DEPARTMENT OF BOTANY
PRAGJYOTISH COLLEGE
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PROGRAMME OUTCOME (PO)
PROGRAMME SPECIFIC OUTCOME (PSO)
&
COURSE OUTCOME (CO)

Programme Outcome (PO)

Programme Name: Bachelor of Science (B.Sc.)

PO1. Disciplinary Knowledge: Demonstrate comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate programme of study.

PO2. Social Interaction: Express thoughts and ideas effectively in writing and speaking; listen and communicate with others using appropriate media. Work effectively and respectfully with diverse teams; act together as a group or a team in the interests of a common cause; Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO3. Effective Citizenship: Demonstrate empathetic social concern and equity centered national development, and act with an informed awareness of issues and participate in civic life through volunteering; embrace moral/ ethical values in conducting one's life, possess knowledge of the values and beliefs of multiple cultures and a global perspective; engage in a multicultural society and interact respectfully with diverse groups.

PO4. Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

PO5. Information and Digital Literacy: Use ICT in a variety of learning situations; demonstrate ability to access, evaluate and use a variety of relevant information sources; and use appropriate software for analysis of data.

PO6. Research-related skills: Critically evaluate practices, policies and theories by following scientific approach to knowledge development. Have a sense of inquiry and capability for asking relevant/ appropriate questions, problematizing, synthesizing and articulating; ability to recognize cause- and- effect relationships, define problems, formulate hypotheses, interpret and draw conclusions from data, ability to plan, execute and report the results of an experiment or investigation; ability to apply one's learning to real life situations.

Programme Specific Outcomes (PSOs)

Programme Specific Name: B.Sc. in Botany

The programme specific outcome of the syllabus prescribed as per Gauhati University for the Honours students of Botany is mentioned below:

- **PSO1.** Graduates will demonstrate advanced understanding and proficiency in specialized areas of botanical sciences, such as plant taxonomy, plant physiology, plant pathology and microbiology, plant genetics, or plant ecology.
- **PSO2.** Graduates will possess the ability to design and conduct independent research projects in botany, including formulating research questions, designing experiments, collecting, and analyzing data, and drawing scientifically valid conclusions.
- **PSO3.** Graduates will be able to interpret and analyze complex botanical data using statistical and computational methods, and effectively communicate their findings through written reports and oral presentations.
- **PSO4.** Graduates will have acquired proficiency in a wide range of laboratory

techniques and methodologies commonly used in botanical research, including microscopy, molecular biology techniques, tissue culture, chromatography, and spectroscopy.

- **PSO5.** Graduates will demonstrate competence in fieldwork methodologies, plant specimen collection, preservation, and identification, and possess taxonomic expertise in the classification and identification of plant species.
- **PSO6.** Graduates will develop strong analytical and critical thinking skills, enabling them to identify and address complex botanical problems, evaluate scientific literature, and propose innovative solutions to real-world challenges in plant sciences.
- **PSO7.** Graduates will be able to communicate botanical concepts and research findings effectively to both specialist and non-specialist audiences through written reports, scientific papers, conference presentations, and outreach activities.
- **PSO8.** Graduates will adhere to ethical principles and professional standards in all aspects of their work, including research integrity, respect for intellectual property rights, and consideration of ethical implications in decision-making.
- **PSO9.** Graduates will collaborate effectively with colleagues from diverse disciplines, integrating botanical knowledge with other scientific fields to address multidisciplinary challenges in environmental science, agriculture, biotechnology, and conservation.
- **PSO10.** Graduates will demonstrate a commitment to lifelong learning and professional development, staying abreast of advancements in botanical sciences, engaging in continuing education, and contributing to the advancement of the field through scholarly activities and professional networking.

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. Understand the microbial diversity along with its mode of nutrition, reproduction and its economic importance.	**Unit 1: Introduction to microbial world** Scope of microbes in industry and environment; Microbial nutrition, growth and metabolism.	Remember, Understand

2. Know the role of microbe in the maintenance of the ecological imbalance. 3. Know the importance of microbes in modern research and its application. 4. Knowledge on the systematics of viruses, algae, bacteria and their various metabolic processes. 5. Understand the difference between beneficial and harmful viruses or bacteria. 6. Understand the high industrial application of microbes based on the	**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
	Unit 3: Bacteria Discovery, general characteristics; Types-archaebacteria, eubacteria, actinomycetes, mycoplasma, rickettsia, chlamydiae and spheroplasts); Cell structure; Nutritional types;	Remember, Understand, Apply, Evaluate
metabolite it develops which are useful for the human application in various fields of medicine and nutrient. 7. Role of beneficial or harmful viruses in research, medicine and diagnostics, as causal organisms of plant diseases. 8. To know the various economic benefits of algae and use of them in day today life. 9. Distribution, morphology and life cycle of various algae.	Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in	
	Unit4: 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 *Prochloron*; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Role of	Remember, Understand, Apply

	Unit5: Cyanophyta and Xanthophyta Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life- cycle of	Remember, Understand, Apply
	Unit6: Chlorophyta, Charophyta and Bacillariophyta General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Volvox,*	Remember, Understand, Apply
	Unit7: **Phaeophyta and Rhodophyta** Characteristics; Occurrence; Range of thallus organization; C e l l structure; Reproduction. Morphology and life-cycles of	Remember, Understand, Apply
1. Develop the practical knowledge on models of viruses and their life cycles by having a clear observation of the models	**Practical: Microbiology** 1. Electron micrographs/Models of	Understand, Evaluate, Apply

2. Practical knowledge on the structure, reproduction of bacteria and its know the staining of the gram positive and gram negative bacteria, thus further help in the differentiation among them. 3. Practical understanding of soil microflora and its isolation procedure. 4. Develop the practical knowledge on different forms of algae and their life cycles by having a clear observation of the forms.	drawings/ Photographs of Lytic and Lysogenic Cycle. 2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule. 3. Gram staining. 4. Isolation of soil microflora. 5. Endospore staining with malachite green using the (endospores taken from soil bacteria). **Phycology** 1. Study of vegetative and reproductive structures of *Nostoc*, *Volvox*, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpus*	

Paper Name: Biomolecules and Cell Biology Paper Code: BOT-HC-1026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain level
1. Knowledge on the different bonding pattern among the chemical compounds and further understand the polar compounds. 2. Understand the significance of pH, buffers and their role in biological metabolism. 3. Understand the structure, types and importance of different biomolecules (Lipids, Carbhohydrates, Nucleic Acids, Protein) 4. Develop the concept on	**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	Remember, Understand

5. Understand the different redox reactions and the mechanism of ATP serving as the currency molecule. 6. The students will be able to understand the fundamental biochemical principles of enzymes, such as the structure and function of enzymatic process in living system. 7. Understand the structure and chemical composition of chromatin and concept of cell division. 8. Gain knowledge about "Cell Science" 9. Understand Cell wall Plasma membrane, Cell organelles and cell division.	nucleotides; Types of nucleic acids; Structure of A, B, C, D, Z types of DNA; Types of RNA.	
	Unit 2: Bioenergetics Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure,	Remember, Understand
	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 theroy), Michaelis – Menten	Remember, Understand, Evaluate
	Unit4: The Cell Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell	Remember, Understand, Apply
	Unit5: 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,	Remember, Understand
	Unit6: Cell organelles **Nucleus:** Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. **Cytoskeleton:** Role and structure of microtubules, microfilaments and intermediary filament. **Chloroplast, mitochondria and peroxisomes:** Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. **Endomembrane**	Remember, Understand

	Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes	
	Unit7: **Cell division** Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of	Remember, Understand, Evaluate
1. Gain practical knowledge to detect the presence of different biomolecules and differentiate among them through various qualitative tests based on their color variation. 2. Understand the different staining procedure of various cells and know the usage of different stains. 3. Understand the types of cells and their structure. 4. Knowledge on the physiological phenomenon of cells in different osmotic conditions 5. Practical observation of different stages of cell division and gain a clear concept on the cell cycle and its various steps.	**Practical** 1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins. 2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo*/*Crinum*. 3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* and *Vallisnaria* leaf. 4. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains). 5. Cytochemical staining of : DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.	Understand, Evaluate, Apply

2nd Semester (Honours)

Paper Name: Mycology and Phytopathology Paper Code: BOT-HC-2016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level

1. Identify true fungi and demonstrate the principles and application of plant pathologyin the control of plant disease. 2. Demonstrate skills in laboratory, field and glasshouse work related to mycology and plant pathology. 3. Develop an understanding of microbes, fungi and lichens and appreciate their adaptive strategies. 4. Identify the common plant diseases according to geographical locations and device control measures	**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 *et al.* 2007); Classification of Fungi (Ainsworth, 1973, Webster 1977) up to sub-division with diagnostic characters and examples.	Remember, Understand, Apply
	Unit 2: Mastigomycotina (Chytridiomycetes and Oomycetes) Characteristic features; Reproduction; Life	Remember, Understand, Apply
	Unit 3: Zygomycotina Characteristic features; Reproduction; Life cycle with	Remember, Understand, Apply
	Unit4: Ascomycotina General characteristics (asexual and sexual fruiting bodies); Life cycle, Heterokaryosis and parasexuality; Life cycle and classification with reference to *Saccharomyces,*	Remember, Understand, Apply
	Unit5: Basidiomycotina General characteristics; Life cycle and Classification with reference to black stem rust on wheat *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only), *Agaricus*; Bioluminescence, Fairy Rings	Remember, Understand, Apply
	Unit6: Deuteromycotina (Fungi Imperfecti) General characteristics; Thallus organization; reproduction; classification with special	Remember, Understand, Apply
	Unit7: **Allied Fungi-Myxomycota** General characteristics; Status of Slime molds, Classification; Occurrence; Types of	Remember, Understand, Apply

	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- Ectomycorrhi	Remember, Understand, Apply
	Unit 9: Applied Mycology Role of fungi in biotechnology; food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoprotein s); Pharmaceutical (Secondary metabolites); Agriculture (Biofertilizers); Mycotoxins; Biological control	Remember, Understand, Apply
	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	Remembe r, Understa nd
1. Practically understanding the various morphological and reproductive structures of various fungal groups. 2. Hands on practice of collection, preservation and isolation of fungi. 3. Practical knowledge on the theory studied in regarding various plant pathogens and their symptoms in different plants.	**Practical** 1. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides. 2. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs. 3. *Peziza*: sectioning through ascocarp. 4. *Alternaria*:	Understand , Evaluate, Apply

of various plant pathogens in different plants. 5. Understand the symbiotic relationship betwee n microbes i.e. Lichen and its importance in the ecological maintenance.	5. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts. 6. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown. 7. Study of phaneroplasmodium from actual specimens and /or photograph.Study of *Stemonitis* sporangia. 8. *Albugo:* Study of symptoms of plants infected with *Albugo*; asexual phase study through section/ temporary mounts and sexual structures through permanent slides. 9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs) 10. Phytopathology: Bottle specimens, Herbarium specimens should be made of bacterial diseases, Viral diseases, Fungal diseases (Locally available). 11. Applied mycology: Photographs of Mycorrhizae, Fungi used in medicine (Cylindriocarpon,	

Paper Name: Archegoniate
Paper Code: BOT-HC-2026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. Demonstrate an understanding of archegoniate, Bryophytes, Pteridophytes and Gymnosperms 2. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms 3. Understanding of plant evolution and their transition to land habitat. 4. Demonstrate proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, and Gymnosperms	**Unit 1: Introduction** Unifying features of archegoniates; Transition to land habit; Alternation of generations.	Remember, Understa
	Unit 2: Bryophytes General characteristics; Adaptations to land habit; Classification; Range of thallus	Remember, Understand, Apply
	Unit 3: Type Studies- Bryophytes Classification, morphology, anatomy and reproduction of *Riccia, Marchantia, Anthoceros, Sphagnum* and *Polytrichum*; Reproduction and evolutionary trends in *Riccia,*	Remember, Understand, Apply
	Unit4: Pteridophytes General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*).	Remember, Understand, Apply
	Unit5: Type Studies- Pteridophytes Classification, morphology, anatomy and reproduction of *Psilotum*, *Lycopodium, Selaginella*, *Equisetum, Pteris* and *Marsilea*. Apogamy and apospory,	Remember, Understand, Apply
	Unit6: Gymnosperms General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus*, *Ginkgo* and *Gnetum*; Ecological and economic importance.	Remember, Understand, Apply
1. Develop critic understand by al	**Practicals** ***1.*** **Riccia** – Morphology of	Understand, Apply

analysis of morphology, anatomy and reproductive structure of Bryophytes, Pteridophytes and Gymnosperms. 2. Demonstrate proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, and Gymnosperms.	***2.*** **Marchantia**- Morphology of thallus and reproductive parts; vertical and transverse section of thallus; vertical section of Gemma cup, Antheridiophore and Archegoniophore.Sphagnum- Morphology of plant, whole mount of leaf. ***3.*** **Sphagnm**- Morphology of plant; whole mount of leaf. ***4.*** **Polytrichum**- Morphology of vegetative and reproductive parts; Transverse Section of rhizome, whole mount of leaf; Longitudinal Section through antheridial and archegonial heads; L.S. of capsule. ***5.*** **Lycopodium**- Morphology of plant, whole mount of leaf; transverse section of stem; Longitudinal Section of strobilus; morphology of sporophyll. ***6.*** **Selaginella**- Morphology of plant, whole mount of leaf with ligule, transverse section of stem and rhizophore; longitudinal section of strobilus; morphology of sporophyll. ***7.*** **Equisetum**- Morphology of plant, transverse section of internode, longitudinal and transverse section of strobilus, whole mount of sporangiophore and spore. ***8.*** **Pteris**- Morphology of plant, transverse section of rachis, vertical section of leaflets through sorus; whole mount of prothallus with sex (permanent slide). ***9.*** **Marsilea**- Morphology of	

	megasporophyll; Longitudinal section of ovule (permanent slide). ***11.*** **Pinus**- Morphology of plant; transverse section of Needle; longitudinal section of male cone and female cone; whole mount of Microspores. ***12.*** **Ginkgo**- Morphology of plants and reproductive structures (only photographs). ***13.*** **Gnetum**- Morphology of plant; Morphology of male and female strobilus; vertical	

3rd Semester (Honours)

Paper Name: Morphology and Anatomy of Angiosperms Paper Code: BOT-HC-3016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy
1. Develop an understanding of concepts and fundamentals of plant anatomy 2. Examine the internal anatomy of plant systems and organs 3. Develop critical understanding on the evolution of concept of organization of shoot and root apex. 4. Analyze the composition of different parts of plants and their relationships 5. Evaluate the adaptive and protective systems of plants	**Unit 1: Morphology** Morphology of inflorescence, stamens and carpel, fruit; Telome theory, phyllode theory; Role of morphology in plant	Remember, Understand
	Unit 2: Introduction and scope of plant Anatomy Application in systematics, forensics and pharmacognosy.	Remember, Understand, Apply
	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	Remember, Understand, Apply
	Unit4: Tissues Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and	Remember, Understand, Apply

	transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.	
	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	Remember, Understand, Apply
	Unit6: VascularCambium 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;	Remember, Understand, Apply
	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

1. Knowing various angiosperms in real life and exploring their various features. 2. Understanding the phyllotaxy, aestivation and floral arrangement in various plant species. 3. Develop practical knowledge of various cell structures and their arrangements present in plant systems 4. Practically exploring various staining techniques available for plant cells.	**Practical** 1. Study of special types of inflorescences – Cyathium, Hypanthodium, Verticillaster, Hypanthium. 2. Study of special types of fruits- Superior fruits (*Dillenia*); Aggregate fruits (Custard apple, *Michelia*, Periwinkles, *Polyalthia*); Multiple fruits (Pine apple, Jack fruits). 3. Study of anatomical details through permanent slides/temporary stain mounts / macerations / museum specimens with the help of suitable examples. 4. Apical meristem of root, shoot and vascular cambium. 5. Epidermal system: cell types, stomata types; trichomes: non- glandular and glandular. 6. Root: monocot, dicot, secondary growth. 7. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels. 8. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).	Understand, Evaluate, Apply

Paper Name: Economic Botany

Paper Code: BOT-HC-3026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems 2. Develop critical understanding on the evolution of concept of organization of apex new crops/varieties, importance of germplasm diversity, issues related to access and 3. Ownership 4. Develop a basic knowledge of taxonomic diversity and important families of useful plants 5. Increase the awareness and appreciation of plants & plant products encountered in everyday life 6. Appreciate the diversity of plants and the plant products in human use.	**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	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	Remember, Understand, Apply
	Unit4: Sources of sugars and starches Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato	Remember, Understand
	Unit5: Spices Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black	Remember, Understand, Apply
	Unit6: Beverages Tea, Coffee (morphology, processing & uses).	Remember, Understand, Apply
	Unit7: **Sources of oils and fats** General description, classification, extraction, theiruses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & 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,	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	Remember, Understand, Apply
1. Acquiring of the real-life knowledge o f economically important plants of their locality. 2. Practically study the economically important parts of plants. 3. Students will understand the various medicinally important plants and their parts.	**Practical's**	Understan d, Evaluate,
	1. **Cereals**: Study of useful parts: Rice/Bean (habit sketch, study of paddy and grain, starch grain, micro-chemical test). 2. **Legumes**: Bean, Groundnut, (habit, fruit, seed structure, micro-chemical tests). 3. **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans). 4. **Sources of oils and fats**: Coconut and Mustard. 5. **Rubber**:Specim en, photograph/model of tapping, samples of rubber products. 6. **Test for alkaloids:** Neem, *Vinca rosea*. 7. **Fiber-yielding plants**: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose) Jute (specimen	

Paper Name: Genetics
Paper Code: BOT-HC-3036

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level

1. Have conceptual understanding of laws of inheritance, genetic basis of loci and alleles and their linkage. 2. Comprehend the effect of chromosomal abnormalities in numerical as well as structural changes leading to genetic disorders. 3. Develop critical understanding of chemical basis of genes	**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	Remember, Understand, Evaluate
	Unit 2: Extrachromosomal Inheritance Chloroplast inheritance: Variegation in Four o'clock plant; Mitochondrial in yeast;	Remember, Understand

and dosage. 5. Examine the structure, function and replication of DNA.	**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	Remember, Understand
	Unit4: Variation in chromosome number and structure Deletion, Duplication, Inversion, Translocation. Position effect.	Remember, Understa
	Unit5: Gene mutations Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. Role of Transposons in	Remember, Understand
	Unit6: Fine structure of gene Classical vs molecular concepts of gene; Ciston, Racon, Muton,	Remember, Understand, Apply
	Unit7: **Population and Evolutionary Genetics** Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic	Remember, Understand, Apply
1. Practical knowledge on various stages of cell division 2. Practical knowledge on the chromosomal study of organisms using karyotyping. 3. Gain knowledge on the interactions of gene controlling different quantitative traits	**Practical** 1. Meiosis through temporary squash preparation. 2. Mendel's laws through seed ratios. 3. Chromosome mapping using point test cross data. 4. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4). 5. Permanent Slides showing Translocation Ring, Photograph showing Laggards and	Understand, Analysis, Apply

Paper Name: Biofertilizers-I (SEC I)
Paper code: BOT-SE-3014

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. Environmental awareness and Carbon Footprint reduction 2. Self-employment through the acquired knowledge of garden and nursery development. 3. Employment generation through entrepreneurship skills. 4. Knowledge on Compost making	Unit 1: General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier-based inoculants, Actinorrhizal symbiosis.	Remember, Understand, Apply
	Unit 2: Azospirillum: isolation and mass multiplication – carrier-based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter	Remember, Understand, Apply
	Unit 3: Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice	Remember, Understand, Apply
	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.	Remember, Understand, Apply
	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.	Remember, Understand, Analyze, Apply

4th Semester (Honours)

Paper Name: Molecular Biology Paper Code: BOT-HC-4016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. Understand the structures and chemical properties of DNA and RNA through various historic experiments. 2. Differentiate the main types of prokaryotes through their grouping abilities and their characteristic 3. Evaluate the experiments establishing central dogma and genetic code. 4. Gain an understanding of various steps in transcription, protein synthesis and protein modification.	**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	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-	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	Remember, Understand
	Unit4: Central dogma and genetic code Key experiments establishing- The Central Dogma (Adaptor hypothesis and discovery of	Remember, Understand

	Genetic code (deciphering & salient features**).**	
	Unit5: Transcription Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E. coli.* Eukaryotes: transcription	Remember, Understand
	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	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	Remember, Understand
1. Various molecular techniques of isolation and quantification of plant DNA. 2. Understanding various molecular events related to the DNA replication and enzymes responsible for the event. 3. Acquiring knowledge on molecular structure of RNA polymerase present in different types of cells	**Practical** 1. DNA isolation from any plant material. 2. DNA estimation by diphenylamine reagent/UV Spectrophotometry (Demostration). 3. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).	Understand, Analysis, Apply

	4. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs. 5. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and	

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

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. Understand core concepts of biotic and abiotic 2. Classify the soils on the basis of physical, chemical and biological components 3. Analysis the phytogeography or phytogeographical division of India 4. Evaluate energy sources of ecological system 5. Assess the adaptation of plants in relation to light, temperature, water, wind and fire. 6. Conduct experiments using skills appropriate to subdivisions.	**Unit 1: Introduction** Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis	Remembe r, Understa nd, 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, hail, dew); Hydrological Cycle; Water in soil; Water table	Remember, Understand, Apply
	Unit4: Adoptation of plants to various environmental factors Light, temperature, wind and	Remembe r, Understa nd,
	Unit5: Biotic interaction Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis,	Remembe r, Understa nd,

	food chains and webs; ecological pyramids; biomass, standing crop	
	Unit6: Population ecology Population characteristics, Growth curve, population regulation, r and k selection. Ecological speciation: Allopatric/ Sympatric and Parapatric speciation	Remember, Understand, Apply
	Unit7: **Plant communities** Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax	Remembe r, Understa nd, Evaluate
	Unit 8: Ecosystem Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.	Remembe r, Understa nd,
	Unit 9: Functional aspects of ecosystem Principles and models of energy flow; Production and productivity; Ecological efficiencie s; Biogeochemical cycles; Cycling of Carbon, Nitrogen and	Remembe r, Understa nd, 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	Remember, Understand, Apply
1. Practical knowledge on how to measure the abundance, frequency of a species, population or community using quadrate method. 2. Knowledge on the	**Practical** 1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemomet er, psychrometer/hygrometer,	Understan d, Analysis, Apply

non-polluted water; thereby understand the demand of oxygen in a particular ecosystem for the organisms present. 3. To do soil sample test for checking nutrient availability and deficiency.	2. Determination of pH of various soil and water samples using pH meter. 3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. 6. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each). (b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants). 7. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed). 8. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency	

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

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. Classify Plant systematics and recognize the importance of herbarium and Virtual herbarium 2. Evaluate the Important herbaria and botanical gardens 3. Interpret the rules of ICN in botanical nomenclature 4. Assess terms and concepts related to Phylogenetic Systematics 5. Generalize the characters of the families according to Bentham and Hooker's system of 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-	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	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);	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 advanced, homology and	Remember, Understand
	monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree	
	Unit6: Angiospermic Families Detail study of the following families: Magnoliaceae, Fabaceae, Asteraceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae.	Remember, Understand
1. Understand in details with practical knowledge of the morphology of different types of inflorescences. 2. Practical knowledge on taxonomy through field study and mehtods to identify the plant species and further techniques of herabarium preparation. 3. Practical understanding of distribution and habitat of angiosperms by field visit	**Practical** 1. Study of vegetative and floral characters of locally available angiospermic plants belonging to the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Fabaceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Musaceae, Orchidaceae. 2. Field visit to familiarise students with vegetation of an area and identification of	Understand, Analysis, Apply

Paper Name: Nursery and gardening Paper Code: BOT-SE-4014

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. Practical knowledge on different gardening and nursery techniques. 2. Self-employment through the acquired knowledge of garden and nursery development. 3. Employment generation through entrepreneurship skills.	**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
	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
	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
	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	Remember, Understand, Apply
	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. Recall the history of reproductive biology of angiosperms & recognize the importance of genetic and molecular aspects of flower development 2. Understand structure and functions of anther wall and pollen wall 3. Evaluate the special structures of Ovule 4. Solve Self-incompatibility in Pollination and fertilization & relate between Embryo,Endosperm and Seed 5. Comprehend the causes of Polyembryony and apomixes with its classification	**Unit 1: Introduction** History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari,	Remember, Understand
	Unit 2: Reproductive development Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects	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	Remember, Understand, Apply
	Unit4: Ovule Structure; Types; Special structures– endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of	Remember, Understand, Apply

	Unit5: Pollination and fertilization Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil;	Remember, Understand
	Unit6: Self incompatibility Basic concepts (interspecific, heteromorphic, GSI and SSI); Methods to overcome self-incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and *in vitro* pollination; Modification of stigma surface, parasexual hybridization; Cybrids, *in vitro*	Remember, Understand
	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 *Paeonia*. Seed structure	Remember, Understand
	Unit 8: Polyembryony and Apomixis Introduction; Classification; Causes and applications	Remember, Understand

1. Practical observation of the morphology and types of pollen grains of different plant species under palynological studies. 2. Embryological understandings of the different types of ovules, anthers and hands on training of the different techniques to study the pollen grains and further differentiate among them 3. Practical knowledge on the various developmental stages of male and female reproductive organs.	**Practical** 1. ***Anther*:** Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation. 2. ***Pollen grains:*** Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen	Understand, Analyse, Apply

	3. ***Ovule:*** Types- anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs). 4. ***Female gametophyte through permanent slides/ photographs:*** Types, ultrastructure of mature egg apparatus. 5. Intra-ovarian pollination; Test tube pollination through photographs. 6. ***Endosperm:*** Dissections of developing seeds for endosperm with free-nuclear	

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

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. Understand Water relation of plants with respect to various physiological processes. 2. Explain chemical properties and deficiency symptoms in plants 3. Classify aerobic and anaerobic respiration 4. Explain the significanceof	**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	Remember, Understand

Photosynthesis and respiration 5. Assess dormancy and germination in plants.	**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	Remembe r, Understa nd, 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	Rememb er, Understa nd
	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–	Rememb er, Understa nd
	Unit5: Plant growth regulators Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic	Rememb er, Understa nd
	Unit6: Physiology of flowering Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.	Remember, Understand, Analyze
	Unit 7: Phytochrome, crytochromes and phototropins Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses	Rememb er, Understa nd
1. Know the various physiological processes of plants through practicals	**Practical**	Understan d, Analyse, Apply

2. Determination of OP, WP and stomatal index 3. To know the effect of light on transpiration 4. To know the effect of carbon dioxide on rate of photosynthesis 5. Histochemical tests for various phytochemical contents. 6. Acquire knowledge on fruit ripening or rooting from cuttings	1. Determination of osmotic potential of plant cell sap by plasmolytic method. 2. Determination of water potential of given tissue (potato tuber) by weight method. 3. Study of the effect of light on the rate of transpiration in excised twig/leaf. 4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte. 5. To study the effect of different concentrations of IAA on Gram/Pea/Moong root (IAA Bioassay). 6. To study the induction of amylase activity in germinating Maize/Bean grains. 7. Effect of carbon dioxide concentration on the rate of photosynthesis. **Demonstration experiments:**	

Paper Name: Natural Resource management Paper Code: BOT-HE-5016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
1. Understand the concept of different natural resources and their utilization. 2. Critically analyze the sustainable utilization land, water, forest and energy resources. 3. Evaluate the management strategies of different natural resources. 4. Reflect upon the different national and international efforts in resource management and their conservation	**Unit 1: Natural resources** Definition and types	Remember, Understa
	Unit 2: Sustainable utilization Concept, approaches (economic, ecological and socio-cultural)	Remember, Understa
	Unit 3: Land Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management	Remember, Understand, Apply
	Unit4: Water Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.	Remember, Understand, Apply
	Unit5: Biological Resources Biodiversity-definition and types; Significance; Threats; Management strategies; Bio-prospecting; IPR; CBD; National Biodiversity Action Plan)	Remember, Understand
	Unit6: Forest Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management	Remember, Understand, Evaluate
	Unit 7: Energy Renewable and non-renewable sources of energy.	Remember, Understa
	Unit 8: Contemporary practices in resource management EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste	Remember, Understand

	Unit 9: National and international efforts in resource management and conservation	Remember
1. Estimation of solid waste generated by a domestic system and impact of it in the environment. 2. Data collection techniques for forest area. 3. Quantitative analysis of ecological footprint. 4. Various geographical indexing techniques for plant managements.	**Practical** 1. Estimation of solid waste generated by a domestic system (biodegradable and non- biodegradable) and its impact on land degradation. 2. Collection of data on forest cover of specific area. 3. Measurement of dominance of woody species by DBH (diameter at breast height) method. 4. Calculation and analysis of ecological footprint. 5. Use of GPS and GIS	Understand, Analyse, Apply

Paper Name: Horticultural Practices and Post-Harvest Technology Paper Code: BOT-HE-5026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain
1. Understand the concept of different types of horticultural crops, their conservation and management	**Unit 1: Introduction** Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban	Remember, Understand
2. Examine the various branches of horticulture, fruit and vegetable crops, floriculture, medicinal and aromatic plants. 3. Critically evaluate different cultivation practices and disease management 4. Reflect upon different	**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,	Remember, Understand, Analyse, Apply

	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	Remember, Understand, Apply
	Unit4: 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	Remember, Understand, Apply
	Unit5: Landscaping and garden design Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and	Remember, Understand, Analyse
	Unit6: Floriculture Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions	Remember, Understand, Apply
	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 loses during storage and	Remember, Understand, Apply
	Unit 8: Disease control and management Field and post-harvest diseases; Identification of deficiency symptoms; remedial	Remember, Understand, Evaluate

	management practices; Crop sanitation; IPM strategies (genetic, biological andchemical methods for pest control); Quarantine practices; Identification of common diseases andpests of ornamentals, fruits and	
	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	Remember, Understand, Analyse
	Unit 10: Field trip Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at suitable	Remember, Understand, Analyse, Evaluate, Apply

6th Semester (Honours)

Paper Name: Plant Metabolism
Paper Code: BOT-HC-6016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain level
1. Differentiate anabolic and catabolic pathways of metabolism 2. Recognize the importance of Carbon assimilation in photorespiration 3. Explain the ATP-Synthesis 4. Interpret the Biological nitrogen fixation in metabolism Remember, understand	**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	Remember, Understand
	Unit 2: Carbon assimilation Historical background, photosynthetic pigments, role of photosynthetic pigments	Remember, Understand

	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	
	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	Remember, Understand, Apply
	Unit5: ATP synthesis Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's	Remember, Understand
	Unit6: Lipid metabolism Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α-oxidation	Remember, Understand, Evaluate
	Unit 7: Nitrogen metabolism Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of	Remember, Understand

	Ammonia assimilation and transamination	
	Unit 8: Mechanisms of signal transduction Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade	Remember, Understand
1. Know the various chromatographic methods such as paper chromatography, TLC. 2. Separation of plant pigments through chromatography and quantitative analysis of absorption spectrum of the pigments. 3. Chemical tests for determination of sugar content 4. Protein estimation 5. Comparison of rate of respiration in different plant parts	**Practical** 1. Chemical separation of photosynthetic pigments. 2. Estimation of sugar content by Somogyi method. 3. Determination of TAN in plant materials. 4. To compare the rate of respiration in different parts of a plant (Demonastration). 5. Estimation of protein in a sample by Biuret method. 6. Separation of amino acids by paper chromatography. 7. Demonstration of Thin layer chromatography (TLC). 8. Quantitative analysis of absorption spectrum of photosynthetic	Understand, Analyse And Apply

Paper Name: Plant Biotechnology Paper Code: BOT-HC-6026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain
1. Understand the core concepts and fundamentals of plant biotechnology and genetic engineering 2. Develop their competency on different types of plant tissue culture 3. Analyze the enzymes and vectors for genetic manipulations 4. Examine gene cloning and evaluate different methods of gene transfer 5. Critically analyze the major concerns and applications of transgenic technology	**Unit 1: Plant Tissue Culture** Historical perspective; Composition of media;	Remember, Understand, Apply
	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	
	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	Remember, Understand, Analyse
	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	Remember, Understand, Analyze

	Unit4: Methods of gene transfer *Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase	Remember, Understand, Apply
	Unit5: Application of Biotechnology Pest resistant (Bt-cotton);	Remember, Understand, Apply
	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); Gentically Engineered Products– Human Growth Harmone; Humulin;	

1. Learn how to prepare culture media, tools and techniques of micropropagation including aseptic culture. 2. Use of computer in biological fields, in silico construction of restriction map. 3. Modern biotechnological and genetic engineering tools and techniques, their application and limitations. 4. Know about various gene transfer methods. 5. Isolation of plasmid DNA and protoplast. 6. Restriction digestion and gel elctrophorasis of plasmid DNA.	**Practical** 1. (a) Preparation of MS medium. (b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc. 2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs. 3. Isolation of protoplasts. 4. Construction of restriction map of circular and linear DNA from the data provided. 5. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr	Understand, Analyse, Apply

Paper Name: Industrial and Environmental Microbiology Paper Code: BOT-HE-6016

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain level
1. Understand the concept and role of microbes in industry and environment. 2. Critically analyze the types of bioreactors and the fermentation process. 3. Evaluate the role of microorganisms in industry and microbes in agriculture. 4. Reflect upon different Landscaping practices and garden design 5. Develop skills on the remediation process of contaminated soils.	**Unit 1: Scope of microbes in industry and environment**	Rememb er, Understa
	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.	Remember, Understand, Apply
	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	Remember, Understand, Apply
	Unit4: Microbial enzymes of industrial interest and enzyme immobilization Microorganisms for industrial applications and hands on screening microorganisms for	Remember, Understand, Apply

	starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized	
	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	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	Remembe r, Understa nd, Evaluate
1. Obtaining knowledge of principles and functioning of instruments in microbiology laboratory. 2. Hands on training on techniques on sterilization and preparation of culture media. 3. Obtaining knowledge on pure culture and various	**Practical** 1. Principles and functioning of instruments in microbiology laboratory 2. Hands on sterilization techniques and preparation of culture media. 3. Pure culture techniques.	Understan d, Analyse, Apply

Paper Name: Analytical Techniques in Plant Sciences Paper Code: BOT-HE-6026

Course Outcome	Unit No. and Topics	Bloom's Taxonomy Domain Level
5. Explain the principles of Light microscopy, compound microscopy, Fluorescence microscopy and confocal microscopy 6. Develop conceptual understanding of cell wall degradation enzymes and cell fractionation. 7. Classify different types of chromatography techniques. 8. Apply suitable strategies in data collections and disseminating research findings.	**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	Remember, Understand, Apply
	Unit 2: Cell fractionation Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient, analytical centrifugation, ultracentrifugation,	Remember, Understand, Apply
	Unit 3: Radioisotopes Use in biological research, auto-radiography, pulse chase	Remember, Understand, Apply
	Unit4: Spectrophotometry Principle and its application in biological research.	Remember, Understand, Apply
	Unit5: Chromatography Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion- exchange chromatography; Molecular sieve chromatography; Affinity	Remember, Understand, Analyze, Apply
	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	Remember, Understand, Apply

	Unit 7: Biostatistics Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency:	Remember, Understand, Evaluate, Apply
	dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.	
1. Obtaining knowledge on various molecular techniques for blotting, DNA fingerprinting, sequencing etc. 2. Study of thin layer chromatography, column chromatography and its use in separation of various chemical compounds. 3. Knowledge on separation and estimation of various macromolecules.	**Practical** 1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs. 2. Demonstration of ELISA. 3. To separate sugars by thin layer chromatography. 4. Isolation of chloroplasts by differential centrifugation. 5. To separate chloroplast pigments by column chromatography. 6. To estimate protein concentration through Lowry's methods. 7. To separate proteins using PAGE. 8. To separation DNA (marker) using AGE. 9. Study of different microscopic	Understand, Analyse, Apply