria and chloroplasts. Structure and functions of; cellular membranes, cell wall and cell organelles Cell division: mitosis and meiosis.
Chromosomes: Structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, Nucleosome structure, DNA, Lampbrush and Polytene chromosomes, Structural and numerical alterations in chromosomes.
Bioenergetics: Principles of the thermodynamics, free energy and chemical potential, free energy of Oxidation – reduction reactions, redox potential. Types of Phosphorylations.

Fats and Lipids: Structure and function of lipids, classification of lipids, fatty acids biosynthesis and oxidation.
Carbohydrates: Classification, structure, properties. Biosynthesis of starch and sucrose.
Enzymes: General characters, nomenclature and classification, Mode of enzyme action, Michaelis – Menton equation and its significance, Determining *KM* and *Vmax,* Regulation of enzymes, coenzymes, isoenzymes and isoenzymes. Factors effecting enzyme activity.
Amino acids: Structure, Types, Properties, Stereo-isomers, Functions, Amino Acids as Precursors of Biomolecules, Biosynthesis and catabolism.
Proteins: Types, Properties, Structure, function, Cellular localization, Reverse turn and Ramchandran Plot.

Unit-4 (Plant Ecology and Biodiversity Conservation)

Environment: Physical environment, biotic environment.
Ecosystem concept: Structure and function, Ecological energetics; energy flow through ecosystem. Biogeochemical cycles (C, N, P and S cycles).
Community ecology: Communities structure and dynamics, Edges and ecotones, processes shaping communities. Organismal and individualistic model of community. Succession: Concept, models and mechanisms.
Population ecology: Properties of populations, fluctuation, age classes; growth measurement; factors affecting population growthConcept of metapopulation – demes and dispersal, interdemic extinctions.
Environmental pollution: agricultural pollution, atmospheric pollution, global environmental changes, mining and quarrying, restoration ecology. Environmental impact assessment. Environmental regulations and laws.
Phytogeography: Major biomes of the world with special reference to desert and grassland; phytogeographical regions of India.
Plant Biodiversity: Concept, levels of biodiversity, diversity indices, status in India, utilization and concerns. Hotspots. Strategies for conservation – *In situ* and *Ex situ* conservation. International efforts and peoples participation for conservation.

Unit-5 (Genetics and Evolution)

Mendelism: Concept of gene, Mendel and his laws. Pattern of inheritance in haploid and diploid organisms.
Extension of Mendelism: alleles, allelic variation and genetic factor dominant relationship, basis of dominant and recessive inheritance, Multiple alleles and allelic series, Pleiotropy.
Chromosomal basis of inheritance: Sex determination; Sex linked, sex influenced and sex limited traits; genetic marker, Linkage and crossing over, Linkage analysis and linkage map.
Extra chromosomal inheritance: Maternal inheritance, Extra-nuclear inheritance in Neurospora, Chlamydomonas, Paramecium, Yeast, Drosophila and Man, Mitochondrial genomes, Chloroplast genomes, Cytoplasmic male sterility.
Genetic recombination: Recombination and genetic mapping, Homologous and non-homologous recombination, site-specific recombination. Molecular markers and mapping. Physical mapping of genes, artificial chromosomes,

Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements.
Mutations: Spontaneous and induced mutations, physical and chemical mutagens. molecular basis of gene mutations, transposable elements in eukaryotes and prokaryotes. Site-directed mutagenesis.
Evolution: Emergence of evolutionary thoughts: Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; spontaneity of mutations; the evolutionary synthesis. Origin of cells and unicellular evolution, Experiment of Miller; the first cell: origin and evolution in prokaryotes and eukaryotes.

Unit-6 (Molecular Biology)

Cell cycle and DNA: interphase nucleus, role of cyclins and cyclin-dependent kinases. DNA structure and types (A-, B-, Z-, DNA). Mechanism of DNA replication, DNA damage and repair mechanisms.
RNA: Structure and types, synthesis and processing: Transcription factors and machinery, RNA polymerases, elongation and termination, RNA processing, Reverse transcriptase.
Protein synthesis and processing: Mechanism of protein biosynthesis in prokaryotes and eukaryotes, translational inhibitors, post-translational modification of proteins.
Gene regulation: Regulation of gene expression in pro- and eukaryotes, the control sequences, Operon model- lac, gal, trp, his and arabinose operon, Role of chromatin in regulating gene expression and gene silencing.
Genomics and Proteomics: Introduction to Structural, functional genomics and its application to health and agriculture, including gene therapy. Brief account of Proteomics.
Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, metastasis, apoptosis, therapeutic interventions of uncontrolled cell growth.

Unit-7 (Structural and Reproductive Plant Biology)

Meristems: Introduction, organization of meristems, shoot development– organization of the shoot apical meristems (SAM), wood development in relation to environmental factors. Organization of root apical meristem (RAM), lateral roots; root hairs.
Tissue and tissue systems; Parenchyma, Collenchyma, Sclerenchyma, Xylem, Phloem, Secretory structures and periderm
Plant anatomy: Primary and secondary structure of root and stem of angiosperms.
Flower: Evolution of flower, genetics of floral organ differentiation; foliar stamens; open carpels; primitive living angiosperms; floral anatomy.
Male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen germination, pollen tube growth and guidance, pollen embryos.
Female gametophyte: Ovule development and types, placentation types and its evolution. Megasporogenesis, organization of the embryo sac, types of embryo sacs.
Pollination and Fertilization: pollen-pistil interaction; pollination mechanisms and vectors; sporophytic and gametophytic self-incompatibility. Double fertilization, *in vitro* fertilization.
Endosperm: Types, ultrastructure, endosperm haustoria, their extension, persistence and function.

Embryo-Polarisation of Zygote, embryogenic types, organogenesis of mono and dicot embryos. Structure and function of suspensor. Polyembryony, Apomixis. Seed development and fruit growth.

Unit-8 (Plant growth and Development)

Water relations: Chemical and Water potential. Absorption of water. Ascent of Sap, Transpiration, Physiology of stomatal movement and regulation of transpiration. Guttation. Membrane transport: transport proteins, passive and active mechanisms.
Plant nutrition: Nutrient requirement of plants. Essential nutrients: macro and micronutrients, Chelating agents, Nutrient deficiency (Symptoms and disorders).
Seed: Seed development, germination and dormancy, bud dormancy, Ageing, Senescence and death.
Plant growth and Regulation: Over view, Historical account, Measurement of growth and growth kinetics. Plant growth regulators: Biosynthesis, chemical nature, physiological effects and mode of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids, jasmonic acid and salicylic acid.
Photomorphogenesis: Over view, Historical account, Photoreceptors: structure, function, properties (Phytochrome and cryptochrome), Photoperiodism, Vernalization.
Signal transduction: Basic concept and principles, Receptors and Second messengers (types, function), Signal transduction and gene expression, Signaling involving calcium, inositol phospholipids and G proteins, Two component sensor regulator system. Plant movements and taxis; Types, role of signal transduction.

Unit-9 (Plant Physiology)

Photosynthesis: Historical account, Evolution of photosynthetic apparatus, Photo pigments, Photosystems; types, structure and function. Photo-protective mechanisms. Carbon assimilation; C_3, C_4 and CAM pathways, Photorespiration and its significance, Photophosphorylation.
Respiration: Over view, Historical account, Evolution of anaerobic and aerobic metabolism, Aerobic respiration: glycolysis, TCA cycle, Pentose phosphate pathway, Oxidative electron transport and chemiosmotic hypothesis of ATP synthesis, alternative oxidase system, Anaerobic respiration. Fermentation: Alcohol and Lactic acid fermentations. Gluconeogenesis
Lipid and Nitrogen metabolism: Oxidation of Fatty acids, β-oxidation, Ketone Bodies.
Uptake, transport and assimilation of nitrate, ammonium assimilation (reductive amination, GS-GOGAT system, transamination).
Biological nitrogen fixation: Non symbiotic and Symbiotic, nitrification and denitrification. Structure of nodule and heterocyst, Role and structure of Nitrogenase, Leghemoglobin, Genetics of Nitrogen fixation.
Secondary metabolism: synthesis, function and uses of Glycosides, anthraquinones, isothiocynates, flavonols, lactones phenols, saponins, cardiac glycosides. Alkaloids, indoles, isoquinolines, tropanes, pyridine and piperidine, steroidal alkaloids. Phenols and Tannins. Antibiotics.
Stress physiology: Types of stress Response and resistance mechanisms, Molecular mechanism of tolerance, Heat stress and heat shock proteins, Reactive oxygen species and oxidative stress, Metal toxicity. Biotic stress and response, HR and SAR mechanisms.

Unit-10 (Plant Systematics and Resources Utilization)

Fundamentals of Systematics: Historical account of development of Taxonomy, Plant nomenclature, Taxonomic structure (concept of taxa, species, genus, family), numerical taxonomy, Botanical gardens, Herbarium, Taxonomic terminology; floral formula and floral diagram. Phylogeny; origin and evolution of angiosperms
Systems of angiosperm classification – broad outline and relative merits and demerits of major systems of classification (Bentham and Hooker; Engler and Prantl; Hutchinson; Takhtajan; Angiosperm Phylogeny Group).
Ethnobotany: Introduction, History and development of ethnobotanical study; scope and potential applications; methods in ethnobotanical study. Applied Ethnobotany and intellectual property rights.
Economic Botany: Origin, evolution, Botany, cultivation and uses of fibre yielding plants, cereal crops, sugar yielding plants, pulses, oil yielding plants.
Economic Botany: Origin, evolution, Botany, cultivation and uses of fruits and nuts, vegetables, spices, condiments, beverages, medicinal plant, rubber yielding plants and petrocrops. Centres of origin.

Unit-11 Plant Tissue Culture and Plant Breeding

History: Scope and applications, Historical account of development of plant tissue culture; Concept of cell totipotency, cellular differentiation and morphogenesis, molecular basis of *in vitro* differentiation.

Tools and techniques: Concept of asepsis and methods of sterilization-physical and chemical methods of sterilization, Principle, construction and operation of instruments used in plant tissue culture- pH meter, ovens, Laminar Flow Clean Air Bench, Glassbead sterilizer, Lux meter, Magnetic stirrer etc. Explant selection, preparation and initiation of cultures, callus and suspension cultures, single cell culture, measurement of growth characteristics.

In vitro regeneration of plants: Different pathways of micropropagation (Enhanced axillary branching, *de novo* shoot bud differentiation, somatic embryogenesis and callus organogenesis) and their applications. Stages of micropropagation. Micropropagation in forestry and horticulture.

Protoplast technology: Protoplast isolation, culture, regeneration and maintenance, Viability tests for protoplast generation, Regeneration from protoplasts, Somatic hybridization. Somaclonal variation-its causes and consequences. Role of plant tissue culture in crop improvement. Virus elimination and culture of obligate parasites.
Secondary plant metabolites: Production by use of cell culture technology. Bioreactors, types and uses. Hairy root culture, cell immobilization.

Plant breeding; Introduction and objectives. Methods of crop improvement, advantages and limitations; Hybridization, mass selection, pure line selection; inbreeding depression, heterosis. Green revolution.

Unit-12 Genetic Engineering

Recombinant DNA Technology: – Gene cloning principles and techniques (Plasmid, phage, cosmid, construction of genomics/ cDNA libraries, choice of vectors. Restriction enzymes. Restriction mapping- concept and techniques. DNA sequencing, PCR, Northern and Southern blotting, RFLP, RAPD, AFLP based DNA finger printing, microarrays. Integration and expression of foreign genes in pro- and eukaryotes.

The Genetics of RNA: Catalytic diversity of RNAs, RNA silencing in plants, Cross talk between RNA metabolic pathways- an RNomics approach. Understanding alternative splicing: Towards a cellular code, Gene discovery by ribozyme and siRNA libraries. Epigenetics. Non-coding RNA and gene silencing, Prions of yeast as epigenetic phenomena.

Genetic Engineering of Plants: Methods of direct and *Agrobacterium* mediated gene transfer, electroporation, microinjection, particle-gun technology. Chloroplast transformation and its utility. Transgenic plants, Current status of transgenic plants in India and other countries, ecological ad ethical issues associated with GM crops and GM food. Labeling of GM plants and products.

Applications: Gene therapy: Principles and different strategies, Gene therapy for inherited diseases, ethical issues related to human gene therapy practices. Stem cells; Biology and genetics, stem cell based therapy and tissue engineering, Ethical and social considerations of stem cell research, genome projects, Basics of protein engineering and design, protein profiling and its significance.

Applications: Biosensors, Biochips, Hybridoma technology, production of edible vaccines and antibiotics using transgenic technology, Animal vaccines, Cryopreservation, germplasm collection and conservation, plant tissue culture certification. Importance of integrated pest management and terminator gene technology.

Unit-13 (Analytical Techniques in Plant Science)

Microscopy: Optical, phase contrast, Fluorescence and electron microscopy (TEM and Scanning); Centrifugation-Principle; Ultra centrifugation.

Electrophoretic techniques:Principle, types of instruments, resolution, separation and application, isoelectric focusing.

Chromatography:Principle and methodology of chromatographic techniques: (a) Paper (b) Thin Layer (c) Column (d) Gel (e) Gas and (f) HPLC.

Spectrophotometry-Principle, and applications, Atomic Absorption Spectrometer, NMR.

Bioinformatics: Introduction, Biological Sequence Databases; National Center for Biotechnology Information (NCBI), EMBL Nucleotide Sequence Database (EMBL-Bank), DNA Data Bank of Japan (DDBJ), Protein Information Resource (PIR), Swiss-Prot. Applications of Bioinformatics.

Biostatistics: Variables in biology, collection, classification and tabulation of data. Graphical and diagrammatic representation, Measures of central tendency – Mean (arithmetic, harmonic and geometric), Median and Mode.

Biostatistics: Measures of dispersion: Standard deviation and standard errors; skewness and kurtosis; Correlation and Regression. Analysis of variance (single factor analysis), chi-square test, type of errors; levels of significance, probability distributions (Binomial, Poisson and normal).