

GOALPARA COLLEGE

DEPARTMENT OF BOTANY

PROGRAMME OUTCOMES

Link to the Syllabus:

1. Botany Honours course (CBCS):
https://goalparacollege.ac.in/upload/dept_syllabus/1645081218.pdf
2. Botany Regular course (CBCS):
https://goalparacollege.ac.in/upload/dept_syllabus/1645081264.pdf
3. Botany Major (Non-CBCS):
https://goalparacollege.ac.in/upload/dept_syllabus/1646802757.pdf
4. Botany General (Non-CBCS):
https://goalparacollege.ac.in/upload/dept_syllabus/1646802757.pdf

PROGRAMME: B.SC. BOTANY

PROGRAMME SPECIFIC OUTCOME

1. Knowledge and Understanding:

- a. Diversity of plants and microbes in terms of structure, function, reproduction and ecological roles.
- b. Evaluation and assessment of plant diversity.
- c. Plant systematics and classification.
- d. Value of biodiversity in terms of ecological balance and sustainable development.
- e. Application of Statistics in biological data analysis.
- f. Application of *in-silico* techniques in biological science.
- g. Basics of biotechnology, biochemistry, genetics and modern biological tools and techniques.

2. Intellectual Skills:

- a. Logical interpretation of problems related to biological science.
- b. Searching various burning issues related to biology, environment and sustainable development through internet.
- c. Capacity building for individual survey works related to nature and environment.

3. Practical Skills:

- a. Study of plant and microbial diversity.
- b. Plant classification and identification, anatomy, morphology, plant physiology, plant biochemistry, genetics, plant breeding etc.
- c. Ecological study of the local area.

- d. *In-silco* techniques in biological science.
- e. Preliminary skills on biotechnology, horticulture, biofertilizers, nursery techniques etc.

4. Transferable Skills:

- a. Use of information technology for accumulation and sharing of data.
- b. Dissemination of scientific ideas in writing and orally.
- c. Creation of team spirit.
- d. Access of E- library resources.
- e. Regularity, punctuality, devotion and career planning.

5. Scientific Knowledge and problem analysis:

Application of principles of basic science in studying and analysing problems and phenomena related to biological science.

6. Usage of Modern tools:

- a. Practical application of modern techniques/ instruments in Biochemical and molecular analysis, Biotechnology, *in vitro* culture, microbiology etc.

7. Ethics:

- a. Application of moral and ethical principles to mitigate environmental issues and biodiversity conservation.
- b. Basic knowledge on environment and sustainable development will create responsible citizens.

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Goalpara College

Department of Botany
BSc Botany (Hons) CBCS
COURSE OUTCOME
2023-2024

SEMESTER-I
(Hons)

Paper Name: Phycology and Microbiology

Paper Code: BOT-HC-1016

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Students will learn about the algal diversity. • Students will gain knowledge about the systematics, morphology and structure of Algae. • Students will understand the life cycle pattern of Algae. • Students will understand the useful and harmful activities of Algae. • Students will understand the Microbial world and their diversity. • Students will gain the knowledge of the Economic Importance of Microbes. • Students will know the harmful effects of microbes. 	<p>Unit 1: Introduction to microbial world Scope of microbes in industry and environment; Microbial nutrition, growth and metabolism.</p>	<ul style="list-style-type: none"> • Remember • Understand
	<p>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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>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).</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply • Evaluate
	<p>Unit 4: 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; 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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply • Evaluate
	<p>Unit 5: Cyanophyta and Xanthophyta Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of <i>Nostoc</i> and <i>Vaucheria</i>.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply

<ul style="list-style-type: none"> Students will understand the role of microbes in Research activities. 	<p>Unit 6: <i>Chlorophyta, Charophyta and Bacillariophyta</i> General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of <i>Volvox, Oedogonium, Coleochaete, Chara</i>. General Account of Bacillariophyta.</p>	<ul style="list-style-type: none"> Remember Understand Apply
	<p>Unit 7: <i>Phaeophyta and Rhodophyta</i> Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction; Morphology and life-cycles of <i>Ectocarpus, Fucus</i> and <i>Polysiphonia</i>..</p>	<ul style="list-style-type: none"> Remember Understand Apply

Paper Name: Biomolecules and Cell Biology

Paper Code: BOT-HC-1026

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Students will learn about the chemical nature of biomolecules. • Students will understand the different types of interaction in Biomolecules. • Students will gain knowledge about the structure and general features of enzymes. • Students will attain the concept of enzyme activity and enzyme inhibition. • Students will understand the Biochemical nature of cell and cell organelles. • Students will gain knowledge about the cell divisions: mitosis & meiosis. • Students will attain knowledge about the endomembrane system and protein transport. 	<p>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. 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. Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary; 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, C, D, Z types of DNA; Types of RNA.</p>	<ul style="list-style-type: none"> • Remember • Understand
	<p>Unit 2: Bioenergetics 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>	<ul style="list-style-type: none"> • Remember • Understand
	<p>Unit 3: Enzyme 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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Evaluate
	<p>Unit 4: The Cell Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 5: 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.</p>	<ul style="list-style-type: none"> • Remember • Understand
	<p>Unit 6: 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.</p>	<ul style="list-style-type: none"> • Remember • Understand

	<p>Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.</p> <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>Unit 7: Cell division Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role of protein kinases.</p>	<ul style="list-style-type: none"> • Remember • Understand • Evaluate

SEMESTER-II (Hons)

Paper Name: Mycology and Phytopathology

Paper Code: BOT-HC-2016

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Students will understand the Biodiversity of Fungi and understand the life cycle pattern of Fungi. • Students will gain knowledge about the Economic Importance of Fungi. • Students will attain knowledge about the terminologies in plant pathology. • Students will Understand the scope and importance of Plant Pathology. • Students will gain knowledge about the prevention and control measures of plant diseases and its effect on economy of crops. 	<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 (Hidetta <i>et 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>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<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>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 3: Zygomycotina Characteristic features; Reproduction; Life cycle with reference to Rhizopus.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 4: Ascomycotina General characteristics (asexual and sexual fruiting bodies); Life cycle, Heterokaryosis and parasexuality; Life cycle and classification with reference to <i>Saccharomyces</i>, <i>Aspergillus</i>, <i>Penicillium</i>, <i>Neurospora</i> and <i>Peziza</i>.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 5: 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>	<ul style="list-style-type: none"> • Remember • Understand • Apply

	<p>Unit 6: Deuteromycotina (Fungi Imperfecti) General characteristics; Thallus organization; reproduction; classification with special reference to <i>Alternaria</i> and <i>Colletotrichum</i>.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 7: Allied Fungi- Myxomycota General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.</p>	<ul style="list-style-type: none"> • 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>	<ul style="list-style-type: none"> • 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>	<ul style="list-style-type: none"> • 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 diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.</p>	<ul style="list-style-type: none"> • Remember • Understand

Paper Name: Archegoniate

Paper Code: BOT-HC-2026

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Students will Understand the morphological diversity of Bryophytes. • Students will understand the economical and ecological importance of the Bryophytes. • Students will gain knowledge about the taxonomic position, occurrence, thallus structure, reproduction of Bryophytes. • Students will understand the morphological diversity of Pteridophytes. • Students will understand the economic and ecological importance of the Pteridophytes. • Students will attain knowledge about the taxonomic position, occurrence, thallus structure, reproduction of Pteridophytes. • Students will gain knowledge about the evolution of Bryophytes and Pteridophytes. 	<p>Unit 1: Introduction Unifying features of archegoniate; Transition to land habit; Alternation of generations.</p>	<ul style="list-style-type: none"> • Remember • Understand
	<p>Unit 2: Bryophytes General characteristics; Adaptations to land habit; Classification; Range of thallus organization.</p>	<ul style="list-style-type: none"> • Remember • Understand, • Apply
	<p>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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 4: Pteridophytes General characteristics; Classification; Early landplants (<i>Cooksonia</i> and <i>Rhynia</i>).</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 5: Type Studies- Pteridophytes Classification, 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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 6: 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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply

**SEMESTER-III
(HONS)**

Paper Name: Morphology and Anatomy of Angiosperms

Paper Code: BOT-HC-3016

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Students will understand about the plant communities and ecological adaptations in plants. • Students will gain knowledge about the tissues and tissue systems of Plants. • Students will learn about the wood anatomy. • Students will attain knowledge about the anatomical difference of dicot and monocot. • Students will gain knowledge about the origin, development, arrangement and diversity in size and shape of leaves. 	<p>Unit 1: Morphology Morphology of inflorescence, stamens and carpel, fruit; Telome theory, phyllode theory; Role of morphology in plant classification.</p>	<ul style="list-style-type: none"> • Remember • Understand
	<p>Unit 2: Introduction and scope of plant Anatomy Application in systematics, forensics and pharmacognosy.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 4: 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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 5: 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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply

	<p>Unit 6: Vascular Cambium and Wood Structure, function and seasonal activity of cambium; Secondary growth in root 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.</p>	<ul style="list-style-type: none"> Remember Understand Apply
	<p>Unit 7: 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.</p>	<ul style="list-style-type: none"> Remember Understand, Apply

Paper Name: Economic Botany

Paper Code: BOT-HC-3026

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> Students will gain knowledge about the major introduced plant species, concept of centre of origin and their importance. Students will attain knowledge about crop domestication and loss of genetic diversity. Students will understand the evolution of new crops /varieties. Students will know about the germplasm diversity. Students will understand the economic importance of various plant species. 	<p>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.</p>	<ul style="list-style-type: none"> Remember Understand
	<p>Unit 2: Cereals Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.</p>	<ul style="list-style-type: none"> Remember Understand Apply
	<p>Unit 3: Legumes Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.</p>	<ul style="list-style-type: none"> Remember Understand Apply
	<p>Unit 4: Sources of sugars and starches Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.</p>	<ul style="list-style-type: none"> Remember Understand
	<p>Unit 5: Spices Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper.</p>	<ul style="list-style-type: none"> Remember Understand Apply
	<p>Unit 6: Beverages Tea, Coffee (morphology, processing & uses).</p>	<ul style="list-style-type: none"> Remember Understand Apply
	<p>Unit 7: 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.</p>	<ul style="list-style-type: none"> Remember Understand Apply
	<p>Unit 8: Natural Rubber Para-rubber: tapping, processing and uses.</p>	<ul style="list-style-type: none"> 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).	<ul style="list-style-type: none"> Remember Understand Apply
	Unit 10: Timber plants General account with special reference to teak and pine.	<ul style="list-style-type: none"> Remember Understand Apply
	Unit 11: Fibers Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).	<ul style="list-style-type: none"> Remember Understand Apply

Paper Name: Genetics

Paper Code: BOT-HC-3036

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> Know about the genomic organization or living organisms, study of genes genome, chromosome etc. Gain knowledge on Mendel's genetics and its extensions. Know about variation in chromosome number and structure. Understand about population and evolutionary genetics. 	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.	<ul style="list-style-type: none"> Remember Understand Evaluate
	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.	<ul style="list-style-type: none"> Remember Understand
	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.	<ul style="list-style-type: none"> Remember, Understand
	Unit 4: Variation in chromosome number and structure Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy.	<ul style="list-style-type: none"> Remember Understand
	Unit 5: 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.	<ul style="list-style-type: none"> Remember Understand
	Unit 6: Fine structure of gene Classical vs molecular concepts of gene; Ciston, Racon, Muton, rII locus	<ul style="list-style-type: none"> Remember Understand Apply
	Unit 7: Population and Evolutionary Genetics Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.	<ul style="list-style-type: none"> Remember Understand Apply

SEMESTER-IV
(HONS)

Paper Name: Molecular Biology

Paper Code: BOT-HC-4016

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Students will gain knowledge about the genomic organization or living organisms, study of genes genome, chromosome etc. • Students will gain knowledge on Mendel's genetics and its extensions. • Students will understand about variation in chromosome number and structure. • Students will learn about population and evolutionary genetics. 	Unit 1: 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).	<ul style="list-style-type: none"> • Remember • Understand
	Unit 2: The Structures of DNA and RNA / Genetic Material 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.	<ul style="list-style-type: none"> • Remember • Understand • Apply
	Unit 3: 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; Enzymes involved in DNA replication.	<ul style="list-style-type: none"> • Remember • Understand
	Unit 4: Central dogma and genetic code Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features).	<ul style="list-style-type: none"> • Remember • Understand
	Unit 5: Transcription Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; 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.	<ul style="list-style-type: none"> • Remember • Understand
	Unit 6: 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.	<ul style="list-style-type: none"> • Remember • Understand
	Unit 7: 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.	<ul style="list-style-type: none"> • Remember • Understand

Paper Name: Plant Ecology and Phytogeography

Paper Code: BOT-HC-4026

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> Students will understand the inter-relationship between the living world and environment. 	Unit 1: Introduction Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.	<ul style="list-style-type: none"> Remember, Understand Evaluate
<ul style="list-style-type: none"> Students will gain knowledge about the soil profile and role of climate in soil development. 	Unit 2: Soil Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.	<ul style="list-style-type: none"> Remember Understand Apply
<ul style="list-style-type: none"> Students will understand the concept of ecology and its specification. 	Unit 3: Water Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.	<ul style="list-style-type: none"> Remember Understand Apply
<ul style="list-style-type: none"> Students will learn about ecosystem and its components. 	Unit 4: Adoption of plants to various environmental factors Light, temperature, wind and fire	<ul style="list-style-type: none"> Remember Understand Evaluate
<ul style="list-style-type: none"> Students will understand the principles, endemism, biomes and phytogeographical divisions of India. 	Unit 5: Biotic interaction Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.	<ul style="list-style-type: none"> Remember Understand Evaluate
	Unit 6: Population ecology Population characteristics, Growth curve, population regulation, r and k selection. Ecological speciation: Allopatric/ Sympatric and Parapatric speciation.	<ul style="list-style-type: none"> Remember Understand Apply
	Unit 7: Plant communities Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.	<ul style="list-style-type: none"> Remember Understand Evaluate
	Unit 8: Ecosystem Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.	<ul style="list-style-type: none"> Remember Understand Evaluate
	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.	<ul style="list-style-type: none"> Remember, Understand Evaluate
	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.	<ul style="list-style-type: none"> Remember Understand Apply

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

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Students will gain knowledge of plant identification, concept of classification, principle and rules of nomenclature. • Students will gain knowledge about origin and evolution of angiosperm and their evolutionary relationship. • Students will learn about biometrics, numerical taxonomy and cladistics. • Students will know the history of plant classification. 	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.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • Remember • Understand, • Apply
	Unit 4: Numerical taxonomy and cladistics Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).	<ul style="list-style-type: none"> • Remember • Understand • Apply
	Unit 5: Phylogeny of Angiosperms Terms and concepts (primitive and 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).	<ul style="list-style-type: none"> • Remember • Understand
	Unit 6: Angiospermic Families Detail study of the following families: Magnoliaceae, Fabaceae, Asteraceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Musaceae, Zingiberaceae, Poaceae.	<ul style="list-style-type: none"> • Remember • Understand

SEMESTER-V
(HONS)

Paper Name: Reproductive Biology of Angiosperms

Paper Code: BOT-HC-5016

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Students will gain knowledge of reproductive development of Angiospermic plant. • Students will Understand about the pollination and fertilization mechanism. • Students will gain knowledge about the embryo, endosperm, seed, structure and their development. • Students will attain knowledge about apomixes and polyembryony. 	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.	<ul style="list-style-type: none"> • Remember • Understand
	Unit 2: Reproductive development Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.	<ul style="list-style-type: none"> • Remember, • Understand
	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.	<ul style="list-style-type: none"> • Remember, • Understand • Apply
	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 ultrastructure of mature embryo sac.	<ul style="list-style-type: none"> • Remember • Understand • Apply
	Unit 5: Pollination and fertilization Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.	<ul style="list-style-type: none"> • Remember • Understand
	Unit 6: Self incompatibility 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.	<ul style="list-style-type: none"> • Remember • Understand • Evaluate
	Unit 7: Embryo, Endosperm and Seed 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.	<ul style="list-style-type: none"> • Remember • Understand
	Unit 8: Polyembryony and Apomixis Introduction; Classification; Causes and applications	<ul style="list-style-type: none"> • Remember • Understand

Paper Name: Plant Physiology**Paper Code: BOT-HC-5026**

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Gain knowledge of Plant water relation-ship. • Gain knowledge of mineral & nutrition, nutrient uptake and translocation. • Gain knowledge of plant growth regulators, Physiology of flowering. • Gain knowledge of phytochromes and phototropins. 	<p>Unit 1: Plant-water relation 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. Plant response to water stress.</p>	<ul style="list-style-type: none"> • Remember, • Understand
	<p>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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Evaluate
	<p>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.</p>	<ul style="list-style-type: none"> • Remember • Understand
	<p>Unit 4: 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.</p>	<ul style="list-style-type: none"> • Remember • Understand
	<p>Unit 5: Plant growth regulators Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.</p>	<ul style="list-style-type: none"> • Remember • Understand
	<p>Unit 6: Physiology of flowering Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.</p>	<ul style="list-style-type: none"> • Remember • Understand • Analyze
	<p>Unit 7: Phytochrome, crytochromes and phototropins Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.</p>	<ul style="list-style-type: none"> • Remember • Understand

Paper Name: Natural Resource management

Paper Code: BOT-HE-5016

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Students will gain a comprehensive knowledge on different types of natural resources and their ecological, economical and socio-cultural values. • Students will achieve basic understandings of land, water and forest resources. • Students will attain overall knowledge on resource degradation, their judicious use and management for sustainability. • Students will gain knowledge on biodiversity- its importance management and Bioprospecting. • Students will learn about IPR, and global arena on resource management, conservation and benefit sharing. • Students will have hands on experience on the domestic solid waste estimation and determining its impact on land degradation. • Students will experience a hands on experience on forest study using tools like GPS/GIS, and understanding of ecological importance of forest resources 	Unit 1: Natural resources Definition and types	<ul style="list-style-type: none"> • Remember • Understand
	Unit 2: Sustainable utilization Concept, approaches (economic, ecological and socio-cultural).	<ul style="list-style-type: none"> • Remember • Understand
	Unit 3: Land Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.	<ul style="list-style-type: none"> • Remember • Understand • Apply
	Unit 4: Water Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.	<ul style="list-style-type: none"> • Remember • Understand • Apply
	Unit 5: Biological Resources Biodiversity-definition and types; Significance; Threats; Management strategies; Bio-prospecting; IPR; CBD; National Biodiversity Action Plan).	<ul style="list-style-type: none"> • Remember • Understand
	Unit 6: Forest Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.	<ul style="list-style-type: none"> • Remember • Understand • Evaluate
	Unit 7: Energy Renewable and non-renewable sources of energy.	<ul style="list-style-type: none"> • Remember • Understand
	Unit 8: Contemporary practices in resource management EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.	<ul style="list-style-type: none"> • Remember • Understand
	Unit 9: National and international efforts in resource management and conservation	<ul style="list-style-type: none"> • Remember • Understand • Apply

Paper Name: Horticultural Practices and Post-Harvest Technology

Paper Code: BOT-HE-5026

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Students will gain basic understandings on Horticultural science and its importance in employment generation and socio-economic development. • Students will learn about the classification of horticultural crops, identification of potential horticultural crops – their cultivation, production, management and commercialization. • Students will gain knowledge on horticultural techniques, landscaping and gardening. • Students will attain an overall knowledge on post-harvest technology, disease management, and germplasm management for horticulture. • Students will gain field knowledge of gardening, nurseries, standing crops of horticultural importance 	<p>Unit 1: Introduction Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.</p>	<ul style="list-style-type: none"> • Remember • Understand
	<p>Unit 2: Ornamental plants 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>	<ul style="list-style-type: none"> • Remember • Understand, • Analyse • Apply
	<p>Unit 3: Fruit and vegetable crops 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>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 4: Horticultural techniques 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>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 5: Landscaping and garden design Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.</p>	<ul style="list-style-type: none"> • Remember • Understand • Analyse
	<p>Unit 6: Floriculture Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 7: Post-harvest technology 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 losses during storage and transportation; Food irradiation - advantages and disadvantages; food safety.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 8: Disease control and management 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</p>	<ul style="list-style-type: none"> • Remember • Understand • Evaluate

	and pests of ornamentals, fruits and vegetable crops.	
	<p>Unit 9: Horticultural crops - conservation and management 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>	<ul style="list-style-type: none"> • Remember • Understand • Analyse
	<p>Unit 10: Field trip Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at suitable locations.</p>	<ul style="list-style-type: none"> • Remember • Understand • Analyse • Evaluate • Apply

SEMESTER-VI
(HONS)

Paper Name: Plant Metabolism

Paper Code: BOT-HC-6016

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Students will gain detailed knowledge of metabolic events of photosynthesis and nutrient metabolism. • Students will gain knowledge of signalling molecules and pathways in the plant cell. • Students will attain practical knowledge on different types of chromatographic techniques. • Students will be able to perform estimation of TAN, sugar and protein contents in plant sample 	<p>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).</p>	<ul style="list-style-type: none"> • Remember • Understand
	<p>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, CO₂ reduction, photorespiration, C₄-pathways; Crassulacean acid metabolism; Factors affecting CO₂ reduction.</p>	<ul style="list-style-type: none"> • Remember • Understand
	<p>Unit 3: Carbohydrate metabolism Synthesis and catabolism of sucrose and starch.</p>	<ul style="list-style-type: none"> • Remember • Understand, • Apply
	<p>Unit 4: 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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 5: ATP synthesis 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>	<ul style="list-style-type: none"> • Remember • Understand
	<p>Unit 6: Lipid metabolism Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.</p>	<ul style="list-style-type: none"> • Remember • Understand • Evaluate
	<p>Unit 7: Nitrogen metabolism Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.</p>	<ul style="list-style-type: none"> • Remember • Understand

	Unit 8: Mechanisms of signal transduction Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.	<ul style="list-style-type: none">• Remember• Understand
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Paper Name: Plant Biotechnology

Paper Code: BOT-HC-6026

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> Students will gain knowledge on applications of tissue culture techniques, construction of recombinant DNA and transformation into hosts, construction of DNA libraries. 	<p>Unit 1: Plant Tissue Culture 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, triploids and hybrids; Cryopreservation; Germplasm Conservation).</p>	<ul style="list-style-type: none"> Remember Understand Apply
<ul style="list-style-type: none"> Students will gain knowledge on development of transgenic plants for agricultural or industrial use. 	<p>Unit 2: Recombinant DNA Technology 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>	<ul style="list-style-type: none"> Remember Understand Analyze
<ul style="list-style-type: none"> Practical utility on isolation of plasmid DNA, its digestion and separation of fragments through gel electrophoresis. 	<p>Unit 3: Gene Cloning 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>	<ul style="list-style-type: none"> Remember Understand Analyze
<ul style="list-style-type: none"> Preparation of media for tissue culture techniques and photographic study of plant tissue culture. 	<p>Unit 4: Methods of gene transfer <i>Agrobacterium</i>-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).</p>	<ul style="list-style-type: none"> Remember Understand Apply
<ul style="list-style-type: none"> Photographic study of generating transgenic plants for agriculture 	<p>Unit 5: Application 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.</p>	<ul style="list-style-type: none"> Remember Understand Apply

Paper Name: Industrial and Environmental Microbiology

Paper Code: BOT-HE-6016

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Understanding the roles of microbes in industries and environment. • Basic knowledge of different kinds of bioreactors and fermentation processes. • Knowledge on production processes of some microbial products in industries through site visits. • Knowledge on application of enzymes in industries. • Diversity and distribution of microbes in air, water and soil. • Basic understandings on water microbiology and water analysis methods. • Usefulness of microbes in agriculture and bioremediation of contaminated soils. • Practical experiences on basic microbiological techniques and handlings 	<p>Unit 1: Scope of microbes in industry and environment</p>	<ul style="list-style-type: none"> • Remember • Understand
	<p>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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>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).</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 4: Microbial enzymes of industrial interest and enzyme immobilization Microorganisms for industrial applications and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 5: Microbes and quality of environment Distribution of microbes in air; Isolation of microorganisms from soil, air and water.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 6: 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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Analyze
	<p>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.</p>	<ul style="list-style-type: none"> • Remember • Understand • Evaluate

Paper Name: Analytical Techniques in Plant Sciences

Paper Code: BOT-HE-6026

Course Outcome	Unit No. and Topics	Levels of Bloom's Taxonomy will be Achieved
<ul style="list-style-type: none"> • Knowledge on microscopy and imaging in plant science. • Principles and application of centrifuge, spectroscopy and chromatography in biology. • Basic knowledge on biostatistics including measures of central tendency and dispersions, statistical data analysis and representations. • Practical knowledge on microscopy, chromatography, centrifugation and spectroscopy 	<p>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 etching.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 2: Cell fractionation Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl₂ gradient, analytical centrifugation, ultracentrifugation, marker enzymes.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 3: Radioisotopes Use in biological research, auto-radiography, pulse chase experiment.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 4: Spectrophotometry Principle and its application in biological research.</p>	<ul style="list-style-type: none"> • Remember • Understand • Apply
	<p>Unit 5: Chromatography Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.</p>	<ul style="list-style-type: none"> • Remember • Understand • Analyze • Apply
	<p>Unit 6: 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>	<ul style="list-style-type: none"> • Remember, • Understand • Apply
	<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>	<ul style="list-style-type: none"> • Remember • Understand • Evaluate • Apply

