

**DEPARTMENT OF BOTANY**  
**GAUHATI UNIVERSITY**  
**GUWAHATI-781014**

**SYLLABUS FOR M.Sc. PROGRAMME (CBCS)**  
**IN**  
**BOTANY**

**Effective from Academic Session 2022-2023**

Paper Code	Name of the paper	Total Marks	Internal Assessment	Semester Exam	Teaching Hours/Week	Credits
<b>First Semester</b>						
BOT1016	Diversity I (Algae, Fungi, Bryophytes)	80	20	100	5	6
BOT1026	Diversity II (Pteridophytes, Gymnosperm and Angiosperm)	80	20	100	5	6
BOT1036	Ecology, Environment and Resource Management	80	20	100	5	6
BOT1044	Practical: Algae, Fungi, Bryophytes and Pteridophytes	80	20	100	9	4
BOT1054	Practical : Gymnosperm, Angiosperm, Ecology	80	20	100	9	4
<b>Second Semester</b>						
BOT2016	Cytogenetics , Plant Breeding & Evolution	80	20	100	5	6
BOT2026	Microbiology and Plant Pathology	80	20	100	5	6
BOT2036	Plant Physiology and Biochemistry	80	20	100	5	6
BOT2044	Practical Paper: Microbiology, Plant pathology and Cytogenetics	80	20	100	9	4
BOT2054	Practical: Plant Physiology Biochemistry	80	20	100	9	4
<b>Third Semester</b>						
BOT3016	Reproductive and Developmental Botany, Biostatistics	80	20	100	5	6
BOT3026	Molecular Biology, Plant Biotechnology & Bioinformatics	80	20	100	5	6
BOT3036	Research Methodology and Bioinstrumentation	80	20	100	5	6
BOT3044	Practical - Anatomy, Reproductive and Developmental Botany, Biostatistics	80	20	100	9	4
BOT3054	Practical- Molecular Biology, Plant Biotechnology & Bioinformatics	80	20	100	9	4
<b>Fourth Semester</b>						
BOT4015	Angiosperm Taxonomy Special Paper I	80	20	100	5	5
BOT4025	Angiosperm Taxonomy Special Paper II	80	20	100	5	5
BOT4035	Angiosperm Taxonomy Special Paper III	80	20	100	5	5

BOT4045	Angiosperm Taxonomy Special Paper Dissertation	80	20	100	9	5
BOT4054	Angiosperm Taxonomy Special Paper Practical	80	20	100	9	4
BOT4065	Cytology, Genetics and plant Breeding Special Paper I	80	20	100	5	5
BOT4075	Cytology, Genetics and plant Breeding Special Paper II	80	20	100	5	5
BOT4085	Cytology, Genetics and plant Breeding Special Paper III	80	20	100	5	5
BOT4095	Cytology, Genetics and plant Breeding Special Paper Dissertation	80	20	100	9	5
BOT4104	Cytology, Genetics and plant Breeding Special Paper Practical	80	20	100	9	4
BOT4115	Plant Ecology Special Paper I	80	20	100	5	5
BOT4125	Plant Ecology Special Paper II	80	20	100	5	5
BOT4135	Plant Ecology Special Paper III	80	20	100	5	5
BOT4145	Plant Ecology Special Paper Dissertation	80	20	100	9	5
BOT4154	Plant Ecology Special Paper Practical	80	20	100	9	4
BOT4165	Microbiology Special Paper I	80	20	100	5	5
BOT4175	Microbiology Special Paper II	80	20	100	5	5
BOT4185	Microbiology Special Paper III	80	20	100	5	5
BOT4195	Microbiology Special Paper Dissertation	80	20	100	9	5
BOT4204	Microbiology Special Paper practical	80	20	100	9	4
BOT4215	Mycology and Plant Pathology Special Paper I	80	20	100	5	5

BOT4225	Mycology and Plant Pathology Special Paper II	80	20	100	5	5
BOT4235	Mycology and Plant Pathology Special Paper III	80	20	100	5	5
BOT4245	Mycology and Plant Pathology Special Paper Dissertation	80	20	100	9	5
BOT4254	Mycology and Plant Pathology Special Paper Practical	80	20	100	9	4
BOT4265	Plant Physiology and Biochemistry Special Paper I	80	20	100	5	5
BOT4275	Plant Physiology and Biochemistry Special Paper II	80	20	100	5	5
BOT4285	Plant Physiology and Biochemistry Special Paper III	80	20	100	5	5
BOT4295	Plant Physiology and Biochemistry Special Paper Dissertation	80	20	100	9	5
BOT4304	Plant Physiology and Biochemistry Special Paper Practical	80	20	100	9	4
BOT4316	<b>Open Paper</b> Plant Diversity, Conservation, IPR and Traditional Knowledge	80	20	100	5	6

**Programme specific outcome:**

**M. Sc. in Botany**

Understand the diversity, life cycle pattern, phylogeny and economic values of Cryptogmic and Phanerogamic plants of the NE Region.

Analyse the biotic and abiotic interactions in different ecosystems. Understanding basic concepts and recent trends in Cytology, Genetics and Plant Breeding, Plant Physiology and Biochemistry, Microbiology, Plant Ecology, Mycology and Plant Pathology

Train up skill human resources in the field of Angiosperm Taxonomy.

Perform procedures as per laboratory standards in the above mentioned areas. Understand the application of plant resources in agriculture, health care, industry and other environmental issues.

**FIRST SEMESTER****Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
BOT 1016	80	20	100	6	5
BOT 1026	80	20	100	6	5
BOT 1036	80	20	100	6	5
BOT 1044	80	20	100	4	9
BOT 1054	80	20	100	4	9
Total	400	100	500	26	33

Examination Time: Theory .....3 (Three Hours); Practical...5 (Five Hours)

**BOT 1016**  
**Diversity I (Algae, Fungi, Bryophytes)**

**Unit-I**

Algae: Diversity and classification, recent trends in the classification, pigmentation, morphology and reproduction, phylogeny and interrelationships among different groups, patterns of life cycle and post fertilization stages in Chlorophyta, Xanthophyta, Phaeophyta and Rhodophyta, Ecological importance in different habitats, Algal indicators, Algal blooms, Eutrophication, Productivity in fresh water and marine environment, symbiotic association, Algal culture.

**Unit-II**

Fungi: Characteristics of fungi and cell structure, recent trends in classification and phylogeny, major groups and their interrelationships. Different mode of reproduction, parasexuality and degeneration of sex in fungi.

**Unit-III**

Fungi: Physiological and ecological specialization (coprophilous, cellulolytic, entomogenous and lignolytic); Mutualism: Mycorrhiza, Lichen; Parasites: common parasites of plants and humans, Saprophytes - decomposition of organic matter, Economic importance.

**Unit-IV**

Lichen: Classification and nomenclature, structure and reproduction, mechanism of phycobiont and mycobiont interaction, lichen as ecological indicator.

**Unit-V**

Virus: Types and nomenclature of viruses, replication of RNA and DNA viruses, virus-vector

relationships, tumor virus, viroids, prions and interferons.

Bacterial cell: Ultra structure, cell wall, different groups of bacteria, recent developments in classification.

### **Unit-VI**

Bryophytes: Origin, evolution, classification, biochemistry, physiology and ecology; diversity and distribution in North East India, Economic importance. Morphological, anatomical and reproductive diversity, Morphogenesis, Evolution of gametophytes and sporophytes; Bryophytes as pollution indicator and monitoring.

## **BOT 1026**

### **Diversity II ( Pteridophytes, Gymnosperm and Angiosperm)**

#### **Unit-I**

Pteridophyta: Origin and evolution of Pteridophytes; Telome concept; stellar evolution; heterospory and origin of seed habit; classification of vascular cryptogams. Morphological, anatomical and reproductive diversity, soral evolution in ferns, gametophytic structure in eusporangiate and leptosporangiate forms and evolution of sex.

#### **Unit-II**

Palaeobotany: Geological time scale, fossilization process, classification and nomenclature of fossil plants, techniques in studying fossils, fossils vs. evolution. General account of major fossil groups - Psilophytales, Zosterophyllales, Sphenophyllales, Calamitales, Coenopteridales.

#### **Unit-III**

Gymnosperms: Classification and salient features of major taxa; characteristics, affinities and relationships of Ginkgoales, Coniferales, Taxales and Gnetales.

#### **Unit-IV**

Angiosperms: Historical background of Plant Taxonomy; Pre Darwinian, Post Darwinian and recent system of classifications (Takhtajan, Cronquist, APG); recent trends in Taxonomy; ICN- History, Principles and major rules of nomenclature, type concept, principles of priority and its limitation, effective and valid publication, author citation; plant collection and documentation; importance of botanical gardens and herbaria in taxonomic studies: important botanical gardens in India and abroad; Botanical Survey of India.

**Unit-V**

Phylogeny and affinities of Magnoliales, Ranunculales, Euphorbiales, Scrophulariales, Lamiales, Asterales, Orchidales, Zingiberales, Poales.

**Unit-VI**

Morphology: Origin and evolution of Angiosperms; Inflorescence and flowers; Co- evolution of flower and pollinators; Morphology of stamens and carpels; staminodia; nectaries; types of ovaries, morphology of inferior ovary; placenta and placentation.

**BOT 1036**

**Plant Ecology, Environment and Resource Management**

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**Unit –I**

The Environment- physical and biotic; Definition, principle and scope of ecology, ecological factors. Concept of habitat and nicheresource partitioning; character displacement.

**Unit -II**

Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection). Ccommunity structure and attributes; levels of species diversity and its measurement; edges and ecotones. Methods of studying plant communities. Ecological succession- types; mechanisms; changes involved in succession; concept of climax. Ecosystem- types; structure; function; energy flow and mineral cycling (C, N, P & S).

**Unit -III**

Biodiversity – concept, components and types; importance of biodiversity conservation, Principles and practices, different approaches for biodiversity conservation-In-situ and ex-situ conservation.

**Unit -IV**

Environmental pollution- sources, types of pollutants of various industrial effluents such as pulp and paper mills, oil exploration and refinery, petrochemicals, iron and steel industries, domestic wastes, organic debris, agricultural wastes, pesticides. Effects of pesticides on soil components, residual toxicity and pollution. Global climate change: greenhouse effects, ozone layer depletion, acid rain.

**Unit -V**

Origin, evolution, botany, cultivation and uses of (i) Food & beverage (ii) fiber & oil (iii) medicinal and aromatic plants; important timber-yielding plants and NTFPs. Green revolution: Benefits and adverse consequences, innovations for meeting world food demands, GMO, INM, IPM.

**Unit -VI**

Dynamic phytogeography and its basic principles , theories and hypotheses, centre of origin of cultivated plants, plant migration, theory of tolerance, age and area hypothesis, concept of endemism, megacentres of endemism in India, endemic plants of India with special reference to N E India, phytogeographic regions of the world and India and their characteristic vegetations. Characteristic flora of N E India.

**BOT 1044**

**Practical Paper : Algae, Fungi, Bryophytes and Pteridophytes**

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1. Study of range of thallus organization and reproductive structures of algae with the help of suitable representatives.
2. Gram staining, flagella staining, capsule staining and acid fast staining of bacteria.
3. Collection and study of symptoms of virus infected plants.
4. Study of morphological, anatomical and reproductive features of some fungi growing in Assam
5. Study of morphological and anatomical features of some lichens growing in Assam
6. Study of some important genera of Bryophytes available in NE India with respect to their morphology, anatomy and reproductive structures.
7. Study of some important fossil and living members of major groups of Pteridophytes.

**BOT 1054**

**Practical Paper : Gymnosperms, Angiosperms, Plant Ecology and Resource Management**

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1. Determination of minimum size and number of quadrates necessary to study herbaceous communities
2. Determination of abundance, density, frequency, basal cover of plant communities by quadrat method.
3. Estimation of above ground and below ground biomass from unit area.
4. Effect of biotic disturbances on botanical composition.
5. Study of similarity between plant communities using index of similarity and dissimilarity.
6. Estimation of dissolved oxygen content in eutrophic and oligotrophic water samples.
7. Study on effects of effluents/contaminants on plant growth.
8. Morpho-anatomical adaptive features of hydrophytes and xerophytes.
9. Preparation of a map of India showing biogeographical zones.
10. To plot Biosphere Reserves/ Ramsar sites/ National Parks/Wildlife Sanctuaries located in different biogeographical zones of India in general and NE India in particular.
11. Study of morphological, anatomical and reproductive features of gymnosperms available in the region.
12. Study of Angiospermic plants with analytical drawings, botanical description and identification up to the rank of species
13. Study of special types of inflorescence, primitive and advance flowers, ovaries and fruits
14. Collection and preparation of herbarium specimens of common plants for familiarization of herbarium techniques.
15. Morphological and anatomical studies on economically important plants/ Part (s) of cotton, jute, tea, bay leaf, rauwolfia, tulsi.
16. Field study report.

**SECOND SEMESTER**  
**Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
BOT 2016	80	20	100	6	5
BOT 2026	80	20	100	6	5
BOT 2036	80	20	100	6	5
BOT 2044	80	20	100	4	9
BOT 2054	80	20	100	4	9
Total	400	100	500	26	33

Examination Time: Theory .....3 (Three Hours); Practical...5 (Five Hours)

**BOT 2016**

**Cytogenetics, Plant Breeding and Evolution**

**Unit -I**

Structural organization and function of intracellular organelles, cytoskeleton; structure of prokaryotic and eukaryotic chromosomes, centromeres and telomeres. specialized chromosomes, euchromatin and heterochromatin, cell division and cell cycle, regulation and control.

**Unit-II**

Genome organization, genome size and C-value paradox, DNA packaging, unique and repetitive DNA, linkage, recombination and crossing over, linkage mapping. sex-linked inheritance, cytoplasmic inheritance.

**Unit-III**

Transcriptional regulation in prokaryotes, operon system for lactose, tryptophan and arabinose metabolism; Molecular basis of mutation, spontaneous, reverse and suppressor mutations, transposable genetic elements.

**Unit-IV**

DNA damage and repair; in born errors of metabolism, metabolic pathways, overview of the metabolic basis of inherited diseases.

**Unit-V**

Principle of plant breeding; distant hybridization, barrier to distance hybridization, techniques

for distant hybridization; back Cross methods of plant breeding; breeding for quantitative characters, handling of quantitative data, environmental effect on quantitative characters, estimation of heritability and genetic advance

### **Unit-VI**

Evolution, co evolution, Lamarckism, Darwinism, synthetic theory, Wiseman's theory, modern theory of evolution.

## **BOT 2026**

### **Microbiology and Plant Pathology**

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#### **Unit-I**

Microbial diversity: 'Species' and 'Strain' concept in microbiology, ICN for virus, bacteria and other microbes, microbiome concept, ecological significance of microbes, microbiology of soil, air, water and milk.

#### **Unit-II**

Microbial techniques: sterilization techniques, population estimation (direct spore count, CFU, spectrophotometric method), pure culture and visualization techniques, culture preservation and maintenance, taxonomic and functional characterization of microbes.

#### **Unit-III**

Microbial genetics & Physiology: Mode of reproduction (vegetative, asexual & sexual), genetic recombination, mode of nutrition, growth conditions and nutritional requirements, different metabolic pathways (respiratory and photosynthetic).

#### **Unit-IV**

Plant Pathology: Principles of plant pathology, mechanism of pathogenesis, symptomatology and epidemiology, host defense mechanism, causal organism and etiology of certain important plant diseases occurred in NE India

#### **Unit-V**

Immunology: Innate and acquired immunity, antibodies, cells and tissues of the immune system, immune diseases, serological reactions and serodiagnostics, cancer biology,

#### **Unit-VI**

Applied microbiology: Application of microbes in the field of agriculture, fermented foods

and dairy products, industry and bio-waste management.

**BOT 2036**

**Plant Physiology and Biochemistry**

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**Unit-I**

**Membrane structure and function:** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. **Biomolecules: their structures and functions:** Carbohydrate, lipids, proteins.

**Unit-II**

Enzymes: Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes; Protein synthesis and processing: Nitrate and ammonium assimilation; amino acid biosynthesis. **Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins.**

**Unit-III**

Photosynthesis: Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO<sub>2</sub> fixation-C<sub>3</sub>, C<sub>4</sub> and CAM pathways.

Respiration and photorespiration: Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

**Unit-IV**

Plant hormones: Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.

**Unit-V**

Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement.

**Unit-VI**

Solute transport and photo-assimilate translocation: uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; mechanisms of loading and unloading of photoassimilates.

**BOT 2044**

**Practical Paper: Microbiology, Plant Pathology and Cytogenetics**

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1. Isolation and pure culture of microbes from soil, air and water
2. Identification and characterization of isolated pure cultures
3. Estimation of water quality
4. Identification and characterization of milk bacteria and nodule bacteria
5. Methylene blue reductase test for bacterial contamination of milk
6. Estimation of bacterial growth by spectrophotometric method and counting of cells
7. Effect of physical and chemical factors on growth of microbes
8. Study of plant pathogenic fungi from diseased specimens (symptoms, causal organism and their morphological & reproductive characters)
9. Spore measurement and camera lucida diagram
10. Chromosome analysis, study of chromosome behaviour in mitosis and meiosis, chromosome anomalies in plant cells.
11. Principle, techniques and procedure of emasculation.

**BOT 2054**

**Practical Paper: Plant Physiology and Biochemistry**

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1. Preparation of normal, molar, molal and ppm solutions
2. Extraction of proteins from plant materials and estimation by Lowry's method using BSA standard curve.
3. Extraction of carbohydrates from plant materials and estimation of reducing and non reducing sugars.
4. Extraction of oil/fat from plant materials
5. Extraction of plant phenols and estimation of total phenols.
6. Extraction of chloroplast pigments and quantitative estimation; Determination of chlorophyll a/b ratio and total chlorophyll in C3, C4 and CAM plants.
7. Separation of amino acid mixture by thin layer / paper chromatography.

**THIRD SEMESTER**  
**Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
BOT 3016	80	20	100	6	5
BOT 3026	80	20	100	6	5
BOT 3036	80	20	100	6	5
BOT 3044	80	20	100	4	9
BOT 3054	80	20	100	4	9
<b>Total</b>	<b>400</b>	<b>100</b>	<b>500</b>	<b>26</b>	<b>33</b>
Examination Time:		Theory .....3 (Three Hours);		Practical...5 (Five Hours)	

**BOT 3016**

**Reproductive and Developmental Botany, Biostatistics**

**Unit-I**

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogen gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; genomic imprinting; mutants and transgenics in analysis of development.

**Unit-II**

Sporogenesis and Gametogenesis in plants; pollination, double fertilization, embryogenesis, development of endosperms, types of endosperms; polyembryony, seeds and seed development, seed dispersal; apomixis, apospory, parthenocapcy; comparative embryology

**Unit-III**

Morphogenesis and organogenesis in plants: Organization of shoot and root apices; shoot and root development; root-stem transition; leaf development and phyllotaxy; Transition to flowering and development of flower

**Unit-IV**

Periderm: Origin and activity, Rytidome, protective tissue in Monocotyedons, bark and cork; Cambium- Origin, function, behaviour (normal and abnormal).

**Unit-V**

Palynology: Pollen morphology, ultrastructure, pollen chemistry, viability, storage and adaptation; Applications of palynology: aeropalynology and pollen allergy, melissopalynology, forensic palynology, palaeopalynology and hydrocarbon exploration.

**Unit-VI**

Biostatistics: Measures of central tendencies; mean, mode, median, standard errors and standard deviations. Probability; normal, binomial and poisson distribution; Skewness and kurtosis. Degrees of freedom, Null hypothesis, T-test, Chi Square test, F-test; Analysis of variance (ANOVA): Variance and co-variance analyses, Correlation and methods of studying the correlation, Regression and methods of studying regression, Statistical software packages and their importance in data analysis.

**BOT 3026**

**Molecular Biology, Plant Biotechnology & Bioinformatics**

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**Unit-I:**

Physical properties of DNA (UV absorption spectra, denaturation and renaturation), DNA topology, DNA - Protein Interactions, DNA replication, RNA synthesis and processing, small RNAs

**Unit-II:**

Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial chemotaxis and quorum sensing.

**Unit-III:**

Principles of genetic engineering, cloning vectors, enzymes involved in rDNA technology, transformations, IPR, legal and biosafety issues related to GMOs. DNA markers and its application in genetic diversity study, genome analysis, genetic mapping, molecular systematics and diagnosis.

**Unit-IV:**

Plant Tissue Culture: importance, requirements, culture medium, culture of plant tissues: root, meristem anther, pollen and protoplast culture; in vitro differentiation: organogenesis and somatic embryogenesis; role of tissue culture in crop improvements, Somatic hybridization: protoplast fusion, cybrids

**Unit-V:**

Molecular Basis of Plant Growth and Development: Molecular mechanisms of light perception, signal transduction and gene regulation; Biological clocks and their genetic and molecular determinants, Molecular genetics of floral development and floral organ differentiation. Hormone signal perception, transduction and regulation of gene expression during plant development.

**Unit-VI:**

Introduction to bioinformatics, biological databases, data mining and retrieval, scope and application of bioinformatics, nucleic acid and protein sequence analysis, sequence alignment, local and global alignment, database search for homologous sequences-BLAST and FASTA, protein structure analysis, Ramachandran plot, computer-aided drug discovery.

**BOT 3036**

**Research Methodology and Bioinstrumentation**

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**Unit- I:**

Meaning and importance of research, Types of research, Research hypothesis, Writing of Dissertation, Reports, Research Articles, Research and Publication ethics, Plagiarism.

**Unit- II:**

Sample and sampling, techniques for collection of field samples (plant, soil and water); Dos and don'ts in fields; Lab safety measures, code of conduct in laboratory, handling of chemicals; First aid in field and lab, Experimental design.

**Unit- III:**

Reagents preparation, Concept of normal, molar and molal, parts per million (ppm), parts per billion (ppb); Buffer and Standard solution- concept and procedures for preparation, standard curve and its importance.

**Unit- IV:**

Microscopy: Types, Basics of staining and imaging techniques, Principles and applications of different microscopes (light, dark field, phase contrast, fluorescence, confocal, scanning and transmission electron microscopes), Chromosome banding, FISH; Microtomy and herbarium techniques; Macro and micro-morphological studies of plants.

**Unit- V:**

Spectrophotometry and Chromatography: Principles and applications of UV-VIS, Circular Dichroism, Optical Rotatory Dispersion; basic knowledge on Fluorescence spectrophotometer, Infrared spectroscopy, FTIR, NMR, ESR, AAS, TLC, GCMS, HPLC, LCMS.

**Unit- VI:**

PCR and Electrophoresis Techniques: Different types of PCR; Principles of electrophoresis, Agarose gel electrophoresis, SDS-PAGE, 2D gel electrophoresis; centrifugation techniques, differential and density gradient centrifugation, DNA sequencing methods, Radio-Isotope tracer techniques.

**BOT 3044**

**Practical – Anatomy, Reproductive and Developmental Botany, Biostatistics**

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1. Study of anomalous secondary growth of selective families of Angiosperms.
2. Study of developmental stages of leaf, stem and root.
3. Preparation of pollen grain slides by following different techniques.
4. Study of microsporogenesis, megasporogenesis, embryosacs and endosperms with the help of permanent slides.
5. Preparation of permanent slides by the process of microtome technique
6. To work out mean, mode, median, standard errors and standard deviation
7. Field study and Visit to different Research Institutions/Universities/Centers/ Botanical Garden/ Herbaria within India.

**BOT 3054**

**Practical - Molecular Biology, Plant Biotechnology & Bioinformatics**

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1. Protein isolation and gel electrophoresis
2. DNA isolation, quantification and electrophoresis
3. Restriction digestion and mapping
4. PCR reaction and gel electrophoresis
5. Regeneration of plantlets through tissue culture
6. Culture of Mushroom
7. Production of Synthetic Seeds
8. Sequence (protein/DNA) downloading from databases, alignment and homologous sequence search
9. Sequence BLAST, annotation and gene prediction with the help of bioinformatical tools.
10. Protein modeling and structure prediction

**FOURTH SEMESTER****Optional –I:: Angiosperm Taxonomy (Special Paper)****Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
BOT 4015	80	20	100	5	5
BOT 4025	80	20	100	5	5
BOT 4035	80	20	100	5	5
BOT 4045	80	20	100	5	9
BOT 4054	80	20	100	4	9
<b>Total</b>	<b>400</b>	<b>100</b>	<b>500</b>	<b>24</b>	<b>33</b>

Examination Time: Theory .....3 (Three Hours); Practical...5 (Five Hours)

**BOT 4015****Unit-I**

**Basics of Taxonomy:** Concept, Aims and Principles, Alpha and Omega taxonomy; Concept of Phenetic, Phyletic, and Phylogenetic classification; Classificatory Systems: Pre- and Post Darwinian Classifications, Recent development of classificatory system in Angiosperms-APG System

**Unit-II**

**Phenetic Methods:** Taxometric: Principles, OTUs, coding of characters, Measuring Resemblances, Cluster analysis, Application of Taxometric

**Phylogenetic Methods:** Cladistic taxonomy, Character analysis, Cladogram construction and Analysis.

**Unit-III**

**Taxonomic Structure:** Concept of Taxa; Concept of Species, Genus, Family and Infra specific categories

**Unit-IV**

**Material basis of Taxonomy:** Concept of Character; Character Correlation, Weighing, Variations; Isolation and Speciation.

**Unit-V**

**Botanical Nomenclature:** History, Principles and Major rules, Typification, Effective and Valid Publication, Authors' citation, Principles of Priority and Limitations, synonym, basionym, nomina conservanda, rejection of names, illegitimate names, nomen nudum,

tautonym, later homonym.

**BOT 4025**

**Unit-I**

**Sources of Taxonomic Characters:** Morphology, Anatomy, Palynology, Embryology, Cytology, Phytochemistry, Serology., major areas.

**Unit-II**

**Modern Approach to Taxonomy:** Molecular Approach in taxonomy, Diagnostic tools, Polymerase Chain Reaction (PCR) analysis, applications of molecular markers in plant taxonomy; Biosystematics: Definition, importance and categories; Role of computers in taxonomic studies, commonly available softwares

**Unit-III**

**Taxonomic Literature:** Classical and recent literature of World in general and India in particular (World flora, Indian flora); Taxonomic journals, Icones, Check list, Illustrations

**Unit- IV**

**Process of Identifications:** Herbarium techniques: Methods of Collection, Identification and Documentation; Roles and importance of herbaria, Botanical Gardens and Museums in taxonomic studies, major Herbaria and Botanic Gardens in World and India.

**Unit-V**

**Botanical exploration:** Contributions made in earlier and recent periods. Presentation of Data : Flora, Manuals, Monograph, Revision; Preparation of a flora; Botanical keys, their construction and uses.

**BOT 4035**

**Unit-I: Phytogeography:**

Concept, Static and Dynamic Phytogeography, Phytochoria and botanical provinces of India; Major theories, Ranges, Migration and Barriers; Centres of Origin; Vicariance biogeography; Endemism; IUCN categories; Hotspots, India as a megadiversity country; plant introduction and acclimatization.

**Unit-II: Flora of North East India:**

Characteristics of flora of Northeast India; Endemic, Exotics and RET Plants of North East

India, their multiplication and conservation.

**Unit-III: Botanical Survey of India:**

History, Activities, Publications.

**Unit-IV: Origin and Evolution:**

Characteristic features of early Angiosperms; Origin of Angiosperms, Primitive and advanced angiosperms; Evolutionary trends in Angiosperms.

**Unit-V: Phylogeny and Evolution of Angiospermic Taxa:**

Magnoliales, Ranunculales, Euphorbiales, Scrophulariales, Lamiales, Asterales, Alismatales, Orchidales, Poales, Zingiberales.

**BOT 4045**

Dissertation

Dissertation =	50
Viva-Voce =	30
Internal Assessment =	20
<b>Total =</b>	<b>100</b>

**BOT 4054**

1. Floristic studies of locally available angiospermic plants in and around Greater Guwahati, their collections, describing with analytical drawing, botanical keys and identification up to the rank of species.
2. Practices on Nomenclatural problems
3. Plotting of various centers of BSI, Botanical Gardens and Herbaria in different regions of India.
4. Practices on identification of taxa /herbarium specimens.

**Optional –II:: Cytology, Genetics and Plant Breeding (Special Paper)****Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
BOT 4065	80	20	100	5	5
BOT 4075	80	20	100	5	5
BOT 4085	80	20	100	5	5
BOT 4095	80	20	100	5	9
BOT 4104	80	20	100	4	9
Total	400	100	500	24	33

Examination Time: Theory .....3 (Three Hours); Practical...5 (Five Hours)

**BOT4065****Unit-I**

Cell architecture and function; membrane structure; cytoskeleton: intermediate filaments; microtubules; cell division cycle; cell-division control in multicellular animals.

**Unit-II**

Chromosome structure and organization; chromatin structure, nucleosome, chromosome banding and painting. gene interaction - epistasis, complementation, pleiotropy, penetrance and expressivity

**Unit-III**

Genome organization in viruses, prokaryotes and eukaryotes; organization of nuclear and organellar genomes; c-value paradox; repetitive DNA, satellite DNAs and interspersed repeated DNAs; fine structure of gene, split genes, pseudogenes, overlapping genes and multigene families.

**Unit-IV**

Overview and concept of epigenetics; chromatin modifications and their mechanism of action, role of chromatin in gene expression and gene silencing, types of histones, histone modifications - methylation, acetylation, phosphorylation and its effect on structure and function of chromatin, heterochromatin formation and gene silencing.

**Unit-V**

Molecular basis of gene mutations. molecular nature and use of transposable elements in prokaryotes and eukaryotes; controlling elements in maize, yeast and Drosophila P element.

### Unit-VI

Genetic distance and phylogenetic analysis; molecular divergence and molecular clock; origin of new genes and proteins; gene duplication and divergence.

## BOT 4075

### Unit-I

Structure and processing of messenger RNA, transfer RNA, ribosomal RNA, small interfering RNAs and micro RNAs, regulation through RNA processing and decay, alternative splicing, mRNA stability.

### Unit-II

Transcription, RNA polymerases, initiation, elongation and termination; antitermination, attenuation; eukaryotic promoters, enhancers, transcription factors, processing of mRNA for translation. Operon concept in prokaryotes.

### Unit-III

Techniques in molecular genetics; electrophoresis, restriction digestion, ligation, DNA probes and hybridization, DNA cloning, vectors, genomic and cDNA library, PCR amplification, nested PCR, forensics and PCR, DNA sequencing.

### Unit-IV

Comparative genome analysis, protein analysis, SDS-PAGE, protein purification, monoclonal antibody and hybridoma technology, blotting techniques, model organisms in molecular biology.

### Unit-V

Metagenomic approaches, gene and protein sequence data banks, sequence analysis, multiple sequence alignment, homology and analogy, in silico computational techniques for gene functions, high-throughput analysis of gene functions, single nucleotide polymorphisms.

### Unit-VI

Genetic engineering and public concerns, genetically engineered foods; molecular farming and plantibodies, antisense RNA technology; ethical and environmental concerns on genetic engineering of plants; biosafety issues related to genetically modified organisms.

## BOT 4085

### Unit-I

Principles of plant breeding, hybridization and selection; concepts in improvement of major

crop species; polyploidy inheritance, self-incompatibility.

### Unit-II

Quantitative and evolutionary genetics; polygenic inheritance; QTL mapping using molecular marker, population statistics; heritability; measurement of heritability; population genetics and Hardy-Weinberg law of equilibrium.

### Unit III

Chromosome variation in higher plants; haploid production system, breeding application of haploids; aneuploidy, trisomic, tetrasomic, nullisomic and their significance in genetic studies; parthenogenesis and apogamy, action of physical and chemical mutagens; mutation in crop improvement.

### Unit-IV

Plant transformation; cloning of plant cells and manipulation of plant genomes; Agrobacterium mediated gene transfer - biology and molecular basis of Agrobacterium mediated plant transformation and its application, development of plant vectors for transformation and features.

### Unit-V

Plant genetic engineering: Crop improvement, herbicide resistance, insect resistance, virus resistance, tolerance of environmental extremes in crops - drought, cold, salinity, flooding, heavy metal; plant as bioreactors (molecular farming).

### Unit-VI

Plant cell, tissue and organ cultures; micropropagation and clonal propagation, protoplast culture and somatic hybridization; nuclear and cytoplasmic hybrids; somaclonal variation, DNA-microchip in plant tissue culture industry.

## BOT 4095 Dissertation

Dissertation =	50
Viva-Voce =	30
Internal Assessment =	20
<b>Total =</b>	<b>100</b>

**BOT 4104**

1. Preparation of smears and squashes from pollen mother cells and root tips using suitable staining techniques.
2. Studies on some special chromosomal staining techniques for chromosome banding.
3. Preparation of karyotypes and idiograms from polar view of mitotic metaphase stage.
4. Studies of chiasma frequencies in meiosis cell division.
5. Studies of natural and induced chromosomal aberrations.
6. Studies of effects of colchicines on polyploidy.
7. Emasculation and artificial hybridization.
8. Isolation of genomic DNA from plant materials, purification, estimation, separation with gel electrophoresis and documentations.
9. Working out of genetical problems.
10. Introduction to NCBI databases, BLAST: BLASTn, BLASTp, sequence manipulation, multiple sequence alignment, primer designing, phylogenetic analysis, protein modelling and protein structure analysis.

**Optional –III:: Plant Ecology (Special Paper)****Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
BOT 4115	80	20	100	5	5
BOT 4125	80	20	100	5	5
BOT 4135	80	20	100	5	5
BOT 4145	80	20	100	5	9
BOT 4154	80	20	100	4	9
<b>Total</b>	<b>400</b>	<b>100</b>	<b>500</b>	<b>24</b>	<b>33</b>

Examination Time: Theory .....3 (Three Hours); Practical...5 (Five Hours)

**BOT 4115****Unit –I**

Development of ecology in India from ancient to recent times, evolutionary ecology, Interaction of ecological factors in the environment. Principles pertaining to limiting factors. Biogeochemical cycles.

**Unit -II**

Population concepts- characteristics, dynamics and control. mechanisms of population regulation, habitat specific demography, population viability analysis. Species interactions- types of interactions, interspecific competition, herbivory, carnivory, symbiosis, allelopathy, weed-crop interference. Concept of metapopulation – demes and dispersal, interdemec extinctions, age structured populations. Ecological amplitude of a species and adaptation - ecads, ecotypes, ecospecies.

**Unit -III**

Concepts of community and continuum; analysis of communities (analytical and synthetic characters); community coefficients; interspecific associations; ordination; concept of ecological niche, species diversity ( $\alpha$ ,  $\beta$ ,  $\gamma$ ).

**Unit -IV**

Vegetation development, temporal changes (cyclic and non-cyclic); mechanism of ecological succession (relay floristics and initial floristic composition; facilitation, tolerance and inhibition models); changes in ecosystem properties during succession.

**Unit -V**

Principles and basic concepts of remote sensing; application of remote sensing in environmental studies: land use mapping, forest survey, habitat analysis, water management, drought monitoring and flood studies, wetland survey, rainfall estimation, pollution studies,

soil conservation, watershed management and vegetation mapping. Geographical Information System (GIS) - basic principles and techniques. Importance of Geographical Information System in environmental studies. Global Positioning System (GPS): basic principles, Applications in ecological studies.

### **BOT 4125**

#### **Unit -I**

Ecosystem organization- structure and functions; Terrestrial and aquatic ecosystems, primary production (methods of measurement, global pattern, controlling factors); energy dynamics (trophic organization, energy flow pathways, ecological efficiencies); litter fall and decomposition (mechanism, controlling factors); ecosystem nutrient cycles and nutrient budgeting.

#### **Unit -II**

Ecosystem stability- Concept (resistance and resilience); ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecology of plant invasion; Wetlands, its importance & benefits, causes of degradation and its consequences.

#### **Unit –III**

Introduction and elements of system ecology; ecosystem modeling, conceptual model, working model, auxiliary variable and foresters diagram. Basic concepts to statistical ecology, fundamental knowledge on pattern analysis, cluster analysis and ordination.

#### **Unit –IV**

Introduction to conservation ecology- principles, postulates and ethics , genetic variation and its loss, variation in natural populations, Species and habitat conservation- prioritizing species and habitat, protected area networks; major approaches to their management, Indian case studies on conservation/management strategy

#### **Unit –V**

Methods for biodiversity monitoring, megadiversity zones and hot spots ; biodiversity and ecosystem services- provisioning, regulating, supporting and cultural; threats to biodiversity: Causes of biodiversity loss, species extinction, vulnerability of species to extinction, IUCN threat categories, Red data book; keystone and flagship species. Biodiversity act and biodiversity action plan; IPRs, national and international programs for biodiversity conservation, wildlife values and eco-tourism, wildlife distribution in India, problem in wildlife protection, role of WWF, WCU, CITES, TRAFFIC.

**BOT 4135****Unit -I**

Scope of environmental management, basic concepts of sustainable development, advantages of environmental monitoring, deterioration of environmental quality with reference to anthropogenic impact; methods of assessment of environmental quality; Short term studies/surveys; Rapid assessment; Continuous short and long term monitoring; general guidelines for the preparation of environmental impact statement.

**Unit –II**

Effect of pollution on water quality, on phytoplankton productivity; bio-indicators of water pollution. biological treatment of wastewater. Biomonitoring of air pollution, active and passive monitoring; air pollution tolerance indices; control of air pollution by plants, green belt design. Plant indicators. Environmental problems of NE India with special reference to shifting cultivation, deforestation, opencast coal mining, oil exploration, encroachment, flood, erosion, landslides etc.;

**Unit -III**

Environmental Policies and Regulations. Evolution of International Environmental Policies. Environmental Movement in India. International Environmental Treaties and Conventions. Objectives and Provisions of Environmental Acts and Rules of India. IBP, MAB.

**Unit -IV**

Concepts of ecological restoration, aims and strategies; ecosystem reconstruction, major tools used in restoration, restoration of biological diversity- Acceleration of ecological succession, reintroduction of biota; restoration of degraded ecosystems- Forest, grassland and lake including contaminated soils, mine spoils etc.

**Unit -V**

Bioremediation, biotransformation, biodegradation and phytoremediation, In situ and Ex situ practices. Use of microbes (algae, bacteria and fungi) and plants to check biodegradation, biotransformation; waste water treatment using aquatic plants; root zone treatment. Ecological techniques for biowaste and e-waste management.

**BOT 4145****Dissertation**

Dissertation =	50
Viva-Voce =	30
Internal Assessment =	20
<b>Total =</b>	<b>100</b>

**BOT 4154**

1. Determination of light intensity, relative humidity, wind speed, maximum and minimum temperature at different times of the day.
2. Determination of amount of rainfall.
3. Mapping of vegetation.
4. Analysis of edaphic characters- soil profile, texture, soil moisture, water holding capacity, porosity, pH, organic matter content, quantitative estimation of N, P, K, Na, Ca and C:N.
5. Determination of carbonates, nitrates, chlorides, base deficiency by rapid soil test method.
6. Analysis of water quality- DO,COD,BOD, pH, hardness, alkalinity, conductivity, free CO<sub>2</sub>, chloride, phosphate.
7. Estimation of litter contribution in different forest stands; estimation of litter decomposition rate by litter bag technique, soil respiration.
8. Determination of IVI; lifeform and biological spectrum; phenology; diversity indices in various plant communities.
9. Determination of gross and net primary productivity of aquatic ecosystem by light and dark method; estimation of phytoplankton biomass in terms of chlorophyll.
10. To study primary productivity for herbaceous community by Harvest method; Leaf Area Index.
11. To find out seed output and reproductive capacity of herbaceous plants.
12. To find out allelopathic effects of weeds on cultivated plants.
13. Morpho-anatomical variation of plant species as affected by environmental changes.
14. Ecological data collection for computer use.

**Optional –IV: Microbiology (Special Paper)****Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
BOT 4165	80	20	100	5	5
BOT 4175	80	20	100	5	5
BOT 4185	80	20	100	5	5
BOT 4195	80	20	100	5	9
BOT 4204	80	20	100	4	9
<b>Total</b>	<b>400</b>	<b>100</b>	<b>500</b>	<b>24</b>	<b>33</b>

Examination Time: Theory .....3 (Three Hours); Practical...5 (Five Hours)

**BOT 4165****Unit-I**

Microbial ecology: Interaction of microbes with microbes, plants and animals, quantitative ecology, microbes of extreme environments, bioremediation of contaminated sites with pesticides, xenobiotics, etc., waste-water treatment with microbes, microorganisms in mining and energy production, role of microbes in hydrocarbon recovery and degradation.

**Unit-II**

Soil microbiology: Soil environment, microbial diversity in soil, soil microbial communities and decomposition of organic matter, methods to detect and quantify soil microbes, soil metagenomics, biosensors to monitor soil health and toxicity.

**Unit-III**

Agricultural microbiology: Agriculturally important microbes, biological N<sub>2</sub>-fixation, phosphate solubilization, PGPRs, rhizosphere, phyllosphere, Mycorrhiza, Biofertilizers, Crop diseases caused by different pathogens, Biocontrol of plant diseases.

**Unit-IV**

Industrial microbiology: Industrial importance of microorganisms, Fermentation process, bioreactors, isolation, preservation and maintenance of industrial microbes, kinetics of microbial growth in STR, microbial products, downstream processing, application and immobilization of enzymes, Industrial production of organic acids, antibiotics, ethanol, vitamins and amino acids.

**Unit-V**

Food microbiology: Fermented foods (milk, meat, vegetables, beer, wine and vinegar, SCP), food spoilage, food sterilization and preservation, food borne diseases.

**Unit-VI**

IPR: Concept of IPR, types of IPR, Patent and Patent filing, Design, Trade Mark, Trade Secret, Copyright, Role of IPR in economic growth of a nation, Organization and functioning of IP-India, Biotechnology and IPR, Plant Variety Protection and Farmer's Right, GI, Traditional knowledge and benefit sharing.

**BOT 4175**

**Unit- I**

Microbial Genetics (genetic materials, nuclear DNA, chloroplast DNA, mitochondrial DNA, plasmids, inheritance of traits, vertical and horizontal gene transfer, genes and chromosomes, DNA replication, RNA and protein synthesis, genome evolution)

**Unit- II**

Genetic recombination, conjugation, transduction and transformation in bacteria, host cell restriction, mobile genetic elements, fine structure of a gene, Operon concept, promoter, enhancer, repressor, negative feedback, RNA processing (RNA capping, Poly (A) tail formation, RNA splicing).

**Unit- III**

Gene regulation and gene interactions in prokaryote and eukaryotes, epistasis, complementation, pleiotropy; Concept of genomics, metagenomics, transcriptomics, proteomics and metabolomics; Quorum and anti-quorum sensing

**Unit- IV**

Microbial growth conditions and growth curves, bioenergetics and different glucose catabolic pathways found in microbes (Glycolytic, EMP, PP, ED, Sikkimic, etc.); biosynthesis of lipids, amino acids, proteins and nucleotides)

**Unit- V**

Genetic engineering – tools and techniques, manipulation of natural genetical processes in biotechnology, restriction enzymes and ligases, cloning and expression vectors (plasmid, Ti plasmid, cosmid, fosmid, BAC, YAC and PAC)

**Unit- VI**

Microbial biotechnology for human welfare, cDNA and genomic DNA library, gene isolation, gene cloning, expression of cloned genes, gene therapy, DNA fingerprinting, whole genome sequencing projects, GMOs, application of RNAi technology (miRNA and siRNA) in agriculture and medical sciences.

**BOT 4185**

**Unit- I**

Laboratory diagnoses and control of human diseases caused by virus (AIDS, hepatitis, H1N1), bacteria (Streptococcus pyogenes, Mycobacterium tuberculosis), fungi (Aspergillosis, Candidiasis) and protozoa (malaria).

**Unit- II**

Control of Microorganisms: Physical, chemical and biological; Antibiotics, mode of action of antibiotics, multidrug resistance in bacteria, principles of microbial assay.

**Unit- III**

Immunology: Humoral and cell mediated immunity; Specific and non-specific immunity; Immune responses, Primary and secondary lymphoid organs; Antigens; B and T cells and Macrophages; Major histocompatibility complex (MHC); Antigen processing and presentation; Antibodies, synthesis of antibody and secretion;

**Unit- IV**

Molecular basis of antibody diversity; Polyclonal and monoclonal antibody; Antigen-antibody reaction; Hyper sensitivity; Autoimmunity; Hybridoma technique, advantages and application of monoclonal antibodies, Immunodiagnostics

**Unit- V**

Cancer biology: Mutagens and carcinogens, tumor cells and genetic abnormalities, genetic rearrangements in progenitor cells, mechanism of oncogene activation, tumor suppressor genes, cancer and cell cycle, virus induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth, cancer treatments.

**BOT 4195**

Dissertation

Dissertation =	50
Viva-Voce =	30
Internal Assessment =	20
<b>Total =</b>	<b>100</b>

**BOT 4204**

1. Isolation of specific microorganisms using specific media
2. Staining of bacterial spore, capsule and flagella
3. Bacteriological water analysis
4. Isolation of anaerobic bacteria
5. Methylene blue reductase/ Phosphatase test for milk
6. Detection of organic acids produced by fungi by paper chromatography method
7. Assessment of antimicrobial activity of microbes against plant pathogens
8. Biochemical tests (phosphatase, urease, nitrate reductase, cellulase) for the activity of microbes
9. Fermentation of carbohydrates
10. Study of microflora from the rhizosphere of agriculturally important crops
11. Mycorrhiza – spore population and root colonization
12. Biochemical tests for identification of bacteria (catalase, IMViC, peroxidase, nitrate reductase, oxidase, etc)
13. Isolation and quantification of plasmid/DNA/protein
14. Estimation of total proteins, phenol coefficient,  $\lambda$ -max of DNA/Protein
15. Study of symptoms and causal organisms of some important plant diseases prevalent in the state.

**Optional –V: Mycology and Plant Pathology (Special Paper)****Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
BOT 4215	80	20	100	5	5
BOT 4225	80	20	100	5	5
BOT 4235	80	20	100	5	5
BOT 4245	80	20	100	5	9
BOT 4254	80	20	100	4	9
Total	400	100	500	24	33

Examination Time: Theory .....3 (Three Hours); Practical...5 (Five Hours)

**BOT-4215****Unit-I**

History and development of mycology, ultra structure of fungal cell, Different groups of fungi, ; systematics and phylogenetic relationship among different groups of fungi; modern trends in identification and classification of fungi.

**Unit-II**

Fungal reproduction: different mode of reproduction in fungi, different reproductive structures, parasexuality, degeneration of sex, heterothallism. Spore dispersal mechanism in fungi.

**Unit-III**

Fungal physiology, growth, nutrition, development and metabolism in fungi, nutritional specialization in parasitic fungi.

**Unit-IV**

Ecology of fungi, distribution of fungi, role of fungi in biogeochemical cycling, fungi of terrestrial and aquatic environments, fungi of extreme environments.

**Unit-V**

Fungal biotechnology: Genetically modified fungi, fungi as biocontrol agent, Edible and poisonous mushrooms, cultivation of mushrooms, industrially important fungi as a source of antibiotics, organic acids, enzymes and proteins, IPR.

**BOT-4225**

**Unit- I**

The concept of diseases in plants, history of plant pathology, role of fungi and other organisms as causes of plant diseases, losses caused by plant diseases, Symptoms of plant diseases caused by fungi, bacteria and viruses.

**Unit-II**

Diagnosis of plant diseases, Koch's postulate and germ theory of diseases, pathogenesis and host range, stages of development and disease cycle, dissemination of plant pathogens.

**UNIT-III**

Epidemiology and disease forecasting, Effects of environmental factors on epidemiology; Control of plant diseases, chemical and biological disease control, integrated disease management (IDM), physiological changes due to disease in plants (photosynthesis, movement of water, respiration, permeability of cell membrane, growth and transcription and translation).

**Unit-IV**

Genetics of plant diseases, genes and disease, mechanism of variability, types of plant resistance to pathogens, Genetics of Virulence in pathogens and resistance in host, Enzymes, toxins and growth regulators in plant disease development.

**Unit-V**

Symptomatology, disease cycle, control measures and management of some important plant diseases of Assam caused by fungi, bacteria, virus and nematode.

**BOT-4235**

**Unit I**

Defense mechanisms in plants, structural and chemical defenses, defense through lack of essential factors, induced structural and biochemical defenses, plant immunization- systemic acquired resistance, Induced resistance, plantibodies.

**Unit II**

Biotechnology and plant diseases – resistant gene identification and insertion in suitable host for crop improvement, strategies for development of disease resistance in plants; GMO (bt-

cotton, bt- brinjal, bt-chickpea); Use of immunological techniques in plant pathology.

### **Unit-III**

Aerobiology and Plant diseases: Air microflora, air sampling techniques, factors affecting the distribution of air microflora, air-borne plant diseases, aero-allergens

### **Unit-IV**

Soil borne diseases: Soil as an environment for plant pathogens, nature and importance of rhizosphere and rhizoplane, root exudates, and soil and root borne pathogens, Associative and antagonistic effects; Suppressive soils, biological control- concepts and potentialities for managing soil borne pathogens.

### **Unit-V**

Morphology and anatomy of infected seeds; transmission of pathogens from seed to plants, Seed-borne diseases and pathogens, Toxins affecting seed quality and its impact on human and animal health, management of seed-borne diseases, seed health testing and methods for detecting seed microorganisms, Quarantine and seed certification.

### **BOT-4245**

Dissertation

Dissertation =	50
Viva-Voce =	30
Internal Assessment =	20
<b>Total =</b>	<b>100</b>

### **BOT-4254**

1. Study of vegetative and reproductive structure of different fungal specimens
2. Study of disease symptoms and causal organisms
3. Isolation and identification of pathogen from diseased plant materials
4. In vitro inhibition of plant pathogens by different plant extracts
5. Estimation of spore population and root colonization of mycorrhiza
6. Extraction of cellulase/pectinase/xylanase from diseased plants

7. Proving of Koch's postulate at least one disease
8. Study of the effect of fungicides and plant extracts on the germination and growth of plant pathogenic fungi
9. Isolation and enumeration of microbes from soil samples
10. Study of effect of physical and chemical factors on the growth of plant pathogens.

**Optional –VI: Plant Physiology and Biochemistry (Special Paper)****Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
BOT 4265	80	20	100	5	5
BOT 4275	80	20	100	5	5
BOT 4285	80	20	100	5	5
BOT 4295	80	20	100	5	9
BOT 4304	80	20	100	4	9
Total	400	100	500	24	33
Examination Time:		Theory .....3 (Three Hours);		Practical...5 (Five Hours)	

**BOT 4265****Unit-1**

Membrane transport and translocation of water and solutes: Membrane transport of proteins. Root microbe interactions in facilitating nutrient uptake.

**Unit-II**

Nitrogen and sulphur metabolism: Regulation of nitrogen fixation, products of nitrogen fixation and their transport, mechanism of nitrate uptake and reduction, transamination, nitrogen metabolism in relation to photosynthesis and respiration, Sulphate uptake, transport, reduction and assimilation.

**Unit-III**

The flowering process: Photoperiodism and its significance, endogenous clock and its regulation, floral induction and development- genetic and molecular analysis, role of vernalization.

**Unit-IV**

Post-harvest physiology: Ripening of fruit and its regulation, post-harvest management. Metabolism of leafy vegetables during storage.

**Unit-V**

Stress physiology: Plant responses to water deficit, salinity, metal ion stress, freezing and heat stress, effect of elevated CO<sub>2</sub> concentration on plant metabolism, Oxidative stress -

Generation of reactive oxygen species, Effect of ROS on metabolism, ROX detoxification mechanisms in plants. Biotic stress - effect of fungal infection on plant metabolism; transgenic approach to overcome the abiotic stress in plants.

#### **Unit-VI**

Signal transduction: Overviews, receptors and G- proteins, phospholipids signaling, role of cyclic nucleotides, Calcium-Calmodulin cascade, protein kinases and phosphatases, specific signaling mechanisms. e.g., two component sensor – regulator system in bacteria and plants.

### **BOT 4275**

#### **Unit-I**

Respiration and lipid metabolism: Overview of plant respiration, anaerobic respiration, modern concept of electron transport and ATP synthesis; glycolysis in plants and its regulation; regulation of pentose phosphate pathway and TCA Cycle; inhibitor of respiration, glyoxylate cycle, synthesis of membrane lipids, structural lipids and storage lipids and their catabolism, gluconeogenesis.

#### **Unit-II**

Photochemistry and photosynthesis: Evolution of photosynthetic apparatus, photo-oxidation of water, mechanism of electron and proton transport, Regulation of PCR Cycle and C4 Pathway, RUBISCO and PEP Case, C3–C4 intermediates, ecological significance and modification of CAM.

#### **Unit-III**

Carbohydrate metabolism: Regulation of starch and sucrose biosynthesis, Synthesis and degradation of cellulose; A brief idea of pectin biosynthesis and enzymes involved in pectin degradation.

#### **Unit-IV**

Organic acid metabolism: Metabolism and roles of oxalic acid, ascorbic acid and malic acid.

#### **Unit-V**

Secondary metabolites: Shikimate Pathway and its role in biosynthesis of Secondary Metabolites. Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

**Unit-VI**

Phosphorus nutrition – Forms of phosphorus in soil. Phosphorus uptake, factors controlling 'P' uptake, 'P' fractions in plants. Role of Pyrophosphate in plant metabolism.

**BOT 4285**

**Unit-I**

Growth and morphogenesis: photomorphogenesis: phytochromes and cryptochromes and their photochemical and biochemical properties; phytochrome biosynthesis, cellular localization, roles, mechanism of action of photomorphogenetic receptors.

**Unit-II**

Plant developments: Biochemical changes during development of seeds; phototropism, geotropism and nastic movements.

**Unit-III**

Senescence and PCD- Biochemical changes during senescence of leaves and petals and regulation of senescence. Programmed Cell Death.

**Unit-IV**

Enzyme kinetics: Km value, enzyme inhibition, factors responsible for enzyme interaction, abzyme and ribozyme

**Unit-V**

A brief idea about role of tissue culture, and mutants in physiological studies.

**Unit-VI**

Plant Growth Regulators – A brief idea about discovery, role and possible mechanism of action of Triaccontanol, Brassins, Salicylic acid, Jasmonates and Polyamines. A brief idea about role of plant growth retardants- CCC, Maleic hydrazide, Trizoles and TIBA.

**BOT 4295**  
**Dissertation**

Dissertation =	50
Viva-Voce =	30
Internal Assessment =	20
<b>Total =</b>	<b>100</b>

**BOT 4304**

1. Estimation of starch, Ascorbic acid, Polyphenols, Cellulose.
2. Study of Oxalic acid accumulation in leaf tissue.
3. Hormonal regulation of leaf and petal senescence.
4. Study of changes in starch / protein content during seed development.
5. To study the effect of different PGRs on seedling growth
6. Sugar and amino acids analysis of phloem sap with paper chromatography.
7. Estimation of nitrate in different plant parts.
8. Study of lipid accumulation during development of oil seeds.
9. Study of effect of PEG induced water stress on seed germination
10. Measurement of RWC and Osmotic potential
11. Study of protein/ amino acid profile in plants under stress.
12. Study of effect of fungal infection on peroxidase activity.
13. Study of free radicals scavenging enzymes, Catalase and super oxide dismutase.
14. Study of free proline accumulation in plants under stress.
15. Study of seed germination under stress condition.

**BOT 4316****(Open)****Plant Diversity, Conservation, IPR and Traditional Knowledge****Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
BOT 4316	80	20	100	6	6
Examination Time:	Theory .....3 (Three Hours)				

**Unit -I**

Plants as basic component of biodiversity, objectives and components of plant systematics; ICN: Principles, Major rules (Typification, Rules of Priority, Effective and Valid publication).

**Unit -II**

Biodiversity – concept, components and types; importance of biodiversity conservation, Different approaches for biodiversity conservation.

**Unit-III**

Strategies for conservation – in situ conservation: international efforts and Indian initiatives, protected regions for conservation of biodiversity. RET Plants of Northeast India and their conservation initiatives.

**Unit-IV**

Strategies for conservation – ex situ conservation : Principles and practices; botanical gardens, gene banks, seed banks, in vitro repositories, cryobanks; National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR) and their conservation efforts.

**Unit-V**

Principles of IPR and Patent law, patent application procedure, Trade Mark, Copyright, Enforcement of IPR, Information Technology related IPR, Computer software and IPR, Biotechnology and IPR, protection of plant varieties, geographical indicators, farmers right, resource rights.

### **Unit-VI**

Traditional Knowledge: Concept & types of Traditional Knowledge, Holders Protection, need for a Sui-Generis regime, TK vs modern knowledge, digital library, biopiracy & bioprospecting.

### **Course outcome:**

### **Programme : M. Sc. in Botany**

#### **Course: BOT 1016 Diversity I – Algae, Fungi, Bryophytes**

- CO1. Knowledge on classification of different groups of algae and their distribution, understanding their phylogeny, life cycles, ecological roles and industrial applications.
- CO2. Comprehensive knowledge on fungal classification, phylogeny, physiological and ecological roles and their utilization as resource.
- CO3. Understand about the classification and nomenclature of viruses and bacteria and their reproductive mechanism.
- CO4. Understand the origin, evolution, classification of bryophytes and their biochemistry, physiology, ecology, diversity and distributional pattern in NE states and roles in the environment.

#### **Course: BOT 1026 Diversity II – Pteridophytes, Gymnosperms and Angiosperm**

- CO1. Comprehensive account on the origin, evolution, life cycle patterns pteridophytes
- CO2. Knowledge on fossil pteridophytes and gymnosperms and process of fossilization
- CO3. Understand about the classification, salient features and relationships of major taxa of living gymnosperms
- CO4. Knowledge on angiosperm taxonomy, recent International Codes on Nomenclatures, roles of botanical gardens and herbarium and BSI
- CO5. Understand about the phylogeny of major orders of angiosperm
- CO6. Knowledge on origin and evolution of floral parts, understanding the mechanism of co-evolution of flower and pollinator

**Course: BOT 1036 Ecology, Environment and Resource Management**

- CO1. Knowledge on various components of environment and their interaction, comprehensive knowledge about the niche concept, resource utilization and character displacement
- CO2 Knowledge about the population and community, ecological succession, energy flow and mineral cycling in the environment
- CO3. Knowledge on biodiversity & conservation strategies of RET plants and their environment.
- CO4. Knowledge on environmental issues, pollution and their solutions.
- CO5. Knowledge about the origin and evolution of economically important plants, GMO, IPR, INM, IPM.
- CO6. Enriched with the concept of phytogeography, centre of origin of cultivated plants, endemism, endemic flora and vegetation pattern of NE India

**Course: BOT 1044 Algae, Fungi, Bryophytes and Pteridophytes (Practical)**

- CO1. Practical knowledge on algae, fungi, bryophytes, pteridophytes and lichen of NE region

**Course: BOT 1054 Gymnosperm, Angiosperm, Ecology (Practical)**

- CO1. Practical knowledge on Gymnosperm and Angiosperm of NE region, Knowledge on population and community analysis.

**Course: BOT 2016 Cytogenetic, Plant Breeding and Evolution**

- CO1. Knowledge on cellular structures and organization; genome organization; prokaryotic and eukaryotic gene expression; DNA damage and repair.
- CO2. Knowledge on principles of plant breeding and evolution

**Course: BOT 2026 Microbiology and Plant Pathology**

- CO1. Knowledge on microbial diversity, techniques, microbial genetics and physiology
- CO2. Knowledge on principles plant pathology and mechanism of pathogenesis, immunology and applied microbiology.

**Course: BOT 2036 Plant Physiology and Biochemistry**

- CO1. Knowledge on structure and function of membranes and biomolecules,
- CO2. Knowledge on kinetics, regulation and mechanism of enzyme catalysis, protein synthesis and processing.
- CO3. Knowledge on mechanism of photosynthesis, respiration and photorespiration CO4. Knowledge on biosynthesis, storage, breakdown, transport, physiological effects and mechanism of action of plant hormones

CO5.Knowledge on sensory photobiology; transpirations solutes transport and photoassimilate translocation

**Course: BOT 2044 Microbiology, Plant Pathology and Cytogenetics (Practical)**

CO1. Practical knowledge on isolation, identification of microbes from different habitate and preparation of pure culture.

CO2. Practical Knowledge on plant pathogenic fungi.

CO3. Practical Knowledge on chromosome behavior

**Course: BOT 2054 Plant Physiology and Biochemistry (Practical)**

CO1. Practical knowledge on extraction and estimation of proteins, carbohydrate, phenolics and chloroplast pigments.

CO2. Practical knowledge on TLC and paper chromatography

**Course: BOT 3016 Reproductive and Developmental Botany, Biostatistics**

CO1. Knowledge on embryology and anatomy of plants.

CO2. Knowledge on concept of palynology and microtechniques and their application CO3. Knowledge on Biostatistics and their applications in biology

**Course: BOT 3026 Molecular Biology, Plant Biotechnology & Bioinformatics**

CO1.Detail knowledge on replication, repair and recombination of DNA; Synthesis and processing of RNA, small RNAs.

CO2.Knowledge on concept and mechanism of cell signaling.

CO3.Knowledge on genetic engineering, biosafety issues; plant tissue culture and bioinformatics

**Course: BOT 3036 Research Methodology and Bioinstrumentation**

CO1. Basic knowledge on research principles and procedures applicable in plant science.

CO2. Knowledge on research methodology helpful for cracking PhD and other competitive examination.

CO3. Knowledge on different instruments applicable for research works in plant science.

**Course: BOT 3044 Anatomy and Reproductive and Developmental Botany, Biostatistic (Practical)**

CO1.Practical knowledge on secondary growth in plants, sporogenesis and gametogenesis.

CO2. Practical knowledge on morphogenesis, organogenesis and anatomy of plants.

CO3. Practical knowledge on concept of palynology and microtechniques and their application CO4.Practical knowledge on Biostatistics and their applications in biology.

**Course: BOT 3054 Molecular Biology, Plant Biotechnology & Bioinformatics (Practical)**

CO1. Hands on knowledge on isolation of proteins and DNA, PCR and tissue culture CO2. Practical knowledge bioinformatics, nucleotide search, BLAST, sequence alignment, protein modeling and structure prediction

**Course: BOT 4015 Angiosperm Taxonomy-I**

CO1. Knowledge on basics of taxonomy, Classification including APG  
CO2. Concept of Taxa and characters, nomenclature and taxonomic literatures

**Course: BOT 4025 Angiosperm Taxonomy-II**

CO1. Knowledge on molecular systematic, sources of taxonomic characters CO2. Tools and material basis of taxonomy

**Course: BOT 4035 Angiosperm Taxonomy-III**

CO1. Knowledge on phylogeography, endemism, BSI and flora of NE India CO2. Knowledge on phylogeny of major orders of angiosperms

**Course: BOT 4045 Angiosperm Taxonomy (Dissertation)**

CO1. Knowledge on solving taxonomic problems of Assam

**Course: BOT 4054 Angiosperm Taxonomy (Practical)**

CO1. Practical knowledge on locally available taxa and their identification CO2. Practices on solving nomenclatural problems, herbarium specimens

**Course: BOT 4065: Cytology, Genetics and Plant Breeding-I**

CO1. Knowledge on cell architecture and function, chromosome structure and organization  
CO2. Knowledge on Genome organization in viruses, prokaryotes and eukaryotes, concept of epigenetic, molecular basis of gene mutation, genetic distances and phylogenetic analysis.

**Course: BOT 4075: Cytology, Genetics and Plant Breeding-II**

CO1. Knowledge on transcription, structure and processing of RNAs.  
CO2. Knowledge on techniques on molecular genetics, comparative genome and protein analysis  
CO3. Knowledge on Metagenomic approaches, genetic engineering and public concerns

**Course: BOT 4085: Cytology, Genetics and Plant Breeding-III**

- CO1. Knowledge on Principles of plant breeding, quantitative and evolutionary genetics, chromosome variation in higher plants
- CO2. Knowledge on plant transformation and genetic engineering, cell, tissue and organ culture

**Course: BOT 4095: Cytology, Genetics and Plant Breeding (Dissertation)**

- CO1. Knowledge on solving problems of bioinformatics, abiotic stress and marker based study.

**Course: BOT 4104: Cytology, Genetics and Plant Breeding (Practical)**

- CO1. Practices on preparation of smears from pollen mother cells and root tips, karyotypes and idiograms
- CO2. Hands on training on emasculation and artificial hybridization, DNA isolation and bioinformatics tools

**Course: BOT 4115: Plant Ecology-I**

- CO1. Knowledge on ecological literatures, concept of population and community, metapopulations, ecological niche, ecads, ecotypes and ecospecies
- CO2. Population regulation and community analysis
- CO2. Species interaction and diversity (alpha, beta and gamma), remote sensing, GIS, GPS and their applications

**Course: BOT 4125: Plant Ecology-II**

- CO1. Knowledge on ecosystems organization, modelling, stability, resistance and resilience, nutrient analysis and budgeting, succession
- CO2. Knowledge on conservation ecology and biodiversity management.

**Course: BOT 4135: Plant Ecology-III**

- CO1. Knowledge on environmental issues and management, sustainable development and EIA
- CO2. Restoration ecology, concept of bioremediation, phytoremediation, waste management and waste water treatment

**Course: BOT 4145 Plant Ecology (Dissertation)**

- CO1. Knowledge on solving the problems of crude oil degraded ecosystem of Assam
- CO2. Analysis on biotic and abiotic interaction in different ecosystem of Assam
- CO3. Vegetation analysis through standard ecological protocols.

**Course BOT 4154 Plant Ecology (Practical)**

CO1. Knowledge on phytosociology of plants and biomass estimation. CO2. Litter assessment and understanding of nutrient dynamics CO3. Estimate water and soil quality of different ecosystems

CO4. Assessment of biodiversity

**Course: BOT 4165: Microbiology-I**

CO1.Knowledge on Microbial interactions, bioremediation, microorganisms in mining and energy production

CO2. Knowledge on soil microbes, soil metagenomics

CO3. Knowledge of Biofertilizers and biocontrol of plant diseases

CO4. Knowledge on Industrial production of organic acids, antibiotics , ethanol, vitamins and amino acids

**Course: BOT 4175: Microbiology-II**

CO1. Microbial genetics, tools and techniques of genetic engineering CO2.Knowledge conjugation, transduction and transformation in Bacteria CO3. Knowledge on microbial biotechnology for human welfare

**Course: BOT 4185: Microbiology-III**

CO1.Knowledge of laboratory diagnosis and control of AIDS, hepatitis, swine flue CO2. Knowledge on immunology including immunity, antigen – antibodies CO3.Basic knowledge of mutagens and carcinogens in cancer biology

**Course: BOT 4195 Microbiology (Dissertation)**

CO1. Knowledge on solving the problems of degraded systems by employing candidate microbes

**Course BOT 4204 Microbiology (Practical)**

CO1. Practices on isolation of microbes from different habitats CO2. Practices on biochemical test for activity of microbes CO3. Practices on biochemical test for identification of bacteria

CO4. Practices on isolation and quantification of plasmid/DNA/proteins CO5. Practices on mycorrhizal spore population and root colonization

**Course BOT 4215 Mycology and Plant Pathology-I**

- CO1. Knowledge on mycological literature, ultra structure, systematic and phylogeny of fungi
- CO2. Knowledge on fungal reproduction and physiology, mode of nutrition, fungal ecology
- CO3. Knowledge on fungal and their application

**Course BOT 4225 Mycology and Plant Pathology-II**

- CO1. Knowledge on plant disease, symptoms of fungal, bacterial and viral diseases,
- CO2. Knowledge on Koch postulates and disease cycle, IDM, physiological changes due to disease
- CO3. Knowledge on genetics of plant disease, virulence, application of enzymes, toxins, plant growth regulators in disease management.

**Course BOT 4235 Mycology and Plant Pathology-III**

- CO1. Knowledge on different defense mechanism of plants against disease, air, soil and seed born diseases
- CO2. Biological controls of disease, quarantine and seed certification

**Course BOT 4245 Mycology and Plant Pathology (dissertation)**

- CO1. Knowledge on solving the problems of plant diseases of selected crop plants of Assam

**Course BOT 4254 Mycology and Plant Pathology (Practical)**

- CO1. Practices on isolation of fungal pathogens from diseased plants, soil microbes
- CO2. Practices on in vitro inhibition study of plant pathogens

**Course: BOT 4265: Plant Physiology and Biochemistry-I**

- CO1. Membrane transport of proteins, root-microbe interaction in nutrient uptake, nitrogen and sulphur metabolism
- CO2. Photoperiodism, vernalization, post harvest physiology, stress physiology and signal transduction

**Course: BOT 4275: Plant Physiology and Biochemistry-II**

- CO1. Respiration and lipid metabolism, photochemistry and photosynthesis
- CO2. Metabolism of carbohydrates and organic acids, secondary metabolites and phosphorus nutrition

**Course: BOT 4285: Plant Physiology and Biochemistry-III**

CO1. Growth and morphogenesis, plant development, senescence and programmed cell death  
CO2. Enzyme kinetics, role of tissue culture and mutants in physiological studies, plant growth regulators

**Course: BOT 4295: Plant Physiology and Biochemistry (Dissertation)**

CO1. Preparation of dissertation on stress physiology and biochemical analysis

**Course: BOT 4304: Plant Physiology and Biochemistry (Practical)**

CO1. Practical knowledge on estimation of selected biomolecules and hormonal regulation in senescence

CO2. Protein and amino acid profiles in stressed plants

**Credits: Total: 24/ Paper**

1 Theory period of one hour per day over a semester

1 Tutorial period of one hour per day over a semester

1 Practical period of three hours per day over a semester

Course work 80; Internal Assessment 20; Credit 6 (Theory)/ 4 (Practical)/5 (Dissertation)