



DEPARTMENT OF BOTANY

PRAGJYOTISH COLLEGE

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COURSE OUTCOME (CO)

B.Sc. in Botany (Honours) syllabus (CBCS)

1st Semester (Honours)

Paper Name: Phycology and Microbiology

Paper Code: BOT-HC-1016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain level
1. CO1. Detailed knowledge on microbes, viruses and bacteria, and their importance in agriculture and medicine	Unit 1: Introduction to microbial world Scope of microbes in industry and environment; Microbial nutrition, growth and metabolism.	Remember, Understand
2. CO2. Knowledge on Algal classification, Economic and ecological importance of Algae	Unit 2: Viruses Discovery, physiochemical 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.	Remember, Understand, Apply
3. CO3. Practical knowledge on structure of T-Phage and TMV, lytic and lysogenic life cycle		
4. CO4. Practical knowledge on microscopy of bacteria and algae	Unit 3: Bacteria Discovery, general characteristics; Types-archaeobacteria, eubacteria, actinomycetes, mycoplasma, rickettsia, chlamydiae and sphaeroplasts); 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 (Alcohol and Antibiotic production).	Remember, Understand, Apply, Evaluate
	Unit 4: Algae General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment	Remember, Understand, Apply

	system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; Evolutionary significance of <i>Prochloron</i> ; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Role of algae in the environment, agriculture, biotechnology and industry, Economic importance of Diatoms.	
	Unit5: Cyanophyta and Xanthophyta Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of Nostoc and Vaucheria.	Remember, Understand, Apply
	Unit6: Chlorophyta, Charophyta and Bacillariophyta General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of <i>Volvox</i> , <i>Oedogonium</i> , <i>Coleochaete</i> , <i>Chara</i> . General Account of Bacillariophyta.	Remember, Understand, Apply
	Unit7: Phaeophyta and Rhodophyta Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of <i>Ectocarpus</i> , <i>Fucus</i> and <i>Polysiphonia</i> .	Remember, Understand, Apply

Paper Name: Biomolecules and Cell Biology

Paper Code: BOT-HC-1026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain level
1. CO1. Knowledge on structure, classification and physicochemical properties of biomolecules and enzymes	Unit 1: Biomolecules Types and significance of chemical bonds; Structure and properties of water; pH and buffers. Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.	Remember, Understand
2. CO2. Detailed knowledge on structure, properties and functions of cell and its components	Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions, and properties; Phosphoglycerides.	
3. CO3. Practical	Proteins: Structure of amino acids;	

<p>knowledge on properties of cell and cell membrane, DNA staining techniques and microscopy of plant cell</p> <p>4. CO4. Knowledge on qualitative tests of biomolecules</p>	<p>Levels of protein structure-primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins.</p> <p>Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, C, D, Z types of DNA; Types of RNA.</p>	
	<p>Unit 2: Bioenergetics</p> <p>Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule.</p>	Remember, Understand
	<p>Unit 3: Enzyme</p> <p>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 theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.</p>	Remember, Understand, Evaluate
	<p>Unit4: The Cell</p> <p>Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).</p>	Remember, Understand, Apply
	<p>Unit5: Cell wall and plasma membrane</p> <p>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.</p>	Remember, Understand
	<p>Unit6: Cell organelles</p> <p>Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.</p> <p>Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.</p> <p>Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.</p>	Remember, Understand

	<p>Endomembrane system: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes</p>	
	<p>Unit7: Cell division Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role of protein kinases.</p>	Remember, Understand, Evaluate

2nd Semester (Honours)

Paper Name: Mycology and Phytopathology

Paper Code: BOT-HC-2016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
<p>1. CO1. Detailed knowledge on different classes of fungi, their structure, classification, life cycle and reproduction</p> <p>2. CO2. Knowledge on diseases in plants caused by viruses, bacteria and fungi and biotechnological applications of fungi</p>	<p>Unit 1: Introduction to Fungi General characteristics; Status of Fungi in living system; Thallus organization, modification of hyphae; Cell and Cell wall composition; Nutrition, flagella, septum, homothallism and heterothallism, cell division. History of Classification (Hidettaet <i>al.</i> 2007); Classification of Fungi (Ainsworth, 1973, Webster 1977) up to sub-division with diagnostic characters and examples. General characteristics of Myxomycota, Oomycota, Zygomycota, Ascomycota, Basidiomycota and Deuteromycota.</p>	Remember, Understand, Apply
<p>3. CO3. Structural analysis of different classes of fungi and their reproductive stages</p>	<p>Unit 2: Mastigomycotina (Chytridiomycetes and Oomycetes) Characteristic features; Reproduction; Life cycle with reference to <i>Synchytrium</i>, <i>Phytophthora</i> and <i>Albugo</i>.</p>	Remember, Understand, Apply
<p>4. CO4. Knowledge on structures of symbiotic associations (Lichens, Mycorrhiza)</p>	<p>Unit 3: Zygomycotina Characteristic features; Reproduction; Life cycle with reference to Rhizopus.</p>	Remember, Understand, Apply
	<p>Unit4: Ascomycotina General characteristics (asexual and sexual fruiting bodies); Life cycle, Heterokaryosis and parasexuality; Life</p>	Remember, Understand, Apply

	cycle and classification with reference to <i>Saccharomyces</i> , <i>Aspergillus</i> , <i>Penicillium</i> , <i>Neurospora</i> and <i>Peziza</i> .	
	<p>Unit5: Basidiomycotina General characteristics; Life cycle and Classification with reference to black stem rust on wheat <i>Puccinia</i> (Physiological Specialization), loose and covered smut (symptoms only), <i>Agaricus</i>; Bioluminescence, Fairy Rings and Mushroom Cultivation.</p>	Remember, Understand, Apply
	<p>Unit6: Deuteromycotina (Fungi Imperfecti) General characteristics; Thallus organization; reproduction; classification with special reference to <i>Alternaria</i> and <i>Colletotrichum</i>.</p>	Remember, Understand, Apply
	<p>Unit7: Allied Fungi- Myxomycota General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.</p>	Remember, Understand, Apply
	<p>Unit 8: Symbiotic associations Lichen – Occurrence; General characteristics; Range of thallus organization; Internal structure and nature of associations of algal and fungal partners; Reproduction. Mycorrhiza- Ectomycorrhiza, Endomycorrhiza and their significance.</p>	Remember, Understand, Apply
	<p>Unit 9: Applied Mycology Role of fungi in biotechnology; food industry (Flavour& texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Pharmaceutical (Secondary metabolites); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.</p>	Remember, Understand, Apply
	<p>Unit 10: 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 of cotton. Viral</p>	Remember, Understand

	diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.	
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Paper Name: Archegoniate

Paper Code: BOT-HC-2026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. CO1. Detailed knowledge on morphology, anatomy, classification and properties of bryophytes, pteridophytes and gymnosperms	Unit 1: Introduction Unifying features of archegoniate; Transition to land habit; Alternation of generations.	Remember, Understand,
	Unit 2: Bryophytes General characteristics; Adaptations to land habit; Classification; Range of thallus organization.	Remember, Understand, Apply
2. CO2. Knowledge on reproduction and economic importance and ecological significance of bryophytes, pteridophytes and gymnosperms	Unit 3: Type Studies- Bryophytes Classification, morphology, anatomy and reproduction of <i>Riccia</i> , <i>Marchantia</i> , <i>Anthoceros</i> , <i>Sphagnum</i> and <i>Polytrichum</i> ; Reproduction and evolutionary trends in <i>Riccia</i> , <i>Marchantia</i> , <i>Anthoceros</i> , <i>Sphagnum</i> and <i>Polytrichum</i> . Ecological and economic importance of bryophytes.	Remember, Understand, Apply
	Unit4: Pteridophytes General characteristics; Classification; Early land plants (<i>Cooksonia</i> and <i>Rhynia</i>).	Remember, Understand, Apply
3. CO3. Practical knowledge on morphology and reproductive structures of archegoniate	Unit5: Type Studies- Pteridophytes Classification, morphology, anatomy and reproduction of <i>Psilotum</i> , <i>Lycopodium</i> , <i>Selaginella</i> , <i>Equisetum</i> , <i>Pteris</i> and <i>Marsilea</i> . Apogamy and apospory, heterospory and seed habit, telome theory, stelar evolution; Ecological and economic importance.	Remember, Understand, Apply
	Unit6: Gymnosperms General characteristics, classification (up to family), morphology, anatomy and reproduction of <i>Cycas</i> , <i>Pinus</i> , <i>Ginkgo</i> and <i>Gnetum</i> ; Ecological and economic importance.	Remember, Understand, Apply
4. CO4. Spore morphology analysis and detailed knowledge on male and female reproductive structures in gymnosperms		

3rd Semester (Honours)

Paper Name: Morphology and Anatomy of Angiosperms

Paper Code: BOT-HC-3016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. CO1. Knowledge on morphology of angiosperms and developmental biology of plant body	Unit 1: Morphology Morphology of inflorescence, stamens and carpel, fruit; Telome theory, phyllode theory; Role of morphology in plant classification.	Remember, Understand
2. CO2. Knowledge on structural and anatomical organization of tissue system in plants and their classification	Unit 2: Introduction and scope of plant Anatomy Application in systematics, forensics and pharmacognosy.	Remember, Understand, Apply
3. CO3. Practical knowledge on inflorescences and fruits of angiosperms	Unit 3: Structure and Development of Plant Body Internal organization of plant body: The three tissue systems, types of cells and tissues. Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development.	Remember, Understand, Apply
4. CO4. Practical knowledge on anatomical features of plant body parts	Unit4: 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. Hydathodes, cavities, lithocysts and laticifers.	Remember, Understand, Apply
	Unit5: Apical meristems Evolution of concept of 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. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. 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.	Remember, Understand, Apply
	Unit6: VascularCambium and Wood Structure, function and seasonal activity of cambium; Secondary growth in root	Remember, Understand, Apply

	and stem. 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. Development and composition of periderm, rhytidome and lenticels.	
	Unit7: 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.	Remember, Understand, Apply

Paper Name: Economic Botany

Paper Code: BOT-HC-3026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. CO1. Knowledge on morphology, uses and economic importance of crop plants 2. CO2. Knowledge on uses of industrially important plants 3. CO3. Practical knowledge on economically important plant parts and their products	Unit 1: Origin of Cultivated Plants Centres of Origin, their importance with reference to Vavilov's work. Introductions, domestication and loss of crop genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.	Remember, Understand
	Unit 2: Cereals Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.	Remember, Understand, Apply
	Unit 3: Legumes Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.	Remember, Understand, Apply
	Unit4: Sources of sugars and starches Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.	Remember, Understand
	Unit5: Spices Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron,	Remember, Understand, Apply

	clove and black pepper.	
	Unit6: Beverages Tea, Coffee (morphology, processing & uses).	Remember, Understand, Apply
	Unit7: Sources of oils and fats General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.	Remember, Understand, Apply
	Unit 8: Natural Rubber Para-rubber: tapping, processing and uses.	Remember, Understand, Apply
	Unit 9: Drug-yielding plants Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis; Tobacco (Morphology, processing, uses and health hazards).	Remember, Understand, Apply
	Unit 10: Timber plants General account with special reference to teak and pine.	Remember, Understand, Apply
	Unit 11: Fibers Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).	Remember, Understand, Apply

Paper Name: Genetics

Paper Code: BOT-HC-3036

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. CO1. Knowledge on Mendelian concepts in genetics; structure, functions and properties of chromosome; chromosomal aberration 2. CO2. Knowledge on gene structures and gene mutations, population genetics 3. CO3. Practical knowledge on chromosomal mapping and	Unit 1: 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.	Remember, Understand, Evaluate

<p>gene interaction studies</p> <p>4. CO4. Practical visualization of chromosomal anomalies</p>	<p>Unit 2: Extrachromosomal Inheritance Chloroplast inheritance: Variegation in Four o'clock plant; Mitochondrial in yeast; Maternal effects-shell coiling in snail; Kappa particles in Paramecium.</p>	Remember, Understand
	<p>Unit 3: 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.</p>	Remember, Understand
	<p>Unit4: Variation in chromosome number and structure Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy.</p>	Remember, Understand
	<p>Unit5: 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.</p>	Remember, Understand
	<p>Unit6: Fine structure of gene Classical vs molecular concepts of gene; Ciston, Racon, Muton, rII locus</p>	Remember, Understand, Apply
	<p>Unit7: Population and Evolutionary Genetics Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.</p>	Remember, Understand, Apply

Paper Name: Biofertilizers-I (SEC I)

Paper code: BOT-SE-3014

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. CO1. Basic knowledge on the microbes used as biofertilizer and understand the process of	Unit 1: General account about the microbes used as biofertilizer – Rhizobium – isolation,	Remember, Understand, Apply

<p>their isolation, identification, mass multiplication, carrier-based inoculants and knowledge on Actinorrhizal symbiosis</p>	<p>identification, mass multiplication, carrier-based inoculants, Actinorrhizal symbiosis.</p>	
<p>2. CO2. Concept on the general characteristics, isolation, mass multiplication carrier-based inoculants of Azospirillum and Azotobacter also the knowledge on the crop response to Azotobacter</p>	<p>Unit 2: Azospirillum: isolation and mass multiplication – carrier-based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.</p>	<p>Remember, Understand, Apply</p>
<p>3. CO3. Basic knowledge on Cyanobacteria including factors affecting growth of Cyanobacteria, concept on the nitrogen fixation and use of blue green algae in rice cultivation</p>	<p>Unit 3: Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.</p>	<p>Remember, Understand, Apply</p>
<p>4. CO4. Brief knowledge on the Mycorrhizal association and understand the details of various types, taxonomy, occurrence, distribution, and growth parameters of Mycorrhiza</p>	<p>Unit4: Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.</p>	<p>Remember, Understand, Apply</p>
<p>5. CO5. Details about the organic farming, maintenance and recycling of biodegradable waste material and understand the methods of making biocompost and vermicompost with application</p>	<p>Unit5: Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.</p>	<p>Remember, Understand, Analyze, Apply</p>

4th Semester (Honours)

Paper Name: Molecular Biology

Paper Code: BOT-HC-4016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. CO1. Detailed knowledge on architecture of nucleic acids, organization of DNA in organisms, models of replication and the factors associated with it	<p>Unit 1: Nucleic acids: Carriers of genetic information</p> <p>Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.</p>	Remember, Understand
2. CO2. Detailed knowledge on transcriptional and post transcriptional events in a cell, translation of proteins	<p>Unit 2: The Structures of DNA and RNA / Genetic Material</p> <p>DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. Organelle DNA -- mitochondria and chloroplast DNA. The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.</p>	Remember, Understand, Apply
3. CO3. Practical acquaintance of isolation and quantification of DNA from plants	<p>Unit 3: The replication of DNA</p> <p>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; Enzymes involved in DNA replication.</p>	Remember, Understand
4. CO4. Knowledge on photographic study of RNA polymerases and RNA modification machinery	<p>Unit4: Central dogma and genetic code</p> <p>Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features).</p>	Remember, Understand
	<p>Unit5: Transcription</p> <p>Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation;</p>	Remember, Understand

	Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in <i>E. coli</i> . Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.	
	Unit6: Processing and modification of RNA Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing (5' cap, 3' poly A tail); Ribozymes; RNA editing and mRNA transport.	Remember, Understand
	Unit7: Translation 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.	Remember, Understand

Paper Name: Plant Ecology and Phytogeography
Paper Code: BOT-HC-4026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. CO1. Knowledge on origin, formation and properties of abiotic components of the ecosystem, interactions and adaptation of plants with biotic and abiotic factors 2. CO2. Knowledge on properties of communities in a population and tropical and habitat organization in an ecosystem 3. CO3. Practical knowledge	Unit 1: Introduction Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.	Remember, Understand, Evaluate
	Unit 2: Soil Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.	Remember, Understand, Apply
	Unit 3: Water Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow,	Remember, Understand, Apply

<p>on property analysis of abiotic components of the ecosystem</p>	<p>hail, dew); Hydrological Cycle; Water in soil; Water table.</p>	
<p>4. CO4. Practical knowledge on vegetation study and different ecological sites</p>	<p>Unit4: Adoption of plants to various environmental factors Light, temperature, wind and fire</p>	<p>Remember, Understand, Evaluate</p>
	<p>Unit5: Biotic interaction Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.</p>	<p>Remember, Understand, Evaluate</p>
	<p>Unit6: Population ecology Population characteristics, Growth curve, population regulation, r and k selection. Ecological speciation: Allopatric/ Sympatric and Parapatric speciation.</p>	<p>Remember, Understand, Apply</p>
	<p>Unit7: Plant communities Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.</p>	<p>Remember, Understand, Evaluate</p>
	<p>Unit 8: Ecosystem Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.</p>	<p>Remember, Understand, Evaluate</p>
	<p>Unit 9: Functional aspects of ecosystem Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.</p>	<p>Remember, Understand, Evaluate</p>
	<p>Unit 10: Phytogeography Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Vegetation types of NE India with special reference to Assam.</p>	<p>Remember, Understand, Apply</p>

Paper Name: Plant Systematics**Paper Code: BOT-HC-4036**

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. CO1. Knowledge on plant identification and classification systems, plant nomenclature 2. CO2. Knowledge on phylogenetic and evolutionary relationships of angiosperms 3. CO3. Practical knowledge on foliar morphology and taxonomical study of angiosperms	Unit 1: Significance of Plant Systematics Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Functions and importance of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Concept of taxa (family, genus, species); Categories and taxonomic hierarchy.	Remember, Understand, Evaluate, Apply
	Unit 2: Botanical Nomenclature Principles and rules (ICN); Ranks and names; Typification, author citation, Effective and valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.	Remember, Understand, Apply
	Unit 3: 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) classification.	Remember, Understand, Apply
	Unit4: Numerical taxonomy and cladistics Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).	Remember, Understand, Apply
	Unit5: Phylogeny of Angiosperms Terms and concepts (primitive and	Remember, Understand

	advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).	
	Unit6: Angiospermic Families Detail study of the following families: Magnoliaceae, Fabaceae, Asteraceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Musaceae, Zingiberaceae, Poaceae.	Remember, Understand

Paper Name: Nursery and gardening

Paper Code: BOT-SE-4014

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. CO1. Brief idea about objectives, scope, infrastructure and maintenance of Nursery	Unit 1: Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.	Remember, Understand, Apply
2. CO2. Concept on structure, types and dormancy of seeds and brief idea about seed storage including types and process and knowledge on seed production technology	Unit 2: Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion – Seed production technology - seed testing and certification.	Remember, Understand, Apply
3. CO3. Knowledge on various modes of vegetative propagation and maintenance of plants in green house	Unit 3: Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants – green house - mist chamber, shed root, shade house and glass house.	Remember, Understand, Apply
4. CO4. Brief idea about development and maintenance of gardening including scope and types and understand the various gardening operations including management of pests and diseases	Unit 4: Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and	Remember, Understand, Apply

5. CO5. Detail knowledge on managements of seeds and seedlings and concept about cultivation, storage and marketing of important vegetables	diseases and harvesting.	
	Unit 5: Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.	Remember, Understand, Analyse, Apply

5th Semester (Honours)

Paper Name: Reproductive Biology of Angiosperms

Paper Code: BOT-HC-5016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. CO1. Knowledge on detailed morphological and anatomical study of reproductive structures of angiospermic plants	Unit 1: 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.	Remember, Understand
2. CO2. Knowledge on embryology and embryological abnormalities in angiosperms	Unit 2: Reproductive development Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.	Remember, Understand
3. CO3. Structural documentation of reproductive structures of angiosperms	Unit 3: Anther and pollen biology Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. 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.	Remember, Understand, Apply
4. CO4. Practical knowledge on developmental biology of embryo and endosperms	Unit 4: Ovule Structure; Types; Special structures—endothelium, obturator, aril, caruncle and hypostase; Female gametophyte—megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of <i>Polygonum</i> type); Organization and	Remember, Understand, Apply

	ultrastructure of mature embryo sac.	
	<p>Unit5: Pollination and fertilization</p> <p>Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.</p>	Remember, Understand
	<p>Unit6: Self incompatibility</p> <p>Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and <i>in vitro</i> pollination; Modification of stigma surface, parasexual hybridization; Cybrids, <i>in vitro</i> fertilization.</p>	Remember, Understand, Evaluate
	<p>Unit 7: Embryo, Endosperm and Seed</p> <p>Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in <i>Paeonia</i>. Seed structure, importance and dispersal mechanisms.</p>	Remember, Understand
	<p>Unit 8: Polyembryony and Apomixis</p> <p>Introduction; Classification; Causes and applications.</p>	Remember, Understand

Paper Name: Plant Physiology

Paper Code: BOT-HC-5026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
<p>1. CO1. Knowledge on mechanisms of water, minerals, and nutrient absorption of plants</p> <p>2. CO2. Knowledge on roles of plant hormones and mechanism of flowering in</p>	<p>Unit 1: Plant-water relation</p> <p>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</p>	Remember, Understand

plants 3. CO3. Practical knowledge on effects of growth regulators on plant parts 4. CO4. Practical knowledge on determination of osmotic and water potential	affecting transpiration, antitranspirants, mechanism of stomatal movement. Plant response to water stress.	
	Unit 2: 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, Ion antagonism and toxicity.	Remember, Understand, Evaluate
	Unit 3: 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.	Remember, Understand
	Unit4: 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.	Remember, Understand
	Unit5: Plant growth regulators Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.	Remember, Understand
	Unit6: Physiology of flowering Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.	Remember, Understand, Analyze
	Unit 7: Phytochrome, cryptochromes and phototropins Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.	Remember, Understand

Paper Name: Natural Resource management

Paper Code: BOT-HE-5016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. CO1. Comprehensive knowledge on different types of natural resources and their ecological, economical and socio-cultural values	Unit 1: Natural resources Definition and types	Remember, Understand
	Unit 2: Sustainable utilization Concept, approaches (economic, ecological and socio-cultural).	Remember, Understand
2. CO2. Basic understandings of land, water and forest resources	Unit 3: Land Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.	Remember, Understand, Apply
3. CO3. Overall knowledge on resource degradation, their judicious use and management for sustainability	Unit4: Water Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.	Remember, Understand, Apply
4. CO4. Knowledge on biodiversity - its importance, management and Bioprospecting	Unit5: Biological Resources Biodiversity-definition and types; Significance; Threats; Management strategies; Bio-prospecting; IPR; CBD; National Biodiversity Action Plan).	Remember, Understand
5. CO5. Knowledge on IPR, and global arena on resource management, conservation and benefit sharing	Unit6: Forest Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.	Remember, Understand, Evaluate
6. CO6. Hands on experience on the domestic solid waste estimation and determining its impact on land degradation	Unit 7: Energy Renewable and non-renewable sources of energy.	Remember, Understand
7. CO7. Hands on experience on forest study using tools like GPS/GIS, and understanding of ecological importance of forest resources	Unit 8: Contemporary practices in resource management EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.	Remember, Understand
	Unit 9: National and international efforts in resource management and conservation	Remember

Paper Name: Horticultural Practices and Post-Harvest Technology

Paper Code: BOT-HE-5026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain
1. CO1. Basic understandings on Horticultural science and its importance in employment generation and socio-economic development	<p>Unit 1: Introduction</p> <p>Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.</p>	Remember, Understand
2. CO2. Classification of horticultural crops, identification of potential horticultural crops – their cultivation, production, management and commercialization	<p>Unit 2: Ornamental plants</p> <p>Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (opuntia, agave and spurges)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, coraltree).</p>	Remember, Understand, Analyse, Apply
3. CO3. Knowledge on horticultural techniques, landscaping and gardening	<p>Unit 3: Fruit and vegetable crops</p> <p>Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).</p>	Remember, Understand, Apply
4. CO4. Overall knowledge on post-harvest technology, disease management, and germplasm management for horticulture	<p>Unit4: Horticultural techniques</p> <p>Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.</p>	Remember, Understand, Apply
5. CO5. Field knowledge of gardening, nurseries, standing crops of horticultural importance	<p>Unit5: Landscaping and garden design</p> <p>Planning and layout (parks and avenues); gardening traditions -</p>	Remember, Understand, Analyse

	Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.	
	<p>Unit6: Floriculture</p> <p>Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.</p>	Remember, Understand, Apply
	<p>Unit 7: Post-harvest technology</p> <p>Importance of post-harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing loses during storage and transportation; Food irradiation - advantages and disadvantages; food safety.</p>	Remember, Understand, Apply
	<p>Unit 8: Disease control and management</p> <p>Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); Quarantine practices; Identification of common diseases and pests of ornamentals, fruits and vegetable crops.</p>	Remember, Understand, Evaluate
	<p>Unit 9: Horticultural crops - conservation and management</p> <p>Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.</p>	Remember, Understand, Analyse
	<p>Unit 10: Field trip</p> <p>Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at suitable</p>	Remember, Understand, Analyse, Evaluate, Apply

	locations.	
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6th Semester (Honours)

Paper Name: Plant Metabolism

Paper Code: BOT-HC-6016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain level
1. CO1. Detailed knowledge of metabolic events of photosynthesis and nutrient metabolism 2. CO2. Knowledge of signalling molecules and pathways in the plant cell 3. CO3. Practical knowledge on different types of chromatographic techniques 4. CO4. Estimation of TAN, sugar and protein contents in plant sample	Unit 1: Concept of metabolism Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes; classification, nomenclature and importance of enzyme; concept of coenzyme, apoenzyme and prosthetic group; enzyme inhibition (allosteric, covalent modulation and Isozymes).	Remember, Understand
	Unit 2: 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, CO ₂ reduction, photorespiration, C ₄ -pathways; Crassulacean acid metabolism; Factors affecting CO ₂ reduction.	Remember, Understand
	Unit 3: Carbohydrate metabolism Synthesis and catabolism of sucrose and starch.	Remember, Understand, Apply
	Unit4: 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.	Remember, Understand, Apply

	<p>Unit5: ATP synthesis</p> <p>Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.</p>	Remember, Understand
	<p>Unit6: Lipid metabolism</p> <p>Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.</p>	Remember, Understand, Evaluate
	<p>Unit 7: Nitrogen metabolism</p> <p>Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.</p>	Remember, Understand
	<p>Unit 8: Mechanisms of signal transduction</p> <p>Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.</p>	Remember, Understand

Paper Name: Plant Biotechnology

Paper Code: BOT-HC-6026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain
<p>1. CO1. Knowledge on applications of tissue culture techniques, construction of recombinant DNA and transformation into hosts, construction of DNA libraries</p> <p>2. CO2. Knowledge on development of transgenic plants for agricultural or</p>	<p>Unit 1: Plant Tissue Culture</p> <p>Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids,</p>	Remember, Understand, Apply

<p>industrial use</p> <p>3. CO3. Practical utility on isolation of plasmid DNA, its digestion and separation of fragments through gel electrophoresis</p>	<p>triploids and hybrids; Cryopreservation; Germplasm Conservation).</p>	
<p>4. CO4. Preparation of media for tissue culture techniques and photographic study of plant tissue culture</p> <p>5. CO5. Photographic study of generating transgenic plants for agriculture</p>	<p>Unit 2: Recombinant DNA Technology</p> <p>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).</p>	<p>Remember, Understand, Analyse</p>
	<p>Unit 3: Gene Cloning</p> <p>Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR.</p>	<p>Remember, Understand, Analyze</p>
	<p>Unit4: Methods of gene transfer</p> <p><i>Agrobacterium</i>-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).</p>	<p>Remember, Understand, Apply</p>
	<p>Unit5: Application of Biotechnology</p> <p>Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (FlavrSavr 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;</p>	<p>Remember, Understand, Apply</p>

	Biosafety concerns.	
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Paper Name: Industrial and Environmental Microbiology

Paper Code: BOT-HE-6016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain level
1. CO1. Understanding the roles of microbes in industries and environment	Unit 1: Scope of microbes in industry and environment	Remember, Understand
2. CO2. Basic knowledge of different kinds of bioreactors and fermentation processes	Unit 2: Bioreactors/Fermenters and fermentation processes Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratory, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.	Remember, Understand, Apply
3. CO3. Knowledge on production processes of some microbial products in industries through site visits		
4. CO4. Knowledge on application of enzymes in industries		
5. CO5. Diversity and distribution of microbes in air, water and soil	Unit 3: Microbial production of industrial products Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase or lipase activity, Organic acid (citric acid or glutamic acid), alcohol (Ethanol) and antibiotic (Penicillin).	Remember, Understand, Apply
6. CO6. Basic understandings on water microbiology and water analysis methods		
7. CO7. Usefulness of microbes in agriculture and bioremediation of contaminated soils		
8. CO8. Practical experiences on basic microbiological techniques and handlings	Unit4: Microbial enzymes of industrial interest and enzyme immobilization Microorganisms for industrial applications and hands on screening microorganisms for casein hydrolysis;	Remember, Understand, Apply

	starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).	
	Unit5: Microbes and quality of environment Distribution of microbes in air; Isolation of microorganisms from soil, air and water.	Remember, Understand, Apply
	Unit6: Microbial flora of water Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.	Remember, Understand, Analyse
	Unit 7: Microbes in agriculture and remediation of contaminated soils Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.	Remember, Understand, Evaluate

Paper Name: Analytical Techniques in Plant Sciences

Paper Code: BOT-HE-6026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. CO1. Knowledge on microscopy and imaging in plant science 2. CO2. Principles and application of centrifuge, spectroscopy and chromatography in biology	Unit 1: 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	Remember, Understand, Apply

<p>3. CO3. Basic knowledge on biostatistics including measures of central tendency and dispersions, statistical data analysis and representations</p>	<p>etching.</p>	
	<p>Unit 2: Cell fractionation Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl₂ gradient, analytical centrifugation, ultracentrifugation, marker enzymes.</p>	<p>Remember, Understand, Apply</p>
<p>4. CO4. Practical knowledge on microscopy, chromatography, centrifugation and spectroscopy</p>	<p>Unit 3: Radioisotopes Use in biological research, auto-radiography, pulse chase experiment.</p>	<p>Remember, Understand, Apply</p>
	<p>Unit4: Spectrophotometry Principle and its application in biological research.</p>	<p>Remember, Understand, Apply</p>
	<p>Unit5: Chromatography Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.</p>	<p>Remember, Understand, Analyze, Apply</p>
	<p>Unit6: 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.</p>	<p>Remember, Understand, Apply</p>
	<p>Unit 7: 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.</p>	<p>Remember, Understand, Evaluate, Apply</p>