

Semester-I

Core Course I: Microbiology and Phycology – 100 marks
(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Introduction to microbial world, microbial nutrition, growth and metabolism.

Viruses:- Discovery, physicochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases.

Unit-II Bacteria: - Discovery, general characteristics, types-archaeobacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts), cell structure, nutritional types, reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

Unit-III Algae:- General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; and methods of reproduction, classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar). Role of algae in the environment, agriculture, biotechnology and industry.

Unit-IV Cyanophyta:- Ecology and occurrence, range of thallus organization, cell structure, heterocyst, reproduction. economic importance; role in biotechnology. Morphology and life-cycle of *Nostoc*.

Chlorophyta:- General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of *Chlamydomonas*, *Volvox*, *Oedogonium*, *Coleochaete*.

Unit-V Charophyta:- General characteristics; occurrence, morphology, cell structure and life-cycle of *Chara*; evolutionary significance.

Xanthophyta:- General characteristics; range of thallus organization; Occurrence, morphology and life-cycle of *Vaucheria*.

Phaeophyta:- Characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of *Ectocarpus* and *Fucus*.

Rhodophyta:- General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycle of *Polysiphonia*.

Semester-I

Core Course II: Biomolecules and Cell Biology – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Biomolecules:- Types and significance of chemical bonds; Structure and properties of water; pH and buffers.

Carbohydrates: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage –starch, insulin)

Lipids: Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties.

Proteins: Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, tertiary and quarternary; Isoelectric point; Protein denaturation and biological roles of proteins.

Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

Unit-II Bioenergenetics: Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule.

Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

Unit-III The cell: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

Cell wall and plasma membrane: Chemistry, structure and function of Plant Cell Wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.

Unit-IV Cell organelles: Nucleus; Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.

Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

Unit-V Cell division: Eukaryotic cell cycle, different stages of mitosis and meiosis. Cell cycle, Regulation of cell cycle.

Semester-II

Core Course III: Mycology and Phytopathology – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Introduction to true fungi: Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cellwall composition; Nutrition; Classification.

Chytridiomycetes: General account

Zygomycota: General characteristics; Ecology; Thallus organisation; Life cycle with reference to *Rhizopus*.

Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to *Saccharomyces*, *Aspergillus*, *Penicillium*, *Neurospora*,

Unit-II Basidiomycota: General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only), *Agaricus*; Bioluminescence, Fairy Rings and Mushroom Cultivation.

Allied Fungi: General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.

Oomycota: General characteristic; Ecology; Life cycle and classification with reference to *Phytophthora*, *Albugo*.

Unit-III Symbiotic associations: Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction. Mycorrhiza- Ectomycorrhiza, Endomycorrhiza and their significance.

Unit-IV Applied Mycology: Role of fungi in biotechnology, Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.

Unit-V Phytopathology: Terms and concepts; General symptoms; Geographical distribution of diseases; etiology; symptomology; Host- Pathogen relationships; disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and angular leaf spot disease of Cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, white rust of crucifers.

Semester-II

Core Course IV: Archegoniate – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Introduction: Unifying features of archegoniate; Transition to land habit; Alternation of generations.

Unit-II Bryophytes: General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Classification (up to family). *Riccia*, *Marchantia*, *Anthoceros*, *Sphagnum* and *Funaria*; Reproduction and evolutionary trends in *Riccia*, *Marchantia*, *Anthoceros* and *Funaria* (developmental stages not included). Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

Unit-III Pteridophytes: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Apogamy and apospory, heterospory and seed habit, telome theory, stellar evolution. Ecological and economic importance.

Unit-IV Gymnosperms: General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus*, *Ginkgo* and *Gnetum*. (Developmental details not to be included). Ecological and economic importance.

Unit-V Fossils: Geographical time scale, fossils and fossilization process. Morphology, anatomy and affinities of *Rhynia*, *Calamites*, *Lepidodendron*, *Lyginopteris* and *Cycadeoidea*.

Semester-II

Generic Elective (GE –II): For Zool Hons

Bio – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Unit-I Microbes : Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit-II Algae: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and lifecycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Fucus*, *Polysiphonia*. Economic importance of algae.

Fungi : Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations-Lichens:

Unit-III Introduction to Archegoniate : Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Bryophytes : General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

Unit-IV Pteridophytes : General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes.

Unit-V Gymnosperms: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included). Ecological and economical importance.

Semester-III

Core Course V: Anatomy of Angiosperms – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Introduction and scope of Plant Anatomy: Applications in systematics, forensics and pharmacognosy.

Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances.

Unit-II Stem: Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem.

Leaf: Structure of dicot and monocot leaf, Kranz anatomy.

Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

Unit-III Vascular Cambium: Structure, function and seasonal activity of cambium; Secondary growth in root and stem.

Wood: Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology.

Periderm: Development and composition of periderm, rhytidome and lenticels.

Unit –IV Adaptive and Protective Systems Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni- and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

Unit - V Secretory System: Hydathodes, cavities, lithocysts and laticifers.

Semester-III

Core Course VI: Economic Botany – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Unit-II Cereals : Wheat and Rice (origin, morphology, processing & uses), brief account of millets.

Legumes: General account, importance to man and ecosystem.

Sugars & Starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

Unit-III Spices: Listing of important spices, their family and part used, economic importance with special reference to fennel, saffron, clove and black pepper

Beverages: Tea, Coffee (morphology, processing & uses)

Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Digitalis*, *Papaver* and *Cannabis*.

Tobacco: Tobacco (Morphology, processing, uses and health hazards)

Unit-IV Oils & Fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and *Brassica* and Coconut (Botanical name, family & uses)

Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.

Unit-V Natural Rubber: Para-rubber: tapping, processing and uses.

Timber plants: General account with special reference to teak and pine.

Fibres: Classification based on the origin of fibres, Cotton and Jute (morphology, extraction and uses).

Semester-III

Core Course VII: Genetics – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour); PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Mendelian genetics and its extension Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.

Unit-II Extrachromosomal Inheritance: Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium*.

Unit-III Linkage, crossing over and chromosome mapping: Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.

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Unit-IV Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy

Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation. DNA repair mechanisms.

Unit-V Fine structure of gene: Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.

Population and Evolutionary Genetics: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

Semester-IV

Core Course VIII: Molecular Biology – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Unit-I Nucleic acids : Carriers of genetic information: Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment).

Unit-II The Structures of DNA and RNA / Genetic Material: DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA Prokaryotes, Viruses, Eukaryotes. RNA Structure- Organelle DNA - mitochondria and chloroplast DNA. The Nucleosome –Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

The replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5' end of linear chromosome; Enzymes involved in DNA replication.

Unit-III Central dogma and genetic code: Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features).

Mechanism of Transcription: Transcription in prokaryotes; Transcription in eukaryotes.

Processing and modification of RNA: Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I & group II intron splicing, alternative splicing eukaryotic mRNA processing (5' cap, 3' polyA tail); Ribozymes.

Unit-IV Translation (Prokaryotes and Eukaryotes): Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.

Unit-V Regulation of transcription in prokaryotes and eukaryotes: Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli*. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones.

Semester-IV

Core Course IX: Plant Ecology and Phytogeography – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Unit-I Introduction Concept of ecology, Autoecology, Synecology, system ecology, Levels of organization. Inter-relationships between the living world and the environment, the components of environmental, concept of hydrosphere and lithosphere and dynamism, homeostasis.

Unit-II Soil: Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.

Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

Light, temperature, wind and fire: Variations; adaptations of plants to their variation.

Unit-III Biotic interactions;

Population ecology: Characteristics and Dynamics .Ecological Speciation.

Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

Unit-IV Ecosystems: Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.

Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

Unit-V Phytogeography: Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.

Semester-IV

Core Course X: Plant Systematics – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Unit-I Plant identification, Classification, Nomenclature; Biosystematics.

Identification: Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access.

Unit-II Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).

Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

Unit-III Systematics- an interdisciplinary science: Evidence from palynology, cytology, phytochemistry and molecular data.

Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Unit-IV Biometrics, numerical taxonomy and cladistics: Characters; Variations; OTUs, character weighting and coding; cluster analysis; Phenograms, cladograms (definitions and differences).

Unit-V Phylogeny of Angiosperms: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades).origin& evolution of angiosperms.

Semester-IV

Skill Enhancement Courses (SEC –II):
Plant Diversity and Human Welfare – 50 marks
(Credits-2: Lectures: 30)
THEORY (Each class 1 hour)
[50 marks (Mid Sem 10 + End Sem 40)]

Unit-I Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values,

Unit-II Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss.

Unit-III Management of Plant Biodiversity: Organizations associated with biodiversity management- Methodology for execution- IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication.

Unit-IV Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, *In situ* and *ex situ* conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development.

Unit-V Role of plants in relation to Human Welfare; a) Importance of forestry, their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Wood and its uses.

Semester-IV

Generic Elective (GE –II): For Zool Hons
Plant Ecology and Taxonomy – 100 marks
(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15 + End Sem 60)]

Unit-I

Introduction: Ecology, Taxonomy and Plant Physiology.

Ecological factors : Soil: Origin, formation, composition, soil profile.

Water: States of water in the environment, precipitation types. Light and Temperature. Adaptation of hydrophytes and xerophytes.

Plant-water relations: Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Unit-II

Ecosystem : Structure; Biotic and abiotic components, energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity.

Mineral nutrition: Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit-III

Introduction to plant taxonomy: Identification, Classification, Nomenclature.

Photosynthesis: Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C₃, C₄ and CAM pathways of carbon fixation; Photorespiration.

Unit-IV

Nitrogen metabolism : Biological nitrogen fixation; Nitrate and ammonia assimilation.

Classification: Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

Unit-V

Botanical nomenclature: Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Plant growth regulators : Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Semester-V

Core Course XI: Reproductive Biology of Angiosperms – 100 marks
(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Introduction: History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.

Unit-II Anther: Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.

Pollen biology: Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

Unit-III Ovule: Structure; Types; Special structures—endothelium, obturator, aril, caruncle and hypostase; Female gametophyte— megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.

Endosperm: Types, development, structure and functions.

Embryo: Six types of embryogeny; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paonia*.

Unit-IV Pollination and fertilization: Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.

Self incompatibility: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome selfincompatibility: mixed pollination, bud pollination, stub pollination; Intraovarian and *in vitro* pollination; Modification of stigma surface, parasexual hybridization; Cybrids, *in vitro* fertilization.

Unit-V Seed: Structure, importance and dispersal mechanisms

Polyembryony and apomixes: Introduction; Classification; Causes and applications.

Germline transformation: Pollen grain and ovules through pollen tube pathway method/ *Agrobacterium*/ electrofusion/floral dip/biolistic.

Semester-V

Core Course XII: Plant Physiology – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Plant water relationship: Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap–cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.

Translocation in the phloem: Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

Unit-II Mineral nutrition: Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

Unit-III Nutrient Uptake: Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

Unit-IV Plant growth regulators: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene. Brassinosteroids and Jasmonic acid.

Unit-V Physiology of flowering: Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

Phytochrome: Discovery, chemical nature, role of phytochrome in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Semester-V

Discipline Specific Elective (DSE –1):

Analytical Techniques in Plant Sciences – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy;

Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit-II Cell fractionation: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl₂ gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit-III Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment.

Spectrophotometry: Principle and its application in biological research.

Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit-IV Characterization of proteins and nucleic acids: Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Unit-V Biostatistics: Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Semester-V

Discipline Specific Elective (DSE –2)

Natural Resource Management – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Natural resources: Definition and types.

Sustainable utilization : Concept, approaches (economic, ecological and socio-cultural).

Unit-II Land: Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

Water: Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

Unit-III Biological Resources: Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).

Forests: Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.

Unit-IV Energy: Renewable and non-renewable sources of energy

Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint.

Unit-V Resource Accounting; Waste management. National and international efforts in resource management and conservation

Semester-VI

Core Course XIII: Plant Metabolism – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Concept of metabolism: Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).

Unit-II Carbon assimilation: Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO₂ reduction, photorespiration, C₄ pathways; Crassulacean acid metabolism; Factors affecting CO₂ reduction.

Unit-III Carbohydrate metabolism: Synthesis and catabolism of sucrose and starch.

Carbon Oxidation: Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyer's conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

Unit-IV Lipid metabolism: Synthesis and breakdown of triglycerides, β -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.

Unit-V Nitrogen metabolism: Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

Mechanisms of signal transduction: Calcium, phospholipids, cGMP, NO.

Semester-VI

Core Course XIV: Plant Biotechnology – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Plant Tissue Culture: Historical perspective; Aseptic tissue culture techniques, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones).

Unit-II Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Unit-III Recombinant DNA technology-I: Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC and briefly PAC, MAC, HAC). Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning).

Unit-IV Recombinant DNA technology-II: Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; Probes-oligonucleotide, heterologous, PCR; Methods of gene transfer- *Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

Unit-V Applications of Biotechnology: Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

Semester-VI

Discipline Specific Elective (DSE –3)

Research Methodology – 100 marks

(Credits-6: Theory-4, Practical-2)

THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)

[75 marks (Mid Sem 15 + End Sem 60)]

Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I Basic concepts of research : Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

General laboratory practices: Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions. Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.

Unit-II Data collection and documentation of observations: Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

Overview of Biological Problems : History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics- Transcriptional regulatory network.

Unit-III Methods to study plant cell/tissue structure: Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, noncoagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.

Unit-VI Plant microtechniques : Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials.

Unit-V The art of scientific writing and its presentation : Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Power point presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.