BODOLAND UNIVERSITY

M.Sc. Syllabus in Botany under Choice Based Credit System (CBCS)
(*w. e. f.* 2015-2016)

DEPARTMENT OF BOTANY, BODOLAND UNIVERSITY
CBCS SYLLABUS *w.e.f.* 2019-20

1. Name of the Course : M.Sc., Botany
2. Duration of the Course : Two Years (Four Semesters)

SEMESTER I

Course Code	Course Title	Credits	L+T+P	Total Marks		
				In-Sem	End-Sem	Total
BOT 101	Phycology, Mycology & Lichenology	4	3+1+0	20	80	100
BOT 102	Bryology, Pteridology & Paleobotany	4	3+1+0	20	80	100
BOT 103	Gymnosperm, Angiosperm anatomy & Advanced morphology	4	3+1+0	20	80	100
BOT 104	Instrumentation & Laboratory technique	4	3+1+0	20	80	100
BOT 105(P)	Practical-I	5	0+0+5	20	80	100
BOT 106 (OE)	1. Plant propagation and nursery management 2. a	2	1+1+0	10	40	50
Total		**23**		**100**	**400**	**550**

SEMESTER II

BOT 201	Plant Taxonomy & Economic Botany	4	3+1+0	20	80	100
BOT 202	Cytology, Genetics, Plant Breeding & Evolution	4	3+1+0	20	80	100
BOT 203	Plant physiology & Biochemistry	4	3+1+0	20	80	100
BOT 204	Ecology, environment & Phytogeography	4	3+1+0	20	80	100
BOT 205(P)	Practical-I	5	0+0+5	20	80	100
BOT 206(Open elective-I)	1. Elective-I 2.	2	2+0+0	10	40	50
Total		**23**		**110**	**440**	**550**

SEMESTER III

BOT 301	Microbiology & Plant pathology	4	3+1+0	20	80	100
BOT 302	Molecular biology & Plant Biotechnology	4	3+1+0	20	80	100
BOT 303	Reproductive & Developmental Biology	4	3+1+0	20	80	100
BOT 304	Bioinformatics & Biostatistics	4	3+1+0	20	80	10

						0
BOT 305 (P)	Practical-I	5	0+0+5	20	80	100
BOT 306 (DSE -II)	1. Elective –II 2.	3	3+0+0	20	80	100
		24		**120**	**480**	**600**

SEMESTER IV

BOT 401	Special Paper-I *(Any one from list)*	4	4+1+0	20	80	100
BOT 402	Special Paper-II	4	4+1+0	20	80	100
BOT 403	Special paper III	4	4+1+0	20	80	100
BOT 404 (P)	**Advanced Practical (Special paper)**	4	0+0+4	20	80	100
	Project Work/Dissertation	6	0+0+6	20	80	100
Total		**22**		**100**	**400**	**500**
Grand Total		**92**				**2200**

Details of the elective courses:

ELE-I (Open)	I. Biodiversity & conservation
ELE-II (Open)	I. Plant resources, Pharmacognosy & Ethnobotany / II. IPR, Traditional knowledge & Ethnobotany
DSE-I	1. A 2.

Special Paper-I ***from the list*** Special Paper-II Special Paper III ***any one***	**Special paper** i) Angiosperm Taxonomy ii) Microbiology iii) Advanced Plant Physiology and Biochemistry iv) Ecology v) Cytology, Genetics and Plant Breeding vi) Mycology and plant pathology

SEMESTER-I
PAPER CODE: BOT-101
PAPER TITLE: PHYCOLOGY, MYCOLOGY & LICHENOLOGY
Total Marks=100

PHYCOLOGY

Unit - I

Algal Diversity and distribution: Thallus Organization; Pigments; Food reserves; Reproduction-Different types of life cycle in Algae.

Algal cytology: Ultra structure of algal cell, Cell wall, Flagella, Chloroplast, Pyrenoids, Eyespot; Importance of algal intra-cellular structures in classification.

Classification of Algae: Criteria for classification of Algae; Recent trends in Algal Classification.

Unit-II

General account: Thallus structure, reproduction, life cycle and post fertilization stages, phylogeny, inter-relationship and Evolutionary trends in following: Chorophyta, Xanthophyta, Pheophyta, Rhodophyta, Bacillariophyta and Chrysophyta Cynophyta: Cell structure, reproduction interrelationships, cynotoxins and cynophages

Economic importance of Algae: Role of Algae in soil fertility, Industrial uses of Algae, Algae as Biofuels, Algal cell culture techniques.

Ecological importance: Algae in global warming-Carbon capture by Algae, Algal indicators, Algal blooms, Eutrophication, Algae in Bio-remediation.

MYCOLOGY

Unit-III

General characteristics of Fungi: Fungal cytology: Ultrastructure of Fungal cell,

Composition of fungal cell wall; Fungal Nutrition; Life cycle; Reproduction and Somatic recombination in fungi: Heterothallism, Parasexuality, Heterokaryosis, Evolution of sex in Fungi

Classification: Recent trends in fungal classification with reference to vegetative and reproductive structures; Outline of classification as per Anisworth, Alexopolous and Webster.

Unit-IV

Comparative account of thallus structure, spore producing organs; Life cycle pattern, phylogeny and interrelationships of the following: **Mastigomycotina, Zygomycotina, Acomyctina, Deuteromycotina, Basidiomycotina.**

Ecological and physiological specialization in fungi: Mycorrhizal interaction; Application as biofertillizer and bioprotector in forestry and agriculture; Wood decaying fungi; Common parasitic fungi of plants and animals; Entomogenous fungi, mycoparasite and mycoherbicides, Economic importance of Fungi

LICHENOLOGY

Unit-V

General characteristics, distribution, thallus structure and reproduction, Classification and nomenclature, mechanism of phycobiont and mycobiont interaction, Role of lichen in Succession and monitoring pollutants, Economic importance of Lichen.

PAPER CODE: BOT-102

PAPER TITLE: BRYOLOGY, PTERIDOLOGY & PALEOBOTANY

Total Marks=100

BRYOLOGY

Unit-I

Introduction- Origin, evolution, History of classification and interrelationships.

Diversity in morphology and reproduction: Habitat, Structural organization of gametophytes, Reproduction, sporophytes, spore dispersal mechanism and evolutionary perspective (**Hepaticae, Anthocerotae & Musci)**

Unit-II:

Diversity and distribution of Bryophytes in North East India, Economic importance of Bryophytes; Bryophytes as pollution indicator and monitoring.

PTERIDOLOGY

Unit-III:

Introduction: Theories of origin and interrelationship of pteridophytes; evolution and classification of vascular cryptogams.

Diversity in morphology and reproduction: Diversity of life cycle pattern in Pteridophytes, Apospory and apogamy, heterospory and seed habit, Telome concept; evolution of Sorus.

Ecology & distribution of ferns of N.E. India with special reference to Assam.

Unit-IV:

Morphological and reproductive diversity of **Psilotales, Lycopodiales, Selaginellales, Isoetales, Equisetales**.

Morphological, anatomical and reproductive diversity of **Leptosporangiate** and **Eusporangiate groups**.

Unit-V:

Paleobotany: Geological time scale, fossilization process, classification and nomenclature of fossil plants, techniques in studying fossils.

General account of major fossil groups -**Psilophytales, Zosterophyllales, Lepidodendrales, Asteroxylales, Sphenophyllales, Calamitales, Cladoxylales, Coenopteridales.**

PAPER CODE: BOT-103

PAPER TITLE: GYMNOSPERMS, ANGIOSPERMS ANATOMY AND ADVANCED MORPHOLOGY

Total Marks: 100

Gymnosperms:

Unit-I

Systems of Classification and salient features of major taxa; characteristics, affinities and relationships of **Cycadofilicales, Bennettitales and Cordaitales**.

Unit-II

Characteristics, affinities and relationships of **Ginkgoales, Coniferales, Taxales and Gnetales.**

Economic importance of Gymnosperms, Xylotomy.

Angiosperms anatomy:

Unit-III

Morphogenesis and organogenesis in plants: Meristem, types, origin and activity; **Organization** of **shoot** and **root** apical meristem. Periderm: Origin and activity, Rytidome, protective tissue in Monocotyedons, bark and cork; Cambium- Origin, function, behavior- normal and abnormal. Types of Stomata & Trichome

Unit-IV

Nodal Anatomy- different patterns of nodal anatomy, cambium, vascular cambium, cork cambium, factors influencing the activity of vascular cambium; anomalous secondary growth; seedling anatomy; leaf anatomy, wood anatomy; floral anatomy.

Unit-V

Advanced Morphology: Origin and evolution of flower- Co- evolution of flower and pollinator; origin and evolution of polypetalae, sympetalae, stamens and carpels; Staminodia. Nectaries; types and evolution of ovaries, placenta.

PAPER CODE: BOT-104

PAPER TITLE: INSTRUMENTATION & LABORATORY TECHNIQUE

Total Marks: 100

Unit-1

Microscopic Techniques: General features of Microscope, Principles of microscopy, bright and dark field microscopes, Phase-Contrast, Fluorescence, Confocal, Electron microscopy; Fixation and staining techniques for electron microscope, Micrometry.

Unit-II

Herbarium techniques- drying, poisoning, pressing, labeling, cataloging and preservation.

Microtomy: Principle, sample preparation, block preparation, sectioning, staining and mounting

Unit-III

Dissection, Maceration, Squash, Peeling and whole mount – Pre-treatment and procedures.

Serial Sectioning – Double / Multiple Staining.

Histochemical Techniques – Localisation of specific compounds / reactions / activities in tissues.

Cytochemical Techniques - Localisation of specific compounds / reactions / activities in cells.

Unit-IV

Chromatographic techniques: Basic concepts, Gel filtration chromatography, Ion-exchange chromatography, Affinity chromatography, Gas chromatography,

High Performance Liquid Chromatography

Electrophoresis: Basic concepts, Gel Electrophoresis –agarose and acrylamide

(native, denaturing and gradient), Isoelectric focusing.

Unit-V

Immunological techniques: Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

Spectroscopic Techniques: Basic concept Visible, UV, IR Spectrophotometry, flourimetry, circular dichroism, NMR & ESR Spectroscopy, atomic absorption and mass spectrometry.

Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, safety guidelines.

PAPER CODE: BOT-105 (P)

Total Marks: 100

1. Study of range of thallus organization and reproductive structures of algae with the help of suitable representatives.
2. Culture of algal cells and estimation of their growth by cell counting method
3. Study of morphological, anatomical and reproductive features of some fungi growing in Assam
4. Study of morphological and anatomical features of some lichens growing in Assam
5. Study of Bryophytes in their natural habitats.
6. Study of some important genera of Bryophytes available in NE India with respect to their morphology, anatomy and reproductive structures.
7. Study of epidermal morphology of some important ferns.
8. Study of some important living members of major groups of Pteridophytes.
9. Study of some important fossil members of major groups of Pteridophytes
10. Study of morphological, anatomical and reproductive features of gymnosperms available in the region.
11. Study of different types of inflorescence (morphology), primitive and advance flowers, ovaries and fruits
12. Study the epidermal morphology, anomalous secondary growth, abnormal activity of cambium in selected familiar plants of Angiosperms.

13. Morphology of different types of ovary and placentation types.

    Angiosperms

14. Preparation and use of stains- Haematoxylin, safranin, fast geen and light green, Crystal violet, Methyle violet, Methyl green, Methylene blue, Iodine green, Ruthenium red, Congo red, Pararosanisin.

SEMESTER-II
Paper code: 201
Plant Taxonomy & Economic Botany
Total Marks: 100

Unit-I

Historical development of Plant Taxonomy, Pre Darwinian, Post Darwinian and recent system of classifications, Broad outlines of Bentham and Hooker's system, Engler and Prantle system, Hutchinson's system, Takhtajan's system and Cronquist's system of classification,recent trends in Plant Taxonomy, Use computers, GIS and GPS in plant taxonomy, characteristic features and evolution of early Angiosperms.

Unit-II

Principles and rules of nomenclature, ICBN / ICN- history, major rules, typification, principles of priority and its limitation, effective and valid publication, author citation, rejection of names and names of hybrids.

Unit-III

Plant collection and documentation, importance of botanical gardens and herbaria in

taxonomic studies, important botanical-gardens and herbaria in the world and India, activities of Botanical Survey of India.

Unit-IV

Phylogeny and floral evolution of selected families of the following orders- Magnoliales, Ranunculales, Euphorbiales, Scrophuriales, Lamiales, Asterales, Orchidales, Zingiberales, Poales.

Indian flora- its past and present position with particular reference to N. E. India.

Unit-V

Economic Botany: Centre of origins; Origin, evolution, botany, cultivation and uses of Cereals and Millets, Legumes, Sugar yielding plants, Spices and condiments, Fibre yielding plants, Timber yielding plants, Dyes; Rubber yielding plant, Gums and Resins, Oil yielding plants; Medicinal and aromatics plants, NTFPs and their uses. Economic importance of microbes, role of microbes in industries.

PAPER CODE: BOT-202

. Cytology, Genetics, Plant Breeding & Evolution

Total Marks: 100

UNIT-I

Structural organization and function of intracellular organelles; Nucleus and its components; Structure of Chromatin and chromosomes; structure and function of cytoskeleton; Cell division and cell cycle, regulation and control, Apoptesis.

UNIT-II

Prokaryotic and Eukaryotic Chromosomes; Eukaryotic chromosomes-Chemical composition, DNA packaging; Centromeres and Telomeres; Heterochromatin, Euchromatin; Unique and Repetitive DNA Transposons, interrupted genes, gene families; Genome size and Evolutionary Complexity; C -value paradox; Special types of chromosomes; Organellar genome; Prokaryotic gene regulation and Eukaryotic gene regulation

UNIT-III

Mendelian laws; Gene interactions; Multiple alleles; Qualitative and Quantitative inheritance; Meiosis; Recombination and Crossing Over; Linkage; Gene mapping and Linkage mapping; Autosomal inheritance; Sex chromosomes and Sex-linked inheritance; cytoplasmic inheritance; Genetic diseases, in-born errors of metabolism and gene therapy.

UNIT-IV

Mutation: Basic concept, spontaneous and induced mutation, physical and chemical mutagens; Molecular basis of mutations; Transposons and their use in mutagenesis; Oncogenes and cancer

UNIT-V

Plant Breeding: Distant hybridization in Plant Breeding, barrier to distance hybridization, techniques for distant hybridization; Back Cross methods of plant breeding, application and genetic consequences; Breeding for quantitative characters, handling of quantitative data, environmental effect on quantitative characters, estimation of heritability and genetic advance.

Evolution: Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; spontaneity of mutations; the evolutionary synthesis; Origin of basic biological molecules; Concept of Oparin and Haldane

Paper code: BOT-203
Plant Physiology and Biochemistry
Total Marks: 100

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: Structures and functions: Carbohydrate, lipids, proteins and nucleic acid.

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; CO2 fixation-C3, C4 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.

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

Unit-V

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; transpiration; mechanisms of loading and unloading of photoassimilates.

References

1. *A Textbook of Plant Physiology, Chemistry and Biotechnology by SK Verma and Mohit Verma*
2. *Text Book of Plant Physiology by CP Malik and A. Srivastava*
3. *Principles of Biochemistry by Lehninger*
4. *Introduction to Plant Physiology by WG Hopkins and Norman Huner*
5. *Plant Physiology by Lincoln Taiz and Equardo Zeiger*
6. *Biochemistry and Molecular Biology of Plants by BB Buchanan, W Gruissem and RL Jones (2000).*
7. *Plant Metabolism (Second Edition) by DT Dennis, DH Turpin, DD Lefebvre and DB Layzell (eds) (1997).*
8. *Life processes in Plants by AW Galstone (1989).*
9. *Biochemistry and Physiology of Plant Hormones by TC Moore (1989).*
10. *Physiochemical and Environmental Plant Physiology (Second Edition) by PS Nobel (1999).*
11. *Outline of Biochemistry by E.E. Conn, PK Stumpf and G Bruening*

Paper code: BOT-204
ECOLOGY, ENVIRONMENT & PHYTOGEOGRAPHY

Total Marks: 100

Unit –I

Concept, Principal and scope of Ecology; Environment: Physical and Biotic Environment; Interrelationship of Abiotic and Biotic Environment

Ecosytem: Types; structure; ecosystem function; energy flow and mineral cycling (C, N, P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).

Unit-II

Population Ecology: Concept; characteristics of population (Density, Natality, Morality, Dispersion, Population size, Age structure); population growth curves; population regulation; Life history strategies (r and K selection); population interactions.

Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; Edges and Ecotones; Methods of studying plant communities, Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

UNIT-III

Ecological succession- types; mechanisms; changes involved in succession; concept of climax

UNIT-IV

Environmental pollution: Environmental pollution- kinds, sources, effects on plants and ecosystems, 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. Eutrophication - causes and effects and control measures. Causes of soil pollution; Effects of pesticides on soil components, residual toxicity and pollution, Global change- greenhouse gases, consequences of climate change; ozone layer depletion, causes and consequences

UNIT-V

Phytogeography-Definition, principles and objectives of phytogeography; Descriptive and Dynamic phytogeography; Continuous and discontinuous plant distribution in India; Routes and barriers to plant migration, barrier hypothesis, Age and Area hypothesis; continental drift hypothesis, land -

bridges hypothesis, shifting of poles, island theories of biogeography, theories of differentiation and natural selection, types and areas of natural distribution, Centers of origin; Endemism-Types; Endemism in Indian flora; endemic plants of India with special reference to N E India, Phytogeographical regions of India

SEMESTER-II

PAPER CODE: BOT-205 (P)

Total Marks: 100

1. Taxonomic study of angiospermic plants with analytical drawings, botanical description and identification up to the rank of species.
2. Collection and preparation of herbarium specimens to be submitted along with field note book so as to get acquainted with herbarium techniques. At list east 20 herbarium specimens of common plants to be prepared and submitted.
3. Study of locally available economic products of plant origin.
4. Medicinal plants and their uses.
5. Preparation of fixatives, stains and their uses
6. Chromosome analysis and Karyotype analysis.
7. Study of chromosome behaviour in meiosis and chromosome anomalies in plant cells.
8. Study of the techniques of emasculation, selfing and crossing in some self-pollinated and cross-pollinated plants.
9. Preparation of buffers, solutions and dilutions, extraction of proteins from plant materials and estimation by Lowry's method using BSA standard curve.
10. Extraction of carbohydrates from plant materials and estimation of reducing sugars by Somogyi-Nelson method.
11. Extraction of plant phenolics and estimation of total phenols and O-dihydroxy phenols
12. Extraction of chloroplast pigments and quantitative estimation; Determination of cholorophyll a/b ratio in C3 and C4 plants
13. Separation of amino acid mixture by thin layer chromatography
14. SDS-PAGE analysis of proteins

15. Effect of different solutes and temperature on membrane permeability.

16. Effect of solutes on the response of membranes to different chemicals.

17.Determination of minimum size and number of quadrates necessary to study herbaceous communities.

18.Determination of abundance, density, frequency, basal cover of plant communities by quadrate method.

19.Estimation of above ground and below ground biomass from unit area.

20.Effect of biotic disturbances on botanical composition.

21.Study of similarity between plant communities using index of similarity and dissimilarity.

22.Estimation of dissolved oxygen content in eutrophic and oligotrophic water samples.

23.Morpho-anatomical adaptive features of hydrophytes and xerophytes.

24.Preparation of a map of India showing biogeographical zones. To plot Biosphere Reserves/ Ramsar sites/National Parks/Wildlife Sanctuaries located in different biogeographical zones of India in general and NE India in particular.

FIELD STUDIES: Collection of specimen and preparation of field report by studying within the NE states.

References

1. *Methods and Techniques in Plant Physiology by A Bhattacharya and Vijay Laxmi*

SEMESTER-II

PAPER CODE: BOT-206 (Open Elective)

Biodiversity & conservation
Total Marks: 50

Unit -I

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

Biodiversity – assessment, conservation and management, biodiversity act of India

and related international conventions. Sustainable development, natural resource management in changing environment.

Unit-II

Strategies for conservation – *in situ* conservation: international efforts and Indian initiatives, protected regions for conservation of biodiversity, sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots; RET Plants of Northeast India and their conservation initiatives.

Strategies for conservation – *ex situ* conservation : Principles and practices; botanical gardens, gene banks, Field Gene Bank, seed banks, ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; in-vitro Conservation: germplasm and gene bank; tissue culture: pollen and spore bank, DNA bank. *in vitro* repositories, cryobanks; National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR) and their conservation efforts.

SEMESTER-III
PAPER CODE: BOT-301
Paper title: Microbiology and Plant Pathology
Total Marks: 100

Unit-I

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

Virus: Types and nomenclature of viruses, replication of RNA and DNA viruses, tumor virus, viroids, prions and interferons.

Microbial techniques: Microbial techniques, Isolation of microbes, pure culture, preservation, types of culture, growth media, bacterial growth curve; Control of microorganisms: Sterilization and disinfection

Unit-II

Microbial metabolism (Principals of bioenergetics, enzymes in metabolism, bacterial photosynthesis, catabolism of carbohydrate)

Microbial genetics (Nature of hereditary information, DNA replication, RNA and Protein synthesis, Plasmids, Transposable genetic elements, mutations, genetic recombination) Recombinant DNA technology

Immunology: Innate and acquired immunity, antibodies, cells and tissues of the immune system, immune diseases.

Unit-III

Soil microbiology (Soil microflora, rhizosphere, mycorrhiza, decomposition of organic matter) **Aeromicrobiology** (Aeromicroflora, Air sampling techniques, allergies, air borne diseases) and **water microbiology** (water quality, detection of coliform group in water, waste water treatment)

Unit –IV

Industrial microbiology (Fermentation technology, Production of alcohol andorganic acids); **Food microbiology** (Fermented food products, Milk and milk products, food spoilage and food preservation)

Unit -V

Plant pathology: History of plant diseases; symptomatology; epidemiology and disease forecasting. Stages in disease development, recognition and entry processes of different pathogens like bacteria, virus and fungi in plant host cells. Host-pathogen relationship; alteration of host cell behavior by pathogens; virus induced cell transformation. Molecular basis of plant diseases & defense mechanism

Control of plant diseases: Cultural, chemical, biological, bio-pesticides, breeding for resistant varieties, plant quarantine, integrated pest management.

Paper code: BOT-302

Paper title: Molecular biology & Plant Biotechnology

Total Marks: 100

Unit-I

DNA replication, repair and recombination: Unit of replication, enzymes involved replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination, DNA Methylation and Acetylation.

RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport.

Unit-II

Cell signalling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins. neurotransmission and its regulation.

Unit-III

Comparative genomics and evolution: Techniques of DNA finger printing and marker development (RFLP, RAPD, AFLP, SSR, SNP), application of DNA fingerprinting in genetic diversity study, genome analysis, genetic mapping, molecular systematics and diagnosis.

Unit-IV

Genetic Engineering: genetic engineering of microorganisms, isolation and cloning plasmid and mitochondrial genes, vectors, restriction digestion, DNA ligation, gene cloning, transformations, microinjection, nuclear transplantation, GMO's in crop development. IPR and legal issues related to GMOs, Advantage and limitations.

Biotechnology for healthcare, agricultures, industries and environmental.

Unit-V

Plant Tissue Culture: importance, requirements, culture medium. Culture of plant tissues: root, meristem anther, pollen and protoplast culture; role of tissue culture in crop improvements, somatic hybrids and cybrids.

References

1. *Biotechnology by BD Singh*
2. *Biotechnology by U Satyanarayan*

3. *Molecular Cell Biology (8th edition) by HF Lodish et al.*
4. *Molecular Biology of the cell by Albert*
5. *Molecular Biology of the gene (7th edition) JD Watson et al.*
6. *Molecular Biology Genes to Protein (3rd edition) by BE Tropp*
7.

SEMESTER-III
PAPER CODE: BOT-303
Paper title: Reproductive and Developmental Biology
Total marks=100

Unit-I

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells.

Unit-II

Development of male and Female Gametophyte: Microsporogenesis and Microgametogenesis, role of tapetum, pollen development, pollen germination, pollen tube growth and guidance

Megasporogenesis and megametogenesis,embryo sac development and structure.

Pollination biology: Primary and secondary attractants of pollination; ultra structural and histochemical details of style and stigma, Pollen pistil interaction

UNIT-III

Fertillization: Barriers to fertilization, genetic incompatibility and methods to overcome incompatibility, Double fertilization in plants and its significance
Embryogenesis: development of embryo (dicot and monocot);
Development, structure and types of Endosperm;
Fruit: Development and maturation of fruit, types and parts of fruits, fruit dispersal strategies
Seed: Types of seed, germination of seed types and nature and dispersal of seeds, factors affecting germination.
Apomixis, apospory& parthenocapy

Unit-IV

An overview of plant development: Shoot and Root development, leaf development and phyllotaxy, transition to flowering, floral meristem and floral development, homoetic genes in plants, senescence, programmed cell death and hypersensitive response in plants.

Unit-V

Palynology: Branches of palynology, Morphology, ultrastructure, pollen chemisitry, viability, storage and adaptation; use and applications, aeropalynology.

Experimental embryology. Anther culture, ovary culture, somatic hybridization and production of cybrids, embryo culture and rescue, clonal propagation, cryopreservation and germplasm storage, somatic embryogenesis, somaclonal variations.

SEMESTER-III
PAPER CODE: BOT-304
Paper title: Biostatistics & Bioinformatics
Total marks=100

Unit-I

Biostatistics: Measures of central tendencies; mean, mode, median, standard errors and standard deviations. Probability; normal, binomial and poisson distribution; Skewness and kurtosis. Chi Square test; characteristics, degrees of freedom, test of goodness of fit, null hypothesis.

Unit-II

Analysis of variance (ANOVA): Variance and co-variance analyses, F-test, steps involved in ANOVA. Correlation; methods of studying the correlation, scatter diagram; regression analysis, regression equation, methods of studying regression, graphic and algebraic methods.

Experimental field designs, principles of field experimentation, analysis of stability

Parameters. Statistical software packages and their importance in data analysis.

UNIT III

Introduction to Bioinformatics: Basics of computers, computer languages and operating systems, introduction to bioinformatics, biological databases and data formats, data mining and retrieval systems, nomenclature of nucleotides and amino acids, scope and application of bioinformatics.

- **Databases** - NCBI, EMBL, DDBJ, Genbank, Pubmed, Patent databases, TAIR, PDB, ATIDB).
- **Online tools** - BLAST, ORF finder, Primer3, protein motif and structure prediction tools; Vector NTI, DNASTAR.
- Bioinformatics in genome sequencing and annotation.
- Fundamentals of computer programming.
- Programming in PERL.
- Bioinformatics indrug designing and molecular modeling.

- Structural bioinformatics and drug discovery.

Paper code: BOT-305 (P)
Total Marks: 100

Microbiology and plant pathology

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, nodule bacteria and endophytic bacteria
5. Phosphatase test for bacterial contamination of milk
6. Gram staining, flagella staining, capsule staining and acid fast staining of bacteria
7. Effect of physical and chemical factors on growth of microbes
8. Isolation and identification of pathogens from diseased plants available in Assam
9. Spore measurement and camera lucida diagram
10. Tissue sectioning and direct observation of pathogen by staining with suitable dye
11. Separation of biomolecules by paper and thin layer chromatography
12. Collection and study of symptoms of plants infected by virus, bacteria and fungi.

Molecular Biology & Plant Biotechnology

1. Protein isolation and gel electrophoresis
2. Genomic DNA isolation and quantification
3. Plasmid isolation and restriction mapping
4. PCR reaction and gel electrophoresis
5. Basic laboratory principles and techniques of plant tissue culture.
8. Mushroom cultivation
9. Preparation of Wines from Grapes.
10. Experiment to demonstrate biofuel extraction from plants and microbes and biogas production.

Reproductive and Developmental Botany

1. Preparation of pollen grain slides following different techniques; Identification of pollen grains from air, lake mud, soil, honey and coal following suitable methods; *in vitro* germination of pollen grains pollen viability. Preparation and submission of 20 nos. of palynological and differentialy stained permanent slides showing different anatomical features, as a part of practical records in the examination.

2. Study of microsporogenesis, megasporogenesis, embryosacs and endosperms with the help of permanent slides.

Biostatistics & Bioinformatics

1. To workout the mean, median, mode, range, standard deviation, standard error and covariance
2. of any population data
3. Application of t-test, F-test and Chi-square test for a given set of data
4. Drawing of line graphs and histograms from tabulated data
5. Preparation of skeleton of analysis of variance of the designs - Randomized block
6. design, split-plot and latin square design
7. Data analysis in SPSS software
8. All the theory classes on bioinformatics should be conducted with the aid of available
9. online and offline bioinformatical tools.
10. Sequence alignment and homologous sequence search
11. Sequence annotation and gene prediction with the help of bioinformatical tools.
12. Protein modeling and structure prediction

Pharmacognosy

1. Microscopic structure of the plant tissues, test for oil: Mustard, coconut, sunflower, castor.
2. Test for gums, resins and tannins.
3. Experiment to demonstrate essential oil extraction from plants

Paper Code: 306 (Open elective)

Paper title: Plant Diversity, Pharmacognosy, Ethnobotany

Unit-I

Plant biodiversity: Concept, utilization and concerns, status in India. Sustainable Development: Basic concepts.

Green revolution: Benefits and adverse consequences, innovations for meeting world food demands, GMO, biosafety regulations.

Unit-II

Pharmacognosy: Scope, Nature and importance of Pharmacognosy; Pharmacognosy as a tool for identification of crude drugs and processed medicine. Introduction to the technique for quality control, monitoring and Regulation. Types of Adulterations and Substitution of Drugs. Sources of contamination of Herbal drugs-Aflatoxins, Heavy Metals, Pesticides.

Unit-III

Ethnobotany: History and importance of ethnobotany. Ethnobotany as an interdisciplinary science. Methodology of Ethnobotanical studies: a) Field work b) Herbarium; The relevance of ethnobotany in the present context: Life style, Material Culture and Indigenous Technology. Ethnic groups and Ethnobotany: Major and minor ethnic groups and their life styles and Medico-ethnobotanical resources in India with special reference to NE states.

Optional –II (Elective-2): IPR, TRADITIONAL KNOWLEDGE & ETHNOBOTANY

Unit-I

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-II

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

Unit-III

History and importance of ethnobotany, ethnomedicobotany, ethnozoology, ethnoveterinary, ethnomusicology and ethnoagriculture and methods of studies. Tribals of NE and their socio - cultural practices.

BOT-401
Optional-I: Angiosperm Taxonomy-I

Unit-I

Basics of Taxonomy: Concept, Aims and Principles. Classificatory Systems: Pre- and Post Darwinian Classifications, **Phenetic, Phylogenetic, Cladistic and APG System, Alpha and Omega taxonomy, Numerical Taxonomy**, The components of systematic, Major objectives of systematic.

Unit-II

Concept of Taxa: Species, Genus, Family, Major and Infra specific categories

Unit-III

Concept of Characters: Concept, Correlation, Weighing, variations, Isolation and Speciation.

Unit-IV

Nomenclature: History, Principles and Major rules, Taxonomic hierarchy, Typification, Effective and Valid Publication, Authors' citation, Principles of Priority and Limitations, **Naming a new species;** legitimacy; Synonyms, Draft Biocode and Phylocode.

Unit-V

Taxonomic Literature: Classical and recent literature, **Journals and taxonomic websites**.

Unit-VI

Botanical exploration in India: Contributions made in earlier and recent periods.

BOT-402
Optional-I: Angiosperm Taxonomy-II

Unit-I

Systematic evidence: Morphology, Anatomy, Palynology, Embryology, Cytology, Phytochemistry, Serology

Unit-II

Biosystematics: Definition, importance and categories, major areas.

Unit-III

Molecular Systematics: Diagnostic tools, Restriction Fragment Length Polymorphism (RFLP's), Random Amplified Polymorphic DNA (RAPD), Polymerase Chain Reaction (PCR) analysis, specific applications of RAPD in molecular systematics.

Unit-IV

Tools of Taxonomy: Botanical keys, GIS. GPS, Remote sensing, Flora, Manuals, check list, annoted list, revisionary study, world flora, Indian flora, preparation of flora

Unit-V

Material Basis of taxonomy: Herbarium techniques: Methods of Collection, Identification and Documentation, source of taxonomic materials, plant introduction and acclimatization

Unit-VI

Computation and iData: Analysis of data; commonly available software, construction of Dendrograms and Cladograms

BOT-403
Optional-I:: Angiosperm Taxonomy-III

Unit-I

Phytogeography: Concept, Static and Dynamic Phytogeography, Phytochoria and botanical provinces of India; Major theories, Ranges, Migration and Barriers, Centre of Origin, Vicariance, Endemism, Hotspots, IUCN categories, India as a megadiversity country

Unit-II

Flora of North East India, Endemism, Exotics, RET Plants, their multiplication and conservation.

Unit-III

Botanical Survey of India: History, Activities, Publications.

Unit-IV

Herbaria and Botanic Gardens: Role and importance of herbaria and gardens in taxonomic studies, major Herbaria and Botanic Gardens.

Unit-V

Phylogeny of Angiosperms: Origin of Angiosperms, Primitive and advanced angiosperms, Evolutionary trends

Unit-VI

Phylogeny and Evolution of following Taxa:
Magnoliales, Rananculales, Euphorbiales, Scrophulariales, Lamiales, Asterales, Alismatales, Orchidales, Poales, Zingiberales.

BOT-404(P)
Optional-I :: Angiosperm Taxonomy

1. Floristics study of certain small area in and around Kokrajhar, making collection of their own and from these analytical drawing should be made

Detailed studies of Taxa with botanical keys, analytical drawing and description and Identification up to the rank of species.

2. Practices on Nomenclatural problems

3. Writing exercise

4. Classification exercise

5. Technique in molecular systematic.

6. Identification of taxa/Plant parts/herbarium specimens.

7. Ethnobotanical study of the local tribes

BOT-401
Optional-II:: Microbiology-I

Unit-I

General microbiology: History and development of microbiology as a subject, scope of microbiology, microbiology in human welfare, bioterrorism.

Prokaryotes (cell structure and reproduction, diversity and taxonomy) and eukaryotes (cell structure and diversity), New approaches to bacterial taxonomy, Advantages and limitations of DNA and RNA systematics

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

Virus: Process of infection, function of RNA and DNA in viruses, RNA as genetic material, replication of viruses, lytic and lysogenic cycle of bateriophages.

Unit-IV

Microbial physiology: Bioenergetics (principles of bioenergetics information pathways), metabolism (catabolism of glucose, fatty acids and amino acids; biosynthesis of carbohydrates, lipids and amino acids), growth and nutrition.

Bacterial Photosynthesis: Photosynthetic bacteria, bacterial pigments, CO_2 fixation

Unit-V

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 transcription and protein synthesis, genome evolution.

BOT-401
Optional-II:: Microbiology-II

Unit-I

Microbial molecular biology: Genetic recombination, conjugation, transduction

and transformation in bacteria, proteomics, transcriptomics, metabolomics, genomics, gene regulation in prokaryote and eukaryotes, operon concept (*lac*, *ara* and *trp* operons), one gene many enzyme concept, promoter, enhancer, repressor, negative feedback, RNA processing (RNA capping, Poly (A) tail formation, RNA splicing)

Unit-II

Microbial biotechnology: Microbial biotechnology for human welfare, genetic engineering – tools and techniques, vectors (plasmids, bacteriophage and other viral vectors, cosmids, Ti plasmid, bacterial artificial chromosomes and yeast artificial chromosome), cDNA and genomic DNA library,gene cloning, expression of cloned genes, gene therapy, DNA fingerprinting, whole genome sequencing projects, GMOs, micro RNAs, RNAi

Unit-III

Medical microbiology: Important human diseases caused by virus, bacteria, fungi and protozoa. Laboratory diagnoses and control of diseases caused by *Streptococcus pyogenes*, *Neisseria meningitidis*, *Corynebacterium,diphtheriae*, *Clostridium tetani*, *Vibrio cholerae*, *Mycobacterium tuberculosis*, Poliovirus, Hepatitis virus, immunodiagnostics, vaccination, autoimmune diseases.

Unit –IV

Immunolology: The origin of immunology; Inherent immunity; Humoral and cell mediated immunity; Specific and non-specific immunity; Immune responses, Primary and secondary lymphoid organs; Antigen; B and T cells and Macrophages; Major histocompatibility complex (MHC); Antibodies, synthesis of antibody and secretion; Polyclonal and monoclonal antibody; Complement; Antigen-antibody reaction; Hyper sensitivity; Autoimmunity; Graft versus host reaction. Hybridoma technique, advantages and application of monoclonal antibodies.

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, Tumor suppressors, RB and p53 protein,
DNA methylation and cancer.

BOT-403

Optional-II: Microbiology-III

Unit-I

Microbial ecology:

Interactions among microbial population & with plants and animals.

Biotransformations: microbial degradation of pesticides and toxic chemicals, biodegradation of the agricultural residues, bioremediation of contaminated soils, treatment of solid waste, microbial interaction with xenobiotics and inorganic pollutants.

Microbial community in petroleum; MOER, Microorganisms in mineral and energy recovery and fuel and biomass production.

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Unit-II

Soil microbiology: Soil environment, microbial diversity in soil, microbial interaction in soil, cycling of soil nutrients, methods to detect and quantify soil bacteria and their functional characterization, analysis of microbial communities in soil, soil metagenomics, biosensors to monitor soil health and toxicity, biopesticides, Soil suppressiveness to plant diseases.

Unit-III

Agricultural microbiology: Agriculturally important microorganisms; Biological nitrogen fixation; rhizosphere, phyllosphere, phosphate solubilizing microbes, Plant growth promoting rhizobacteria (PGPR), Microbial pesticides

Unit-IV

Industrial microbiology: Industrial importance of microorganisms, Types of Fermentation process, microbial biomass, microbial enzymes, bioreactors, isolation, preservation and maintenance of industrial microbes, kinetics of microbial growth in STR, microbial products, primary and secondary metabolites, downstream processing, application and immobilization of enzymes, selection and strain improvement strategies.

Industrial production of :

a) Amino Acid – Glutamic Acid.

b) Enzyme – Amylase
c) Organic Acid – Lactic acid, Citric acid.
d) Biofuel – Bio-ethanol, bio-butanol.
g) Biopolymer – PHB, PLA.
h) Special Cells – SCP, Baker's Yeast.
i) Bio-fertillizers

Unit- V

Food microbiology: Importance of studying food and dairy microbiology.Primary sources of microorganisms in foods.Factors influencing microbial growth in foods - extrinsic and intrinsic. Principles of food preservation; preservation methods – irradations, drying, heat processing, chilling and freezing, high pressure, modification of atmosphere and chemical preservatives. Fermented food products and Nutritional value of fermented foods; Contamination and spoilage of fruits, vegetables, meat and poultry products.Concept of prebiotics and probiotics.

BOT-404(P)
Optional-II :: Microbiology

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. Phosphatase test for milk
6. Detection of organic acids produced by fungi by paper chromatography method
7. Assessment of antimicrobial activity of some microbes against some 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 (catalse, IMViC, peroxidase, nitrate reductase, oxidase, etc)
13. Isolation and quantification of plasmid/DNA/protein
14. Estimation of total proteins, phenol coefficient, absorption maxima of DNA/Protein
15. Study of symptoms and causal organisms of some important plant diseases prevalent in the state

BOT-401
Optional-III:: Mycology and Plant Pathology

Unit-I

History and development of mycology, ultra structure of fungal cell, cellular organization of fungi, dimorphism, Fungal taxonomy: Different groups of fungi, species identification and nomenclature of fungi; systematics and phylogenetic relationship among different groups of fungi; modern trends in identification and classification of fungi; Allied fungi

Unit-II

Fungal reproduction: different mode of reproduction in fungi, different reproductive structures, parasexuality, degeneration of sex, heterothallism, Fungal genetics: Inheritance, complementation, incompatibility.

Unit-III

Fungal physiology, growth, nutrition, development and reproduction of fungi, 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, interaction of fungi with other organisms

Economic importance of fungi, fungi as a source of vitamins, amino acids, organic acids, enzymes and proteins, Ecological services

Unit-V

Fungal biotechnology: yeast as model organism, fungal whole genome sequencing, genetically modified fungi, fungi as biocontrol agent (Mycoherbicides, Mycofungicides, Myconematicides), Edible and poisonous mushrooms, cultivation of mushrooms, economic value of mushrooms

BOT-402
Optional-III:: Mycology and Plant Pathology

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, pathology in 21th century and beyond, plant pathology today and future direction, plant pathology as profession

Unit-II

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

UNIT-III

Diseases and changes in plant physiological functions like photosynthesis, movement of water, respiration, permeability of cell membrane, growth and transcription and translation.

Unit-IV

Genetics of plant diseases, genes and disease variability in organisms, mechanism of variability, types of plant resistance to pathogens, Genetics of Virulence in pathogens and resistance in host plants, signal transduction between resistant and pathogenicity genes. Enzymes, toxins and growth regulators in plant disease development, environmental impact on the development of plant diseases, environmental factors that affect plant diseases.

Unit-V

Epidemiology and disease forecasting, Effects of environmental factors on epidemiology; Control of plant diseases, chemical and biological disease control, integrated disease management (IDM), IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, mustard, pulses, and vegetable crops

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

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

BOT-403
Optional-III:: Mycology and Plant Pathology

Unit I

Defence 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-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. Inoculum potential and density in relation to host and soil variables; Associative and antagonistic effects; Suppressive soils, biological control- concepts and potentialities for managing soil borne pathogens.

Unit-V

Seed pathology: History and economic importance of seed pathology; Morphology and anatomy of infected seeds; Disease development in seed and seedling, seed to plant transmission of pathogens. Seed certification and tolerance limits, Quarantine and SPS under WTO; Evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens; Epidemiological factors influencing the transmission of seed-borne diseases, forecasting through seedborne infection. Toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing and methods for detecting seed microorganisms.

Unit-V

Quarantine and seed certification: Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine – domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; History of quarantine legislations, PQ Order 2003; Identification of pest/disease free areas; Symptomatic diagnosis 81 and other techniques to detect

pest/pathogen infestations; VHT and other safer techniques of disinfestation/salvaging of infected material.

BOT-404(P)
Optional-III:: Mycology and Plant Pathology

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. Staining of bacterial flagella, spore and capsule
5. *In vitro* inhibition of plant pathogens by different plant extracts
6. Estimation of spore population and root colonization of mycorrhiza
7. Extraction of cellulase/pectinase/xylanase from diseased plants
8. Proving of Koch's postulate at least one disease
9. Study of the effect of fungicides and plant extracts on the germination and growth of plant pathogenic fungi
10. Isolation and enumeration of microbes from soil samples
11. Study of effect of physical and chemical factors on the growth of plant pathogens .

BOT-401
Optional-IV:: Plant Ecology

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, interdemic 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 (α, β, γ).

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.

Unit-VI

Geographical Information System (GIS) - basic principles and techniques, types of geographical data; data structure; vector and raster data: their advantages and disadvantages; Input, verification, storage and output of geographical data; Importance of Geographical Information System in environmental studies. Global Positioning System (GPS): basic principles, Applications in ecological studies.

BOT-402
Optional-IV :: Plant Ecology

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 and its importance.

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.

Unit-VI

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-403
Optional-IV:: Plant Ecology

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. Acid rain and its impact on soil fertility, rivers and lakes; its effects on plants, leaf injury, buffering, reproduction; forest decline. Biomonitoring of air pollution, active and passive monitoring; air pollution tolerance indices; control of air pollution

by plants, green belt design. Plant indicators.

Unit-III

Environmental problems of NE India with special reference to shifting cultivation, deforestation, opencast coal mining, oil exploration, encroachment, flood, erosion, landslides etc.; wetlands, its benefits, causes of degradation and its consequences

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 bio-waste and e-waste management.

BOT-404(P)
Optional-IV :: Plant Ecology

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 CO2, 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; life-form 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.

BOT-401
Optional-V: Advanced Plant Physiology and Biochemistry

Unit-1

Membrane transport and translocation of water and solutes: Mechanism of xylem and phloem transport, phloem loading and unloading, passive and active solute transport, membrane transport of proteins. Root microbe interactions in facilitating nutrient uptake.

Unit-II

Nitrogen and sulphur metabolism: Nitrogen fixation, nitrogenase, “nif” genes,

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

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

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

Unit-V

Stress physiology: Plant responses to water deficit, salinity, metal ion stress, freezing and heat stress, effect of elevated CO2 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-402

Optional-V: Advanced Plant Physiology and Biochemistry

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, photosynthetic pigments and light harvesting complexes, photo-oxidation of water, mechanism of electron and proton transport, carbon assimilation- the Calvin cycle, Rubisco, significance of photorespiration. 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-403

Optional-V: Advanced Plant Physiology and Biochemistry

Unit-I

Growth and morphogenesis: Meristems in plant development; development of plant organs: root, stem, leaf and flower; 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; ripening of fruit and its regulation; metabolism of leafy vegetables during storage.

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 –Biosynthesis and mechanism of action of Phytohormones: auxin, gibberellin, cytokinin, ethylene and ABA. A brief idea about discovery, role and possible mechanism of action of Triacontanol, Brassins, Salicylic acid, Jasmonates and Polyamines. A brief idea about role of plant growth retardants- CCC, Maleic hydrazide, Trizoles and TIBA.

BOT-404(P)
Optional-V: Advanced Plant Physiology and Biochemistry

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. Study of lipid accumulation during development of oil seeds.
6. To study the effect of different PGRs on seedling growth

7. Sugar and amino acids analysis of phloem sap, with paper chromatography.
8. Determination of Chlorophyll a / b ratio of C3 and C4 plants.
9. Estimation of nitrate in different plant parts.
10. Study of effect of PEG induced water stress on seed germination
11. Measurement of RWC and Osmotic potential
12. Study of protein/ amino acid profile in plants under stress.
13. Study of effect of fungal infection on peroxidase activity.
14. Study of free radicals scavenging enzymes, Catalase and super oxide dismutase.
15. Study of free prolein accumulation in plants under stress.
16. Study of seed germination under stress condition.

BOT-401
Optional-VI :: Cytology, Genetics and Plant Breeding

Unit-I

Cell architecture and function: The evolution of cell; Membrane structure; Cell signaling; Cytoskeleton: The nature of cytoskeleton; Intermediate Filaments; Microtubules; Cell division cycle; cell-division control in multicellular animals.

Unit-II

Chromosome structure and organization: Chromatin structure, nucleosomal and higher order structures, morphology and basic functions of chromosomes: karyotyping, chromosome banding, chromosome labelling, *in situ* hybridization, chromosome painting.

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

Epigenetics: from phenomenon to field, a brief history of epigenetics-overview and concepts; chromatin modifications and their mechanism of action, concept of 'histone-code' hypothesis, epigenetics in *Saccharomyces cerevisiae,* heterochromatin formation, and gene silencing in *Drosophilla.*

Unit-V

Gene Mutation and its mechanism; molecular basis of gene mutations.DNA damage and repair; mechanism of transposition in prokaryotes, molecular nature and use of transposable elements in eukaryotes; controlling elements in maize, *Drosophila* P element.

Unit-VI

Genetic diversity, genetic distance and phylogenetic analysis; origin and evolution of gene; rate of molecular evolution-amino acids and nucleotide substitutions, synonymous codon, molecular divergence and molecular clock; origin of new genes and proteins; gene duplication and divergence.

BOT-402
Optional-VI :: Cytology, Genetics and Plant Breeding

Unit-I

RNA molecules and processing: 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, RNA interference (RNAi).

Unit-II

Transcription: RNA polymerase subunits, different sigma factors, initiation, elongation and termination (rho-dependent and independent) of RNA synthesis; antitermination, attenuation; eukaryotic promoters, enhancers, transcription factors, RNA polymerases; translation: in prokaryotes and eukaryotes and their regulation, processing of mRNA for translation. Operon concept in prokaryotes.

Unit-III

Metagenomics: From genomics to metagenomics, 16S rRNA analysis and culturing, culture independent insight, sequence base analysis, functional based analysis, heterologous expression, global impact of metagenomics.

Unit-IV

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, comparative genome analysis, protein analysis, SDS-PAGE, protein purification with chromatographic system, monoclonal antibody and hybridoma Technology, blotting techniques, model organisms in molecular biology.

Unit-V

Genome analysis: Gene and protein sequence data banks. Access to sequence databases on the Internet, Sequence analysis, multiple sequence alignment, homology and analogy, pattern recognition, analysis package; *in silico*computational techniques for gene functions; Human Genome Project, Other sequenced genomes, High-throughput analysis gene functions, Single Nucleotide Polymorphisms.

Unit-VI

Genetic engineering and public concerns: Plant genetic engineering future - 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-403
Optional-VI :: Cytology, Genetics and Plant Breeding

Unit-I

Principles of plant breeding: Principles involved in breeding and maintaining economic crops; alternative approaches through hybridization and selection; concepts in improvement of major crop species; historically important breeding methods and new approaches; 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: populations, gene pool, gene frequency; Hardy-Weinberg law; the Hardy-Weinberg equilibrium.

Unit III

Chromosome variation in higher plants: Haploid production system, parthenogenesis and apogamy, meiosis in haploid, chromosome pairing in monoploid, breeding application of haploid. Aneuploidy: trisomic, tetrasomic, nullisomic and their significance in genetic studies. Mutation in crop improvement: action of physical and chemical mutagens.

Unit-IV

Plant transformation techniques: Cloning of plant cells and manipulation of plant genes; *Agrobacterium* mediated gene transfer- biology and molecular basis of *Agrobacterium* mediated plant transformation and its application, direct gene transfer methods; 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. Synthetic seeds; protoplast culture and somatic hybridization; nuclear and cytoplasmic hybrids; somaclonal variation, DNA-microchip in plant tissue culture industry.

BOT-404(P)
Optional-VI: Cytology, Genetics and Plant Breeding

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.