

B.Sc. Botany

Programme Outcomes

- PO1. Knowledge and understanding of:** 1. The range of plant diversity in terms of structure, function and environmental relationships. 2. The evaluation of plant diversity. 3. Plant classification and the floristic composition of Manipur. 4. The role of plants in the functioning of the global ecosystem. 5. A selection of more specialized, optional topics. 6. Statistics as applied to biological data
- PO2. Intellectual skills – able to:** 1. Think logically and organize tasks into a structured form. 2. Assimilate knowledge and ideas based on wide reading through the internet. 3. Transfer of appropriate knowledge and methods from one topic to another within the subject. 4. Understanding the evolving state of knowledge in a rapidly developing field. 5. Construct and test hypothesis. 6. Plan, conduct and write a report on an independent term project.
- PO3. Practical skills:** Students learn to carry out practical work in the field and in the laboratory with minimum risk. 1. Interpreting plant morphology and anatomy. 2. Plant identification. 3. Vegetation analysis techniques. 4. A range of physiochemical analyses of plant materials in the context of plant physiology and biochemistry. 5. Analyze data using appropriate statistical methods and computer packages.
- PO4. Transferable skills:** 1. Use of IT (word-processing, use of internet, statistical packages and databases). 2. Communication of scientific ideas in writing and orally. 3. Ability to work as part of a team. 4. Ability to use library resources. 5. Time management. 6. Career planning.
- PO5. Scientific Knowledge:** Apply the knowledge of basic science, life sciences and fundamental process of plants to study and analyze any plant form.
- PO6. Problem analysis:** Identify the taxonomic position of plants, formulate the research literature, and analyze non reported plants with substantiated conclusions using first principles and methods of nomenclature and classification in Botany.
- PO7. Modern tool usage:** Create, select, and apply appropriate techniques, resources and modern instruments and equipments for biochemical estimation, biotechnology, plant tissue culture experiments, cellular and physiological activities of plants with an understanding of the application and limitations.
- PO8. The Botanist and society:** Apply reasoning informed by the contextual knowledge to assess plant diversity, its importance for society, health, safety, legal and environmental issues and the consequent responsibilities relevant to the biodiversity conservation practice.
- PO9. Environment and sustainability:** Understand the impact of the plant diversity in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PO10. Ethics:** Apply ethical principles and commit to environmental ethics and responsibilities and norms of biodiversity conservation

PO11. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes of B.Sc. Botany

PSO1. Critically evaluation of ideas and arguments by collecting relevant information about the plants, so as to recognize the position of plant in the broad classification and phylogenetic level.

PSO2. Identify problems and independently propose solutions using creative approaches, acquired through interdisciplinary experiences, and a depth and breadth of knowledge/expertise in the field of Plant Identification.

PSO3. Accurately interpretation of collected information and use taxonomical information to evaluate and formulate a position of plant in taxonomy.

PSO4. Students will be able to apply the scientific method to questions in botany by formulating testable hypotheses, collecting data that address these hypotheses, and analyzing those data to assess the degree to which their scientific work supports their hypotheses.

PSO5. Students will be able to present scientific hypotheses and data both orally and in writing in the formats that are used by practicing scientists.

PSO6. Students will be able to access the primary literature, identify relevant works for a particular topic, and evaluate the scientific content of these works.

PSO7. Students will be able to apply fundamental mathematical tools (statistics, calculus) and physical principles (physics, chemistry) to the analysis of relevant biological situations.

PSO8. Students will be able to identify the major groups of organisms with an emphasis on plants and be able to classify them within a phylogenetic framework. Students will be able to compare and contrast the characteristics of plants, algae, and fungi that differentiate them from each other and from other forms of life.

PSO9. Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth. They will be able to use specific examples to explicate how descent with modification has shaped plant morphology, physiology and life history.

PSO10. Students will be able to explain how plants function at the level of the gene, genome, cell, tissue, flower development. Drawing upon this knowledge, they will be able to give specific examples of the physiological adaptations, development, reproduction and mode of life cycle followed by different forms of plants.

PSO11. Students will be able to explain the ecological interconnectedness of life on earth by tracing energy and nutrient flow through the environment. They will be able to relate the physical features of the environment to the structure of populations, communities and ecosystems.

PSO12. Students will be able to demonstrate proficiency in the experimental techniques and methods of analysis appropriate for their area of specialization within biology.

Course Specific Outcomes

CSOs of B.Sc. Botany: B.Sc. Part-I, Semester-I

Paper-101: (Virus, Bacteria and Cryptogams)

UNIT I: Virus and Bacteria

On completion of the unit, the students are able to understand

- The size, structure, classification and nomenclature of virus, virus replication with Tobacco Mosaic Virus as a model.
- The theoretical understanding of bacteria as prokaryotic organism from the perspective of morphology, nutrition, reproduction, environment and genetics.
- The simple form of bacterial classification i.e. the gram staining both theoretical and practical handling and the brief accounts of Bergey's manual.
- Phototropism and Chemotropism

UNIT II: Fungi

On completion of the unit, students are able to understand

- General features of Fungi – that includes their diversity, mode of nutrition, sexual and asexual reproduction etc.
- Classification of kingdom Fungi (Ainsworth's outline classification 1971) with regard to their general features.
- Life cycles of different classes of fungi – asexual and sexual cycle of *Saprolegnia*, *Mucor*, *Neurospora*, *Puccinia*, *Penicillium*.
- Economic importance – harmful and beneficial aspects
- Different types of Lichens (crustose, foliose, fruticose) – their habit and habitat, structure, reproduction – vegetative, asexual reproduction, sex organs etc.
- The economic importance of lichens in ecological field, as food, medicinal importance and chemical uses.
- Plant Pathology – classification of plant diseases based on their occurrence (endemic, epidemic, sporadic)
- Classification based on causal agents (parasitic, non-parasitic, virus)
- Inanimate and animate pathogens
- The symptoms caused by fungi, bacteria and plant viruses
- Locally important plant disease and their control measures.

UNIT III: Algae

On completion of the unit, the students are able to:

- Understand general characters of algae, classification (Fritsch)
- Gain knowledge on range of vegetative and reproductive structure of different classes, types of life cycles

- Explain the occurrence, classification, structure, reproduction and life cycles of *Oscillatoria*, *Oedogonium*, *Vaucheria*, *Cyclotella*, *Ectocarpus*, *Polysiphonia*.
- Know the economic importance of algae

UNIT IV: Bryophytes

On completion of the unit, the students are able to:

- Understand the general characteristics of bryophytes
- Know the classification systems of bryophytes
- Know the range of structural organization of gametophytes and sporophytes, methods of reproduction and alternation of generations among bryophytes
- Understand the life cycle pattern of *Riccia*, *Marchantia*, *Anthoceros*, *Pellia*, *Porella*, *Sphagnum* and *Funaria*

UNIT V: Pteridophytes

On completion of the unit, the students are able to

- Understand the general characteristics of pteridophytes
- Know the classification systems of pteridophytes
- Understand the anatomy of sporophytes and reproductive methods
- Understand the life cycle pattern of *Lycopodium*, *Selaginella*, *Equisetum*, *Isoetes*, *Marsilea* and *Dryopteris*

SEMESTER- II:

Paper 202: (Gymnosperms, Angiosperms, Applied Botany and Embryology)

UNIT I: Gymnosperms and Palaeobotany

On completion of the unit, students are able to understand:

- The general features of gymnosperms
- Classification of gymnosperms
- Morphology, reproduction and life cycle of *Cycas*, *Pinus* and *Gnetum*
- Economic importance of gymnosperms
- Fossil types and formation
- Geological time scale
- Dominant fossil flora of different ages

UNIT II: Angiosperm Taxonomy

On completion of the unit, students are able to:

- Understand concept of plant taxonomy
- Know importance of field work, observation, herbarium preparation
- Gain the concept of species, genus and family
- Learn keys for identification, rules of nomenclature (validity, effectivity and priority)
- Classification systems of Linnaeus, Bentham and Hooker, Engler and Prantl and Hutchinson
- Taxonomis studies of the selected families – Ranunculaceae, Brassicaceae, Malvaceae, Fabaceae, Rosaceae, Apiaceae, Asteraceae, Solanaceae, Lamiaceae, Euphorbiaceae, Liliaceae and Poaceae.

UNIT III: Applied Botany and Ethnobotany

On completion of the unit, students are able to:

- Understand the origin of cultivated plants, Vavilov's center of origin
- Understand the origin, cultivation and improvement of Rice and Potato
- Understand history, cultivation and processing of Tea
- Understand characteristics and uses of timber yielding plants: *Tectona* and *Pinus*
- Understand the part of plant used, alkaloid present and its uses of medicinal plants: *Cinchona*, *Rauwolfia* and *Adhatoda*.
- Understand the concept, classification and interdisciplinary approaches of Ethnobotany.

UNIT IV: Plant Anatomy

On completion of the unit, students are able to understand

- Generalized cell structure, their cell wall and cell inclusion.
- Organization of apical meristem
- Structure and distribution of simple and complex tissues
- Primary and secondary growth in plant
- Practical and Theoretical knowledge of Anomalous growth in *Amaranthus*, *Mirabilis* and *Dracaena* stem

UNIT V: Embryology and Palynology

On completion of the unit, students are able to understand:

- History of plant embryology
- Micro-sporogenesis and mega-sporogenesis
- Development of male and female gametophytes
- Fertilization, double fertilization, embryo and endosperm development
- Pollen and spore morphology
- Aerobiology and pollen allergy

CSOs of B.Sc. Botany: B.Sc. Part-II, Semester-III

Paper-303: (Plant Geography, Ecology, Plant Physiology & Molecular Biology)

UNIT I: Plant Geography

On completion of the unit, students are able to understand:

- Scope and importance of plant geography
- Phytogeographical regions of India
- Factors affecting distribution, plant dispersal and migration methods
- Endemism and barriers of distribution

UNIT II: Principles of Ecology

On completion of the unit, students are able to understand:

- Ecosystem – concept, structure and function

- Ecological pyramid, energy flow, mineral cycling (C, N, P), food chain, food web and trophic levels
- Structure of plant community
- Ecological factors (abiotic and biotic factor)
- Ecological adaptation of xerophytes and hydrophytes
- Ecological succession- hydrosere and xerosere

UNIT III: Plant Physiology

On completion of the unit, students are able to understand:

- The relationship between plant, soil and water – diffusion, imbibitions, osmosis, water potential
- How plant absorb water ; Symplastic and Apoplastic pathway
- How water moves from the roots to aerial parts of plant; tissues responsible for translocation of water.
- Role of essential elements for plant growth –micro and macro nutrients.
- Transpiration (loss of water in plant) – how it operate and significance to plants; factors affecting transpiration in plants
- Photosynthesis – how plants are capable of undergoing photosynthesis; the pigments and organelle responsible for photosynthesis; how the process operate.
- Concept of photo-systems
- Process of photophosphorylation both cyclic and non-cyclic process
- Path of carbon reduction in photosynthesis (C₃, C₄, CAM)
- Differences between C₃, C₄ and CAM cycle
- External and internal factors affecting photosynthesis
- Plant respiration- how the process operate and organelles involved -aerobic and anaerobic respiration
- How glucose breaks down into pyruvate
- How complete oxidation of pyruvate to carbon dioxide and water takes place (Kreb's cycle)
- How ATP is formed- process of oxidative phosphorylation.
- Nitrogen cycle – how it supply nitrogen source to soil -symbiotic and non-symbiotic nitrogen fixation.

UNIT IV: Biochemistry

On completion of the unit, students are able to understand:

- Biophysical: Chemical bonds, pH and Buffer.
- Structure, classification and function of biomolecules (carbohydrates, lipids, amino acids, proteins, nucleic acids and vitamins)
- Properties, nomenclature, mechanism of enzyme action and classification of enzyme as per ECIUB.
- Respiration: Glycolysis, Kreb's cycle, Electron transport system and energetic of respiration

UNIT V: Molecular Biology

On completion of the unit, students are able to understand:

- Gene organization of prokaryotes and eukaryotes

- Structure and physical properties of DNA and RNA
- Biosynthesis of nucleic acids - DNA replication, RNA synthesis
- Mechanism of protein synthesis

Semester-IV

Paper-404 (Cytogenetics, Biotechnology and Biometrics)

UNIT I: Cytology

On completion of the unit, students are able to understand:

- The general accounts of organization and function of cell and its components: cell wall, plasmalemma, endoplasmic reticulum, golgi apparatus, ribosomes, mitochondria, plastids and nucleus
- The structure and function of chromosome
- Mitosis and meiosis – their significance

UNIT II: Genetics

On completion of the unit, students are able to understand:

- Mendel's law of inheritance (law of segregation and independent assortment)
- Back cross and test cross
- Gene interaction
- Gene expression
- Structure of gene, Structure of t-RNA
- Transfer of genetic information (transcription, translation) in prokaryotes and eukaryotes
- Linkage and crossing over
- Mutation and mutagens
- Chromosome alterations, e.g., deletions, duplications, translocations, inversions
- Variations in chromosome number: aneuploidy, polyploidy
- Extra nuclear inheritance: sex chromosome and sex determination in plants

UNIT III: Plant Breeding

On completion of the unit, students are able to understand:

- Principles and objectives of plant breeding
- Breeding behaviour: sexual reproduction, asexual reproduction, apomixis
- Polyembryony: causes, classification and importance
- Breeding methods: conventional methods of breeding in self and cross pollinated crops
- Heterosis: causes, hypothesis and effect

UNIT IV: Biotechnology

On completion of the unit, students are able to understand:

- Basic aspects of plant tissue culture
- Cellular totipotency
- Differentiation and morphogenesis
- Genetic engineering in plant improvement
- Application of plant biotechnology in medicine, agriculture and human welfare

UNIT V: Biometry

On completion of the unit, students are able to understand:

- The scope and application of biostatistics
- About the collection of data, sample and sampling methods
- Calculate mean, mode, median and standard deviation
- Probability and Chi-square test

CSOs of B.Sc. Botany: B.Sc. Part III, Semester- V

Paper-505: (Microbial diversity, Plant pathology and Embryophyta)

UNIT I: Microbial Diversity

On completion of the unit, students are able to understand:

- Basic concepts of microbiology, history, classification system (five kingdom system of classification, Carl Woese's three domains of living organism)
- Various microbial forms – viruses (including prions and viroids), archaebacteria, bacteria, algae, fungi, protozoa and their characteristic features
- Microbiology of soil, air and water

UNIT II: Microbes and Human Welfare

On completion of the unit, students are able to understand:

- The role of microbes for the production of various kinds of industrial products like alcohol, antibiotics, organic acids, enzymes, proteins, vitamins, biofuel
- The role of microorganisms in agriculture
- Knowledge in relationship between food and microbes, techniques used in food processing
- The relationship between human disease and microorganisms, pathogenicity, laboratory diagnosis and treatment method

UNIT III: Plant Pathology

On completion of the unit, students are able to understand:

- The concept and history of pathology
- Koch's postulates of Host Pathogen interrelations
- Classification of plant diseases on the basis of causal organisms and symptoms
- The symptoms, disease cycles and control measures of the following diseases
 - Damping off of seedlings
 - Late blight of potato
 - White rust of crucifers
 - Powdery mildew of pea
 - Blast of rice
 - Stem rust of wheat
 - Leaf blight of paddy
 - Citrus canker
 - TMV

UNIT IV: Plant Disease Management

On completion of the unit, students are able to understand:

- The concept of plant quarantine
- Seed certification
- Cultural practices of disease management
- Fungicides classification based on chemical nature and mode of action
- Biological control
- Breeding for plant resistant varieties
- Genetically Modified plants (merits and demerits)
- Concept of Integrated Pest Disease Management

UNIT V: Bryology and Pteridology

On completion of the unit, students are able to understand:

- Evolutionary trend of bryophytes
- Ecological and economic importance of bryophytes
- Development of Bryology in India
- Origin and evolution of pteridophytes
- Relationship of pteridophytes with bryophytes and gymnosperms
- Heterospory
- Seed habit
- Stellar evolution in pteridophytes
- Ecological and economic importance of pteridophytes

Paper-506: (Advanced Plant Taxonomy, Anatomy, Embryology and Palynology)

UNIT I: Primitive Seed Plant and Palaeobotany

On completion of the unit, students are able to understand:

- Concept of progymnosperms
- Diversity among gymnosperms and their distribution in Indian sub-continent
- Origin and evolution of gymnosperms
- Salient features and life cycle of *Ginkgo*, *Taxus*, *Ephedra*
- Fossil Algae and Fungi
- Primitive land plants – *Rhynia*, *Lepidodendron*, *Calamites* and *Sphenophyllum*
- Fossil Gymnosperms – *Cycadofilicales*, *Bennettitales* and *Cordaitales*
- Fossil Angiosperms – *Palmoxylon*, *Enigmocarpon*, *Sahnianthus*
- Palaeobotany in the exploration of fossil fuels

UNIT II: Advanced Plant Taxonomy

On completion of the unit, students are able to understand:

- Objectives, principles and practices of plant taxonomy
- Methods and techniques of herbarium preparation
- Chemotaxonomy, cytotaxonomy, numerical taxonomy and molecular taxonomy
- Application of DNA hybridization technique in plant taxonomic studies
- The role of Botanical Survey of India and taxonomic literatures
- Classical system of classification: Bentham and Hooker
- Description, classification and economic importance of families – Magnoliaceae, Asteraceae, Rutaceae, Anacardaceae, Myrtaceae, Cucurbitaceae, Dipterocarpaceae,

Polygonaceae, Moraceae, Rubiaceae, Apocynaceae, Asclepiaceae, Acanthaceae, Verbenaceae, Arecaceae, Scitaminae, Orchidaceae, Cyperaceae

UNIT III: Plant Resources – Management and Utilization

On completion of the unit, students are able to understand:

- Classification of economic plants based on their uses
- Cyanobacteria: *Spirulina* – its importance
- Origin, cultivation and improvement of Maize, Mustard, Pea and Banana.
- History, cultivation and processing of Rubber.
- Characteristics and uses of timber yielding plants of *Dipterocarpus*, *Phoebe* and *Melanorrhoea*.
- Parts of plant used and alkaloid present in medicinal plants of *Ephedra*, *Carthamus*, *Aloe vera* and *Vinca*.
- Aims and objectives of Pharmacognosy.
- Importance of ethnobotany in gene pool and germplasm conservation.

UNIT IV: Anatomy of Angiosperm

On completion of the unit, students are able to understand:

- Apical meristem
 - Histological theories of shoot and root apices
- Primary shoots of Monocotyledons and Dicotyledons.
- Formation of internodes, branching pattern: monopodial and sympodial growth, root-stem transition.
- The structure and function of cambium:
 - Formation of secondary xylem, characteristics of growth ring, Sap wood and heart wood, secondary phloem.
- Stomata and their types.
- Both, theoretical and practical study of anomalous secondary growth in *Bauhinia*, *Bougainvillea* and *Nyctanthus*.

UNIT V: Plant Embryology and Palynology

On completion of the unit, students are able to understand:

- Microsporangium and types of pollen tetrad
- Megasporangium and types of gametogenesis
- Pre-fertilization and post fertilization process
- Types of ovules
- Development of female gametophyte
- Types of embryo sac
- Pollen-pistil interaction
- Compatibility and incompatibility
- Double fertilization and its significance
- Syngamy and triple fusion
- Development, structure and function of endosperm
- Types of haustoria
- Embryogeny types

- Development of monocot and dicot embryos
- Suspensor, synergid, Polyembryony
- Apomixis and their role
- Pollen production and dispersion in time and space
- Role of pollen in taxonomy
- Applications of palaeopalynology, melisso-palynology and forensic palaeopalynology

Semester – IV

Paper- 608: (Ecology, Plant Physiology and Molecular Biology)

UNIT I: Vegetation and Natural Resources

On completion of the unit, students are able to understand:

- The vegetation and floristic regions of India – evergreen deciduous, mangrove forest
- Natural forest resources, conservation, afforestation, social forestry, agroforestry, timber extraction; dams and their effects
- Mineral resources
- Water resources – floods, drought
- Energy resources – renewable and non-renewable resources

UNIT II: Ecosystems and Pollution

On completion of the unit, students are able to understand:

- Biotic and abiotic interactions in the environment
- Concept of habitat and niche
- Ecosystem: structure (basic component) and function (energy flow, trophic levels)
- Environmental pollution: major pollutants of air, water and solid and its control measures
- Environmental revolution: Climate change and global warming
- Concept of biodiversity

UNIT III: Plant Physiology

On completion of the unit, students are able to understand:

- Absorption of water and mineral elements
- Passive and active absorption
- Physiological role of micro and macro elements – their deficiency symptoms
- Phases of growth – growth curve
- Plant growth hormones – physiological functions of Auxin, Gibberellin, Cytokinin, Ethylene and Abscisic acid
- Senescence
- Photoperiodism
- Photomorphogenesis
- Phytochromes
- Photosynthesis
- Significance of light reactions
- Calvin cycle

- Photorespiration
- Laws of limiting factors
- Pentose phosphate pathway
- Biological nitrogen fixation mechanism
- Elementary knowledge of *Nif*, *Nod* and *Hup* genes
- Leghaemoglobin stress plant physiology (principles and application)

UNIT IV: Biochemistry

On completion of the unit, students are able to understand:

- Universal solvent, weak interaction in aqueous solution/
- Biophysical properties like pH, buffer, thermodynamics and colligative properties.
- Bioenergy, enzymes – kinetics and regulation, isozymes
- Respiration: glycolysis and fermentation, Krebs cycle and Electron Transport Chain.
- Biosynthesis of ATP, Nucleic acid and protein.

UNIT V: Molecular Biology

On completion of the unit, students are able to understand:

- Gene structure
- Expression and regulation of gene
- Gene organization in prokaryotes and eukaryotes
- Operon concept
- Gene regulation in prokaryotes and eukaryotes
- Positive and negative regulation of gene
- Interrupted gene in eukaryotes
- RNA splicing
- Restriction endonucleases in prokaryotes and eukaryotes
- Cloning vectors and its types
- Genomic and DNA library
- Various techniques of gene mapping and concept of DNA fingerprinting
- PCR – its working principle and applications
- DNA sequencing
- Composition of nucleic acids
- DNA structure, A, B and Z forms of DNA
- Denaturation and renaturation of DNA
- Chromatin structure
- DNA replication and recombination
- Different forms of RNA

Paper 609: (Cell Biology, Genetics, Plant Breeding, Biotechnology and Computer Application)

UNIT I: Cell Biology

On completion of the unit, students are able to understand:

- Historical background of cell, cell theory, kingdom-wise cell size and cell structure
- Comparative account of prokaryotic and eukaryotic cell

- Characteristics of archaeobacteria and mycoplasma
- Nucleus, ribosomes – nuclear envelope and nuclear pore complex, nuclear matrix and nucleoplasm
- Mitochondria and chloroplast – origin, structure and biogenesis
- DNA and histones, nucleosome and higher level of organization
- Centromere and telomere
- Organelle membrane and organization of macromolecular complexes
- Structure and function of golgi complex, endoplasmic reticulum, lysosomes, microbodies, peroxisome, glyoxysomes and cytoskeleton
- Cell membrane – origin, ultrastructure, chemical constituents
- Models of cell membrane organization
- Roles of various membrane proteins, lipids and carbohydrates
- Role of ion channels and pumps in cellular transport and signaling

UNIT II: Genetics

On completion of the unit, students are able to understand:

- Mendel's experiment and principles of inheritance; Back cross and test cross
- Gene interactions - Modified dihybrid ratios (complementary, supplementary, epistatic and duplicate factors)
- Multiple allelism: multiple alleles in Drosophila (eye colour), Man (blood groups), Plants (self-incompatibility)
- Quantitative traits and quantitative genetics
- The multiple factor hypotheses

UNIT III: Plant Breeding

On completion of the unit, students are able to understand:

- Types of plant reproduction: vegetative, sexual and apomixis, their effect on generating and fixing genotypic variation
- Methods of plant improvement: Pure line and Mass selection
- Hybridization in self and cross pollinated crops
- Plant introduction and acclimatization
- Hybrid vigour
- Mutation and polyploidy as methods of plant improvement

UNIT IV: Biotechnology

On completion of the unit, students are able to understand:

- History definition and scope of biotechnology
- Cellular differentiation and totipotency
- Organogenesis and embryogenesis
- Protoplasts isolation and culture
- Somatic hybridization
- Clonal propagation
- Genetic engineering of plants
- Vectors for gene delivery
- Selectable markers and reporter genes
- Methods of gene delivery

- Agrobacterium – the natural genetic engineer
- Salient achievements in crop biotechnology and its prospects

UNIT V: Computer Application and Bioinformatics

On completion of the unit,

- The students have cleared the concept of software and hardware pertaining to the syllabus.
- They can now utilize internet.
- They can understand the basic of biological database and can retrieve research papers from biological databases.
- They can understand the concept of biostatistical analysis using computer software and utilize Microsoft Excel for analyzing biological data.

BOT – 505 (G) (ELECTIVE) / BOTANY – V

(Microbiology, Plant Pathology, Archegoniate, Taxonomy, Developmental Biology and Plant Resources)

UNIT I: Microbiology and Plant Pathology:

On completion of the unit, students are able to understand:

- Basic concepts of microbiology, history, classification system (five kingdom system of classification, Carl Woese's three domains of living organism)
- Various microbial forms – viruses (including prions and viroids), archaebacteria, bacteria, algae, fungi, protozoa and their characteristic features
- Microbiology of soil, air and water
- The concept and history of pathology
- Koch's postulates of Host Pathogen interrelations
- Classification of plant diseases on the basis of causal organisms and symptoms
- The symptoms, disease cycles and control measures of the following diseases
 - Damping off of seedlings
 - Late blight of potato
 - White rust of crucifers
 - Powdery mildew of pea
 - Blast of rice
 - Stem rust of wheat
 - Leaf blight of paddy
 - Citrus canker
 - TMV

UNIT II: Archegoniate and Primitive seed plants:

On completion of the unit, students are able to understand:

- Evolutionary trend of bryophytes
- Ecological and economic importance of bryophytes
- Development of Bryology in India
- Origin and evolution of pteridophytes
- Relationship of pteridophytes with bryophytes and gymnosperms
- Heterospory
- Seed habit
- Stellar evolution in pteridophytes
- Ecological and economic importance of pteridophytes

UNIT III: Advanced Plant Taxonomy

On completion of the unit, students are able to understand:

- Objectives, principles and practices of plant taxonomy
- Methods and techniques of herbarium preparation
- Chemotaxonomy, cytotoxicology, numerical taxonomy and molecular taxonomy
- Application of DNA hybridization technique in plant taxonomic studies
- The role of Botanical Survey of India and taxonomic literatures
- Classical system of classification: Bentham and Hooker

- Description, classification and economic importance of families – Magnoliaceae, Asteraceae, Rutaceae, Anacardaceae, Myrtaceae, Cucurbitaceae, Dipterocarpaceae, Polygonaceae, Moraceae, Rubiaceae, Apocynaceae, Asclepiaceae, Acanthaceae, Verbenaceae, Areaceae, Scitaminae, Orchidaceae, Cyperaceae

UNIT IV: Developmental Biology:

On completion of the unit, students are able to understand:

- Apical meristem
 - Histological theories of shoot and root apices
- Primary shoots of Monocotyledons and Dicotyledons
- Formation of internodes, branching pattern: monopodial and sympodial growth, root-stem transition.
- The structure and function of cambium:
 - Formation of secondary xylem, characteristics of growth ring, Sap wood and heart wood, secondary phloem.
- Stomata and their types.
- Both, theoretical and practical study of anomalous secondary growth in *Bauhinia*, *Bougainvillea* and *Nyctanthus*.

UNIT V: Plant Resources:

On completion of the unit, students are able to understand:

- Classification of economic plants based on their uses
- Cyanobacteria: *Spirulina* – its importance
- Origin, cultivation and improvement of Maize, Mustard, Pea and Banana.
- History, cultivation and processing of Rubber.
- Characteristics and uses of timber yielding plants of *Dipterocarpus*, *Phoebe* and *Melanorrhoea*.
- Parts of plant used and alkaloid present in medicinal plants of *Ephedra*, *Carthamus*, *Aloe vera* and *Vinca*.
- Aims and objectives of Pharmacognosy.
- Importance of ethnobotany in gene pool and germplasm conservation.

BOT – 606 (G) (ELECTIVE) / BOTANY – VI

(Plant Physiology, Molecular Biology, Genetics, Plant Breeding, Ecology and Bioinformatics)

UNIT I: Plant Physiology and Biochemistry

On completion of the unit, students are able to understand:

- Absorption of water and mineral elements
- Passive and active absorption
- Physiological role of micro and macro elements – their deficiency symptoms
- Phases of growth – growth curve
- Plant growth hormones – physiological functions of Auxin, Gibberellin, Cytokinin, Ethylene and Abscisic acid

- Senescence
- Photoperiodism
- Photomorphogenesis
- Phytochromes
- Photosynthesis
- Significance of light reactions
- Calvin cycle
- Photorespiration
- Laws of limiting factors
- Pentose phosphate pathway
- Biological nitrogen fixation mechanism
- Elementary knowledge of *Nif*, *Nod* and *Hup* genes
- Leghaemoglobin stress plant physiology (principles and application)
- Universal solvent, weak interaction in aqueous solution/
- Biophysical properties like pH, buffer, thermodynamics and colligative properties.
- Bioenergy, enzymes – kinetics and regulation, isozymes
- Respiration: glycolysis and fermentation, Krebs cycle and Electron Transport Chain.
- Biosynthesis of ATP, Nucleic acid and protein.

UNIT II: Cell Biology and Molecular Biology.

On completion of the unit, students are able to understand:

- Historical background of cell, cell theory, kingdom-wise cell size and cell structure
- Comparative account of prokaryotic and eukaryotic cell
- Characteristics of archaebacteria and mycoplasma
- Nucleus, ribosomes – nuclear envelope and nuclear pore complex, nuclear matrix and nucleoplasm
- Mitochondria and chloroplast – origin, structure and biogenesis
- DNA and histones, nucleosome and higher level of organization
- Centromere and telomere
- Organelle membrane and organization of macromolecular complexes
- Structure and function of golgi complex, endoplasmic reticulum, lysosomes, microbodies, peroxisome, glyoxysomes and cytoskeleton
- Cell membrane – origin, ultrastructure, chemical constituents
- Models of cell membrane organization
- Roles of various membrane proteins, lipids and carbohydrates
- Role of ion channels and pumps in cellular transport and signaling

UNIT III: Genetics, Biotechnology and Plant Breeding.

On completion of the unit, students are able to understand:

- Mendel's experiment and principles of inheritance; Back cross and test cross
- Gene interactions - Modified dihybrid ratios (complementary, supplementary, epistatic and duplicate factors)
- Multiple allelism: multiple alleles in *Drosophila* (eye colour), Man (blood groups), Plants (self-incompatibility)
- Quantitative traits and quantitative genetics
- The multiple factor hypotheses

- History definition and scope of biotechnology
- Cellular differentiation and totipotency
- Organogenesis and embryogenesis
- Protoplasts isolation and culture
- Somatic hybridization
- Clonal propagation
- Genetic engineering of plants
- Vectors for gene delivery
- Selectable markers and reporter genes
- Methods of gene delivery
- Agrobacterium – the natural genetic engineer
- Salient achievements in crop biotechnology and its prospects
- Types of plant reproduction: vegetative, sexual and apomixis, their effect on generating and fixing genotypic variation
- Methods of plant improvement: Pure line and Mass selection
- Hybridization in self and cross pollinated crops
- Plant introduction and acclimatization
- Hybrid vigour
- Mutation and polyploidy as methods of plant improvement

UNIT IV: Ecology and Environment.

On completion of the unit, students are able to understand:

- Biotic and abiotic interactions in the environment
- Concept of habitat and niche
- Ecosystem: structure (basic component) and function (energy flow, trophic levels)
- Environmental pollution: major pollutants of air, water and solid and its control measures
- Environmental revolution: Climate change and global warming
- Concept of biodiversity

UNIT V: Computer Application and Bioinformatics

On completion of the unit,

- The students have cleared the concept of software and hardware pertaining to the syllabus.
- They can now utilize internet.
- They can understand the basic of biological database and can retrieve research papers from biological databases.
- They can understand the concept of biostatistical analysis using computer software and utilize Microsoft excel for analyzing biological data.