DEPARTMENT OF BOTANY
Programme Outcomes and Course Outcomes
(July'2019 – June'2025)

UNIVERSITY OF CALCUTTA

SYLLABUS FOR THREE-YEAR B.Sc. PROGRAMME IN BOTANY (GENERAL COURSE) UNDER CHOICE BASED CREDIT SYSTEM (CBCS):

SEMESTER I
CORE COURSE 1
PLANT DIVERSITY I (PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES AND ANATOMY) (BOT-G-CC-1-1-TH)
THEORETICAL (Credits 4, Lectures 60)

1. Introduction to different plant groups …….2 lectures
2. Phycology 2.1. Diagnostic characters and examples of Cyanophyceae, Rhodophyceae, Chlorophyceae, Charophyceae and Phaeophyceae, 2.2 Classification: Criteria and system of Fritsch, 2.3. Life histories of Chlamydomonas, Chara and Ectocarpus, 2.4. Role of algae in the environment, agriculture, biotechnology and industry. …….14 lectures
3. Mycology 3.1 Diagnostic characters and examples of Oomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina (Ainsworth, 1973). 3.2 Life histories of Rhizopus and Ascobolus, 3.3. Economic importance of fungi, 3.4 Fungal symbioses: Mycorrhiza, Lichen and their importance. …….12 lectures
4. Phytopathology 4.1 Symptoms - necrotic, hypoplastic and hyperplastic, 4.2 Koch's postulates, 4.3 Biotrophs and Necrotrophs, 4.4 Disease triangle, 4.5 Pathotoxins and phytoalexins (brief concept), 4.6 Symptoms, causal organism, disease cycle and control measures of plant diseases (Late blight

Programme Outcomes (POs)

1. **Develop fundamental knowledge** of plant sciences, including plant diversity, physiology, anatomy, taxonomy, and ecology.
2. **Enhance practical skills** in microscopy, staining, specimen identification, and field studies.
3. **Understand the ecological and economic importance** of different plant groups and their role in biotechnology, medicine, and industry.
4. **Encourage research aptitude** by integrating theoretical knowledge with laboratory and field-based investigations.
5. **Promote environmental awareness** by studying plant interactions, conservation strategies, and sustainable agricultural practices.

Course Outcomes (COs) for Theory (BOT-G-CC-1-1-TH)

After completing this course, students will be able to:

1. Introduction to Different Plant Groups

- Understand the classification, characteristics, and evolutionary significance of major plant groups.

2. Phycology (Algae)

- Identify and classify different algal groups (Cyanophyceae, Rhodophyceae, Chlorophyceae, Charophyceae, Phaeophyceae).

of potato, Brown spot of Rice, Stem rot of jute). …….10 lectures 5. Bryophytes 5.1 Unifying features of archaegoniates and transition to land habit, 5.2 Amphibian nature of bryophytes, 5.3 Diagnostic characters and examples of Hepaticopsida, Anthocerotopsida and Bryopsida (Proskauer 1957), 5.4 Life histories of Marchantia and Funaria, 5.5 Ecological and economic importance. …….10 lectures 6. Anatomy 6.1 Stomata - Types (Metcalfe & Chalk), 6.2 Anatomy of root, stem and leaf of monocots and dicots, 6.3 Stelar types and evolution, 6.4 Secondary growth – normal in dicot stem and anomaly in stem of Tecoma & Dracaena. …….12 lectures **<u>PRACTICAL- PLANT DIVERSITY I</u>** **(PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES AND ANATOMY) (BOT-G-CC-1-1-P)** **(Credits 2)** 1. Work out: Microscopic preparation, drawing and labeling of Chlamydomonas, Chara, Ectocarpus, Rhizopus and Ascobolus 2. Anatomical studies (following double staining method) of: 2a. Stem- Cucurbita, sunflower and maize. 2b. Root- Colocassia, gram and orchid. 2c. Leaf- Nerium 3. Identification with reasons: 3a. Cryptogamic specimens (macroscopic/microscopic as prescribed in the theoretical syllabus. 3b. Pathological specimens (herbarium sheets) of Late blight of potato, Brown spot of rice and stem rot of jute. 4. Laboratory records: Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination. Regular attendance in the class must be credited. 5. Atleast one local excursion to be conducted to give an idea of plant diversity, habitat of algae and fungi.	• Describe the life cycles of **Chlamydomonas, Chara, and Ectocarpus** and their reproductive strategies. • Evaluate the role of algae in **ecosystems, agriculture, biotechnology, and industry**. **3. Mycology (Fungi)** • Identify major fungal groups (Oomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina). • Explain the life cycles of **Rhizopus and Ascobolus** and their reproductive structures. • Discuss the **economic significance of fungi**, including their applications in food, medicine, and industry. • Understand **fungal symbioses (Mycorrhiza, Lichen)** and their ecological importance. **4. Phytopathology (Plant Pathology)** • Identify different **symptoms of plant diseases** (necrotic, hypoplastic, hyperplastic). • Explain **Koch's postulates** and differentiate between **biotrophs and necrotrophs**. • Analyze the **disease triangle** and understand the concept of **pathotoxins and phytoalexins**. • Describe the **symptoms, causal organisms, disease cycles, and control measures** of important plant diseases (Late blight of potato, Brown spot of rice, Stem rot of jute). **5. Bryophytes** • Explain the **archaegoniates' unifying features** and transition to a land habitat. • Discuss the **amphibian nature of bryophytes** and their ecological adaptations. • Identify different bryophyte groups (**Hepaticopsida, Anthocerotopsida, Bryopsida**) with examples.

	• Understand the **life histories of Marchantia and Funaria** and their reproductive strategies. • Evaluate the **ecological and economic significance of bryophytes**. **6. Anatomy** • Classify different **stomatal types** (Metcalfe & Chalk). • Describe the **internal structure of monocot and dicot roots, stems, and leaves** with reference to evolutionary adaptations. • Explain **types and evolution of stelar systems** in plants. • Analyze **secondary growth patterns** in dicot stems and anomalous secondary growth in **Tecoma and Dracaena**. **Course Outcomes (COs) for Practical (BOT-G-CC-1-1-P)** After completing the practical sessions, students will be able to: 1. **Microscopic Preparation and Identification:** o Prepare, observe, and label slides of **Chlamydomonas, Chara, Ectocarpus, Rhizopus, and Ascobolus**. 2. **Anatomical Studies (Double Staining Method):** o Study and compare **stem anatomy** of Cucurbita, Sunflower, and Maize. o Examine **root structures** of Colocasia, Gram, and Orchid. o Identify **leaf adaptations** in Nerium. 3. **Specimen Identification and Justification:** o Identify cryptogamic specimens (macroscopic/microscopic) based on theoretical knowledge.

	○ Analyze pathological specimens (herbarium sheets) of **Late blight of potato, Brown spot of rice, and Stem rot of jute**, explaining symptoms and disease cycles. 4. **Field-Based Learning and Record Keeping:** ○ Maintain laboratory records (notebooks, slide preparations) for practical examination. ○ Participate in **local excursions** to observe plant diversity, algal habitats, and fungal specimens in natural environments. **Conclusion:** This course provides **a strong foundation in plant diversity, anatomy, and plant pathology** while developing essential **laboratory, microscopy, and fieldwork skills**. By integrating theoretical and practical knowledge, students will be better prepared for **higher studies, research, and careers in botany, agriculture, and environmental sciences**.
SEMESTER II **CORE COURSE 2** **PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, MORPHOLOGY AND TAXONOMY) (BOT-G-CC-2-2-TH)** **THEORETICAL (Credits 4, Lectures 60)** 1. Pteridophytes 1.1 Diagnostic characters and examples of Psilophyta, Lycophyta, Sphenophyta & Filicophyta (Gifford & Foster 1989). 1.2 Life histories of Selaginella and Pteris, 1.3 Economic importance. …….12 lectures 2. Gymnosperms 2.1 Progymnosperms (brief idea), 2.2 Diagnostic characters and examples of Cycadophyta, Coniferophyta and	**Programme Outcomes (POs)** 1. **Develop a deep understanding** of plant evolution, morphology, taxonomy, and diversity. 2. **Enhance observational and analytical skills** for identifying and classifying different plant groups. 3. **Provide hands-on experience** in plant dissection, floral diagram preparation, and herbarium collection. 4. **Foster environmental awareness and conservation strategies** by

Gnetophyta (Gifford & Foster 1989), 2.3 Life histories of Cycas and Pinus, 2.4 Williamsonia (reconstructed), 2.5 Economic importance of Gymnosperms. …….12 lectures

3. Paleobotany & Palynology 3.1 Fossil, fossilization process and factors of fossilization, 3.2 Importance of fossil study. 3.3 Geological time scale, 3.4 Palynology - Definition, spore & pollen (brief idea), Applications. …….10 lectures

4. Angiosperm Morphology 4.1 Inflorescence types with examples, 4.2 Flower, 4.3 Fruits and seeds- type and examples. …….12 lectures

5. Taxonomy of Angiosperms 5.1 Artificial, Natural and Phylogenetic systems of classificaiton with one example each, 5.2 Diagnostic features of following families- Malvaceae, Leguminosae (Fabaceae), Cucurbitaceae, Rubiaceae, Compositae (Asteraceae), Solanaceae, Acanthaceae, Labiatae (Lamiaceae), Orchidaceae, Gramineae (Poaceae). …….14 lectures

PRACTICAL- PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, MORPHOLOGY AND TAXONOMY) (BOT-G-CC-2-2-P) (Credits 2)

1. Dissection, drawing and labelling, description of angiospermic plants and floral parts, floral formula and floral diagram, identification (family) from the following families: Leguminosae (Fabaceae), Malvaceae, Solanaceae, Labiatea (Lamiaceae), Acanthaceae.

2. Identification with reasons: Macroscopic specimens of Selaginella and Pteris, male and female strobilus of Cycas and Pinus, Anatomical slides (stellar types, transfusion tissue, sieve tube, sunken stomata, lenticels), inflorescence types.

3. Spot identification of the following Angiospermic plants (scientific names and families): Sida rhombifolia (Malvaceae), Abutilon indicum (Malvaceae), Cassia sophera (Fabaceae), Tephrosia halimtonii (Fabaceae), Crotolaria palida (Fabaceae), Coccinia grandis (Cucurbitaceae), Solanum indicum (Solanaceae), Nicotiana plumbagenifolia (Solanaceae), Leucas aspera (Lamiaceae),

studying plant fossils, gymnosperms, and angiosperms.

5. **Encourage research aptitude** in botany through fieldwork, laboratory techniques, and fossil analysis.

Course Outcomes (COs) for Theory (BOT-G-CC-2-2-TH)

After completing this course, students will be able to:

1. Pteridophytes

- Identify major pteridophyte groups (**Psilophyta, Lycophyta, Sphenophyta, Filicophyta**) and their diagnostic features.
- Explain the **life cycles of Selaginella and Pteris**, emphasizing reproduction and alternation of generations.
- Understand the **economic importance of pteridophytes**, including their medicinal and ecological roles.

2. Gymnosperms

- Understand the **evolutionary significance of Progymnosperms**.
- Identify **diagnostic characters** of major gymnosperm groups (**Cycadophyta, Coniferophyta, Gnetophyta**).
- Describe the **life cycles of Cycas and Pinus**, focusing on reproductive adaptations.
- Analyze the **reconstructed structure of Williamsonia**.
- Discuss the **economic importance of gymnosperms**, including their use in timber, medicine, and industry.

3. Palaeobotany & Palynology

- Define **fossils**, explain **fossilization processes**, and list factors influencing fossil preservation.
- Understand the **importance of fossil studies** in evolutionary research.

Leonurus sibiricus (Lamiaceae), Parthenium hysterophorus (Asteraceae), Tridax procumbense (Asteraceae), Eclipta prostrate (Asteraceae), Eragrostis tenella (Poaceae), Chrysopogon aciculantus (Poaceae), Eleusine indica (Poaceae), Vanda taesellata (Orchidaceae). 4. Laboratory records: Laboratory note books (regularly signed) and slides (prepared in class) are to e submitted at the time of Practical Examination. Regular attendance in the class must be credited. 5. Field excursion: Local Excursions (at least two including one to Acharya Jagadish Chandra Bose Botanic Garden, Shibpur, Howrah) 6. Field Records: Field note book and 15 herbarium sheets of common Angiospermic weeds are to be prepared and submitted at the time of Practical Examination. Regular attendance in the class must be credited.	• Interpret the **geological time scale** and its significance in plant evolution. • Explain **palynology**, focusing on **spore and pollen studies** and their applications in forensic science, climate studies, and plant breeding. **4. Angiosperm Morphology** • Classify and describe different **types of inflorescence** with examples. • Understand the structure and function of **flowers, fruits, and seeds** in angiosperms. • Identify different **fruit and seed types** based on their development and adaptations. **5. Taxonomy of Angiosperms** • Compare and contrast **Artificial, Natural, and Phylogenetic classification systems**, with examples. • Recognize the **diagnostic features of major angiosperm families**, including: o **Malvaceae** (Hibiscus family) o **Fabaceae (Leguminosae)** (Bean/Pea family) o **Cucurbitaceae** (Gourd family) o **Rubiaceae** (Coffee family) o **Asteraceae (Compositae)** (Sunflower family) o **Solanaceae** (Nightshade family) o **Acanthaceae** (Acanthus family) o **Lamiaceae (Labiatae)** (Mint family) o **Orchidaceae** (Orchid family) o **Poaceae (Gramineae)** (Grass family) **Course Outcomes (COs) for Practical (BOT-G-CC-2-2-P)**

	After completing the practical sessions, students will be able to: 1. **Angiosperm Dissection & Identification:** o Perform **dissection, drawing, and labelling** of floral parts and prepare **floral formulas and diagrams**. o Identify and classify plant families **(Leguminosae, Malvaceae, Solanaceae, Lamiaceae, Acanthaceae)** based on floral characteristics. 2. **Specimen Identification with Justification:** o Identify **macroscopic specimens of Selaginella and Pteris** based on morphological and anatomical features. o Examine **male and female strobilus of Cycas and Pinus** to understand gymnosperm reproduction. o Analyze anatomical slides to study **stellar types, transfusion tissue, sieve tubes, sunken stomata, and lenticels**. o Identify different **types of inflorescence** through specimens. 3. **Spot Identification of Angiospermic Plants:** o Identify and classify plants using **scientific names and family characteristics**: o **Malvaceae**: *Sida rhombifolia, Abutilon indicum* o **Fabaceae**: *Cassia sophera, Tephrosia hamiltonii, Crotalaria palida* o **Cucurbitaceae**: *Coccinia grandis* o **Solanaceae**: *Solanum indicum, Nicotiana plumbagenifolia* o **Lamiaceae**: *Leucas aspera, Leonurus sibiricus*

	○ **Asteraceae**: *Parthenium hysterophorus, Tridax procumbens, Eclipta prostrata* ○ **Poaceae**: *Eragrostis tenella, Chrysopogon aciculatus, Eleusine indica* ○ **Orchidaceae**: *Vanda tessellata* 4. **Field-Based Learning & Laboratory Work:** ○ Maintain **laboratory notebooks** with regularly signed records of practical work. ○ Submit **slides prepared in class** during the practical examination. 5. **Excursions & Field Studies:** ○ Participate in **at least two local excursions**, including one to the **Acharya Jagadish Chandra Bose Botanic Garden (Shibpur, Howrah)**. ○ Maintain **field records** and prepare **15 herbarium sheets** of common angiospermic weeds for submission. --- **Conclusion:** This course provides **comprehensive knowledge of plant diversity, evolution, morphology, and taxonomy** while developing **critical skills in plant identification, fieldwork, and laboratory techniques**. By integrating theoretical and practical learning, students will be well-equipped for **higher studies, research, and careers in botany, taxonomy, and conservation biology**.
<u>SEMESTER III</u> <u>CORE COURSE 3</u> CELL BIOLOGY, GENETICS AND MICROBIOLOGY (BOT-G-CC-3-3-TH) THEORETICAL (Credits 4, Lectures 60)	**Programme Outcomes (POs)** 1. **Develop a comprehensive understanding** of the cellular and genetic basis of life.

1. Cell Biology and Genetics 1.1 Ultrastructure of nuclear envelope, nucleolus and their functions, 1.2 Molecular organisation of metaphase chromosome (Nucleosome concept). 7 …….6 lectures
2. Chromosomal aberrations- 2.1 deletion, duplication, inversion & translocation, 2.2 Aneuploidy & Polyploidy-types, importance and role in evolution. …….6 lectures
3. Central Dogma, 3.1 Transcription and Translation. …….10 lectures
4. Genetic Code- properties. …….4 lectures
5. Linkage group and Genetic map (three-point test cross). …….6 lectures
6. Mutation – 6.1 Point mutation (tautomerisation; transition, transversion and frame shift), 6.2 Mutagen-physical and chemical. …….8 lectures
7. Brief concept of Split gene, Transposons. …….4 lectures
2. Microbes 2.1 Viruses- Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; 2.2 Bacteria- discovery, general characteristics and cell structure; reproduction- vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance. ……. 16 lectures

PRACTICAL- CELL BIOLOGY, GENETICS AND MICROBIOLOGY
(BOT-G-CC-3-3-P) (Credits 2)

1. Cell Biology: Staining (Aceto-orcein) and squash preparation of onion root tip: study of mitotic stages. Determination of mitotic index (from onion root tip).
2. Microbiology: Workout gram staining (curd/any natural source)
3. Identification with reasons: Cytological slides of different mitotic and meiotic stages. Different forms of bacteria (Coccus, Bacillus, Spiral)
4. Laboratory Records: Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination. Regular attendance in the class must be credited.

2. **Enhance analytical skills** for studying chromosome structure, gene expression, and genetic mutations.
3. **Provide practical exposure** to cell biology and microbiological techniques such as staining, squash preparation, and bacterial identification.
4. **Encourage research skills** in genetics and molecular biology through experimental approaches.
5. **Apply microbiological knowledge** in understanding the role of viruses and bacteria in health, industry, and the environment.

Course Outcomes (COs) for Theory (BOT-G-CC-3-3-TH)

After completing this course, students will be able to:

1. Cell Biology and Genetics
- Explain the **ultrastructure of the nuclear envelope and nucleolus** and their functions.
- Describe the **molecular organization of metaphase chromosomes**, including the **nucleosome concept**.

2. Chromosomal Aberrations
- Differentiate between **deletion, duplication, inversion, and translocation** in chromosome structure.
- Understand **aneuploidy and polyploidy**, their types, and their significance in evolution.

3. Central Dogma
- Explain the **mechanism of transcription and translation** in gene expression.
- Discuss the significance of the **central dogma of molecular biology**.

4. Genetic Code
- Define the **genetic code** and describe its **properties**

	(universality, redundancy, specificity, etc.). **5. Linkage and Genetic Mapping** • Understand the concept of **linkage groups** and construct a **genetic map** using a three-point test cross. **6. Mutation and Mutagenesis** • Explain **point mutations**, including **tautomerization, transition, transversion, and frame-shift mutations**. • Differentiate between **physical and chemical mutagens** and their effects on genetic material. **7. Advanced Genetic Concepts** • Explain the **concept of split genes** and their significance. • Understand the **role of transposons (jumping genes)** in genome evolution. **8. Microbiology** • Discuss the **discovery, structure, and replication** of viruses. • Explain the **lytic and lysogenic cycles** of **DNA viruses (T-phage)** and RNA viruses (**TMV**). • Describe the **general characteristics and structure of bacteria**. • Explain different bacterial **reproduction methods** (vegetative, asexual, and recombination via conjugation, transformation, and transduction). • Assess the **economic importance of viruses and bacteria** in agriculture, medicine, and industry. --- **Course Outcomes (COs) for Practical (BOT-G-CC-3-3-P)** After completing the practical sessions, students will be able to: **1. Cell Biology** • Perform **staining (Aceto-orcein method)** and squash preparation of **onion root tip cells** to study mitotic stages.

	• Identify different **mitotic stages (prophase, metaphase, anaphase, telophase)**. • Calculate the **mitotic index** in onion root tip cells. **2. Microbiology** • Perform **Gram staining** using natural sources (curd or other bacterial cultures). • Identify different **forms of bacteria** based on morphology (**Coccus, Bacillus, Spiral**). **3. Cytological Slide Identification** • Identify and describe **different stages of mitosis and meiosis** through prepared slides. **4. Laboratory Work & Records** • Maintain a **regularly updated laboratory notebook** with properly recorded experiments and observations. • Submit **slides prepared in class** during the practical examination. • Demonstrate **regular attendance and participation** in laboratory sessions. **Conclusion:** This course provides students with a **strong foundation in cell biology, genetics, and microbiology**, equipping them with both **theoretical knowledge and practical skills**. By integrating laboratory techniques with conceptual understanding, students will be prepared for **advanced studies and careers in biotechnology, genetics, microbiology, and molecular biology**.
SEMESTER IV **CORE COURSE 4** **PLANT PHYSIOLOGY AND METABOLISM (BOT-G-CC-4-4-TH)** **THEORETICAL (Credits 4, Lectures 60)** 1. Proteins 1.1 Primary, secondary and tertiary structure, 1.2 Nucleic acid- DNA structure, RNA types, 1.3 Enzyme- Classifications with	**Programme Outcomes (POs)** 1. **Develop an understanding** of the physiological and biochemical processes in plants. 2. **Explore the mechanisms** behind plant growth, metabolism, and energy production.

examples (IUBMB), Mechanism of action. …….8 lectures
2. Transport in plants 2.1 Ascent of sap and Xylem cavitation, 2.2 Phloem transport and source-sink relation. …….4 lectures
3. Transpiration 3.1 Mechanism of stomatal movement, significance. …….4 lectures
4. Photosynthesis 4.1 Pigments, Action spectra and Enhancement effect, 4.2 Electron transport system and Photophosphorylation, 4.3 C3 and C4 photosynthesis, CAM- Reaction and Significance. …….12 lectures
5. Respiration 5.1 Glycolysis & Krebs cycle—Reactions and Significance, 5.2 ETS and oxidative phosphorylation. …….8 lectures
6. Nitrogen metabolism 6.1 Biological dinitrogen fixation, 6.2 Amino acid synthesis (reductive amination and transamination). …….6 lectures
7. Plant Growth regulators 7.1 Physiological roles of Auxin, Gibberellin, Cytokinin, Ethylene, ABA. …….10 lectures
8. Photoperiodism (Plant types, Role of phytochrome and GA in flowering) and Vernalization. …….6 lectures
9. Senescence (brief idea). …….2 lectures

PRACTICAL- PLANT PHYSIOLOGY AND METABOLISM
(BOT-G-CC-4-4-P) (Credits 2)

Plant Physiology:
i) Experiment on Plasmolysis.
ii) Measurement of leaf area (graphical method) and determination of transpiration rate per unit area by weighing method.
iii) Imbibition of water by dry seeds - proteinaceous and fatty seeds.
iv) Evolution of O_2 during photosynthesis (using graduated tube).
v) Evolution of CO_2 during aerobic respiration and measurement of volume.

3. **Understand plant-environment interactions**, including water transport, photosynthesis, and respiration.
4. **Enhance practical skills** through laboratory experiments related to plant functions.
5. **Encourage analytical thinking** in understanding plant metabolism and regulatory mechanisms.

Course Outcomes (COs) for Theory (BOT-G-CC-4-4-TH)

After completing this course, students will be able to:

1. Proteins and Nucleic Acids
- Explain the **primary, secondary, and tertiary structures of proteins** and their functions.
- Understand the **structure of DNA and different types of RNA**.
- Classify enzymes based on **IUBMB nomenclature** and describe their **mechanism of action**.

2. Transport in Plants
- Describe the **ascent of sap** and the process of **xylem cavitation**.
- Explain **phloem transport** and the **source-sink relationship**.

3. Transpiration
- Understand the **mechanism of stomatal movement** and its **significance** in plant physiology.

4. Photosynthesis
- Identify the **pigments** involved in photosynthesis and explain the **action spectrum** and **Emerson enhancement effect**.
- Describe the **electron transport system (ETS) and photophosphorylation mechanisms**.
- Compare **C3, C4, and CAM pathways**, highlighting their **reactions and significance**.

5. Respiration
- Explain the **biochemical pathways of glycolysis and the**

	Krebs cycle along with their significance. • Describe **oxidative phosphorylation and ETS in aerobic respiration**. **6. Nitrogen Metabolism** • Explain the process of **biological nitrogen fixation** and the role of nitrogenase enzymes. • Describe **amino acid synthesis**, including **reductive amination and transamination**. **7. Plant Growth Regulators** • Discuss the **physiological roles of Auxin, Gibberellin, Cytokinin, Ethylene, and Abscisic Acid (ABA)** in plant growth and development. **8. Photoperiodism and Vernalization** • Explain **different plant types based on photoperiodism** and the **role of phytochrome and gibberellins in flowering**. • Describe **vernalization and its significance** in plant growth. **9. Senescence** • Gain a **brief understanding of senescence** and its role in plant life cycles. **Course Outcomes (COs) for Practical (BOT-G-CC-4-4-P)** After completing the practical sessions, students will be able to: **1. Plant Physiology Experiments** • **Perform plasmolysis experiments** to observe the effects of osmosis on plant cells. • **Measure leaf area** using the **graphical method** and determine the **transpiration rate per unit area** by the **weighing method**. • **Study imbibition** in proteinaceous and fatty seeds to understand **water absorption properties**. • **Demonstrate oxygen evolution** during **photosynthesis** using a graduated tube.

	• **Measure CO_2 evolution** during **aerobic respiration** and determine its volume. **2. Laboratory Work & Records** • Maintain **properly documented laboratory records**, including **observations and results**. • Regularly submit **class-prepared slides and experimental reports**. • Attend **practical sessions regularly** and actively participate in experimental work. **Conclusion:** This course helps students **develop a deeper understanding** of plant physiological processes, including **photosynthesis, respiration, nitrogen metabolism, and growth regulation**. By integrating **theory with hands-on experiments**, students gain **practical skills** essential for **further studies and careers in plant sciences, biotechnology, and agricultural research**.
SEMESTER V **DSE A (Group A)** **PHYTOCHEMISTRY AND MEDICINAL BOTANY (BOT-G-DSE-A-5-1-TH)** **THEORETICAL (Credit 4, Lectures 60)** 1. Medicinal botany- History, scope and importance of medicinal plants, a brief idea about indigenous medicinal sciences- Ayurbeda, Siddha and Unani. Polyherbal formulations. …….14 lectures 2. Phramacognosy- 2.1 Scope and its importance, 2.2 Primary metabolites, 2.3 Secondary metabolites- alkaloids, terpenoids, phenolics and their functions. …….10 lectures 3. Organoleptic evaluation of crude drugs. …….10 lectures 4. Pharmcologically active constituents: Source plants (one example), parts used and uses of: 4.1 Steroids (Diosgenin, Digitoxin), 4.2 Tannin (Catechin), 4.3 Resins (Gingerol, Curcumnoids), 4.4 Alkaloids (Strychnine, Reserpine, Vinblastine), 4.5 Phenols (Capsaicin). …….6 lectures	**Programme Outcomes (POs)** 1. **Develop an understanding** of the history, scope, and importance of medicinal plants. 2. **Introduce students** to pharmacognosy, plant-based bioactive compounds, and their medicinal significance. 3. **Explore ethnobotanical knowledge** and its applications in modern medicine. 4. **Enhance practical skills** related to phytochemical analysis and medicinal plant identification. 5. **Foster research interest** in herbal medicine, natural drug discovery, and alternative therapies. **Course Outcomes (COs) for Theory (BOT-G-DSE-A-5-1-TH)**

5. Ethnobotany and folk medicine: 5.1 Brief idea, 5.2 Applications of ethnobotany, 5.3 Application of natural product to certain diseases- Jaundice, Cardiac and Diabetics. …….20 lectures **PRACTICAL- PHYTOCHEMISTRY AND MEDICINAL BOTANY** **(BOT-G-DSE-A-5-1-P) (Credit 2)** 1. Preparations of solution and buffers 2. Acquaintance with laboratory instruments- Autoclave, Incubator, Clinical centrifuge, Analytical balance, pH meter, Colorimeter, Water bath, Distillation plant, Laminar air flow. 3. Qualitative test for proteins and carbohydrates, reducing and non-reducing sugar (glucose, fructose and sucrose) 4. Tests (chemical) for tannin and alkaloid 5. Identification of medicinal plants (list to be provided) 6. Field study (local) and listing of medicinal plants. Records to be substantiated with photographs and description.	After completing this course, students will be able to: **1. Medicinal Botany** • Understand the **history, scope, and importance** of medicinal plants. • Gain a **brief idea** about **Ayurveda, Siddha, and Unani** systems of medicine. • Learn about **polyherbal formulations** and their significance in traditional medicine. **2. Pharmacognosy** • Define **pharmacognosy** and explain its **scope and importance**. • Differentiate between **primary and secondary metabolites** in plants. • Describe the functions and significance of **secondary metabolites** such as **alkaloids, terpenoids, and phenolics**. **3. Organoleptic Evaluation of Crude Drugs** • Learn **methods of crude drug evaluation** based on sensory characteristics. • Understand the **importance of organoleptic properties** in drug standardization. **4. Pharmacologically Active Constituents** • Identify **source plants, parts used, and medicinal applications** of: o **Steroids** (Diosgenin, Digitoxin) o **Tannins** (Catechin) o **Resins** (Gingerol, Curcuminoids) o **Alkaloids** (Strychnine, Reserpine, Vinblastine) o **Phenols** (Capsaicin) **5. Ethnobotany and Folk Medicine** • Gain a **brief understanding of ethnobotany** and its applications. • Explore the **therapeutic potential** of medicinal plants in treating

	diseases such as **jaundice, cardiac disorders, and diabetes**. • Learn the **importance of traditional knowledge** in drug development. **Course Outcomes (COs) for Practical (BOT-G-DSE-A-5-1-P)** After completing the practical sessions, students will be able to: **1. Preparation of Solutions and Buffers** • Learn to **prepare and standardize solutions** for phytochemical experiments. **2. Acquaintance with Laboratory Instruments** • Understand the **working principles** of essential laboratory equipment, including: o **Autoclave, Incubator, Clinical Centrifuge** o **Analytical Balance, pH Meter, Colorimeter** o **Water Bath, Distillation Plant, Laminar Air Flow** **3. Qualitative Tests for Biomolecules** • Perform **qualitative tests for proteins and carbohydrates**. • Differentiate between **reducing and non-reducing sugars** (glucose, fructose, sucrose). **4. Phytochemical Analysis** • Conduct **chemical tests for tannins and alkaloids** to determine their presence in plant extracts. **5. Identification of Medicinal Plants** • Identify **medicinal plants** based on key characteristics (list provided during the course). **6. Field Study and Documentation** • Conduct a **field survey of local medicinal plants** and document findings. • Maintain **detailed field records** with **photographs and descriptions**. **Conclusion:**

	This course provides a **strong foundation in medicinal botany and phytochemistry**, equipping students with both **theoretical knowledge and practical skills** in plant-based medicine. The study of **bioactive compounds, ethnobotanical applications, and crude drug evaluation** opens opportunities for careers in **phytopharmaceuticals, research, and herbal industries**.
SEMESTER V **BIOFERTILIZERS** **(BOT-G-SEC-A-3/5-2) (Credits 2, Lectures 30)** 1. Biofertilizers: General account about microbes used as biofertilisers; Rhizobiumidentification, mass multiplication. Actinorrhizal symbiosis. …….4 lectures 2. Azospirillum- identification, mass multiplication, associative effect of different microorganisms. Azotobacter and crop response to Azotobacter inoculums. …….6 lectures 3. Cyanobacteria, Azolla, Anabaena and Azolla association, blue green algae and Azolla in rice cultivation. …….6 lectures 4. Mycorrhizal association: 4.1 Types of Mycorrhizal association- Brief idea, 4.2 Its influence on growth and yield of crop plants. 10 …….6 lectures 5. Organic farming: 5.1 Green manuring and organic fertilizers, 5.2 Biocompost and vermicompost- making methods and field applications. 5.3 Recycling of biodegradable municipal, industrial and agricultural wastes.	**Programme Outcomes (POs):** 1. **Introduce students to biofertilizers** as an eco-friendly and sustainable alternative to chemical fertilizers. 2. **Develop an understanding** of microbial inoculants, their mass multiplication, and their role in enhancing soil fertility. 3. **Explore different types of biofertilizers** such as nitrogen-fixing bacteria, cyanobacteria, and mycorrhizal fungi. 4. **Promote knowledge of organic farming** and the use of composting techniques for soil health improvement. 5. **Encourage sustainable agricultural practices** through recycling biodegradable waste and using organic amendments. --- **Course Outcomes (COs) for Theory (BOT-G-SEC-A-3/5-2-TH)** After completing this course, students will be able to: **1. Introduction to Biofertilizers** • Define **biofertilizers** and explain their **role in sustainable agriculture**. • Identify **microorganisms used in biofertilizer production**. • Understand the **process of Rhizobium identification and mass multiplication**.

	• Explain the concept of **Actinorrhizal symbiosis** and its significance. **2. Azospirillum and Azotobacter** • Identify **Azospirillum** and describe its **associative effect with other microorganisms**. • Explain the **mass multiplication of Azospirillum** for agricultural application. • Understand the **role of Azotobacter in crop improvement** and its effects on plant growth. **3. Cyanobacteria and Azolla in Agriculture** • Describe the **role of cyanobacteria in nitrogen fixation**. • Explain the **symbiotic relationship between Anabaena and Azolla** and their application in **rice cultivation**. • Discuss the **importance of blue-green algae (BGA) as biofertilizers**. **4. Mycorrhizal Associations and Crop Yield** • Understand the **different types of mycorrhizal associations** and their classification. • Explain how **mycorrhizae influence plant growth and crop productivity**. • Discuss the **significance of mycorrhizal fungi in nutrient absorption and plant stress tolerance**. **5. Organic Farming and Composting Techniques** • Learn the **concept of green manuring and organic fertilizers**. • Understand the **methods of biocompost and vermicompost production**. • Explain the **field applications of composting for sustainable agriculture**.

	• Explore the **recycling of municipal, industrial, and agricultural biodegradable waste** for organic farming. **Conclusion:** This course equips students with **practical knowledge of biofertilizers and organic farming**, promoting **eco-friendly and sustainable agricultural practices**. It helps in developing skills that can be applied in **agriculture, agribusiness, waste management, and environmental conservation**.
SEMESTER VI **DSE B ECONOMIC BOTANY** **(BOT-G-DSE-B-6-3-TH) THEORETICAL** **(Credits 4, Lectures 60)** 1. Origin of cultivated plants: 1.1 Concepts of centres of origin and their importance with reference to Vavilov's work. …….12 lectures 2. Rice- origin, morphology and uses. …….12 lectures 3. Legumes: General account with special reference to Vigna. ……..8 lectures 4. Beverages: Tea- morphology, processing and uses. …….12 lectures 5. Study of the following economically important plants (Scientific names, families, parts used and importance): 5.1 Cereals- Rice, wheat, 5.2 Pulses- Mong, gram, 5.3 SpicesGinger, cumin, 5.4 Beverages- Tea, coffee, 5.5 Medicinal plants- Cinchona, neem, Ipecac, Vasaka, 5.6 Oil yielding plants- Mustard, groundnut, coconut, 5.7 Vegetables- Potato, raddish, bottle groud, cabbage, 5.8 Fibre yielding plants- Cotton, jute, 5.9 Timber yielding plants- Teak, Sal 5.10 Fruits- Mango, apple, 5.11 Sugar yielding plant- Sugarcane. …….16 lectures **PRACTICAL- ECONOMIC BOTANY** **(BOT-G-DSE-B-6-3-P) (Credits 2)** 1. Study of economically important plants (rice/jute/ tea) through herbarium specimens and field study.	**Programme Outcomes (POs):** 1. **Introduce students to the economic significance of plants** in various industries. 2. **Explain the origin and domestication of cultivated plants**, emphasizing Vavilov's concept of crop origins. 3. **Enhance understanding of key food crops, pulses, beverages, and medicinal plants**, along with their morphology and uses. 4. **Explore the economic importance of cereals, pulses, spices, oil-yielding plants, and timber species**. 5. **Develop practical knowledge through fieldwork and reports on local economically important plants**. **Course Outcomes (COs) for Theory (BOT-G-DSE-B-6-3-TH)** After completing this course, students will be able to: **1. Origin of Cultivated Plants** • Understand the **concept of centres of origin** and their significance in crop domestication.

2. Study of cultivation practices in field and submission of report. 3. Study of local economically important plants and submission of report with photographs.	• Explain **Vavilov's work on the origin of cultivated plants** and its relevance in plant breeding. **2. Rice** • Describe the **origin, morphology, and economic uses of rice**. • Understand **rice cultivation practices and its global importance as a staple food**. **3. Legumes** • Explain the **importance of legumes in agriculture and human nutrition**. • Describe the **morphology and economic significance of Vigna species**. **4. Beverages** • Understand the **morphology, processing, and uses of tea**. • Discuss the **economic and cultural importance of beverages**. **5. Study of Economically Important Plants** Students will learn about: • **Cereals:** Rice, wheat – their **botanical aspects, uses, and economic value**. • **Pulses:** Mung, gram – their **nutritional significance and agricultural importance**. • **Spices:** Ginger, cumin – their **culinary and medicinal uses**. • **Beverages:** Tea, coffee – their **processing and economic role**. • **Medicinal Plants:** Cinchona, neem, Ipecac, Vasaka – their **therapeutic properties and applications**. • **Oil-Yielding Plants:** Mustard, groundnut, coconut – their **uses in food and industry**. • **Vegetables:** Potato, radish, bottle gourd, cabbage – their **nutritional and economic importance**. • **Fibre-Yielding Plants:** Cotton, jute – their **industrial and textile applications**.

	• **Timber-Yielding Plants:** Teak, Sal – their **role in construction and furniture**. • **Fruits:** Mango, apple – their **horticultural significance and economic value**. • **Sugar-Yielding Plant:** Sugarcane – its **processing and role in the sugar industry**. **Course Outcomes (COs) for Practical (BOT-G-DSE-B-6-3-P)** After completing the practical component, students will: 1. **Analyze economically important plants** (e.g., rice, jute, tea) through **herbarium specimens and field study**. 2. **Understand cultivation practices in the field** and prepare a **detailed report**. 3. **Identify local economically important plants** and submit a **field study report with photographs**. **Conclusion:** This course **provides comprehensive knowledge of economically important plants** and their role in **food security, medicine, industry, and trade**. It enhances **practical skills in plant identification, field research, and economic analysis**, preparing students for **careers in agriculture, forestry, and herbal medicine industries**.
SEMESTER VI **SEC B PLANT BIOTECHNOLOGY** **(BOT-G-SEC-B-4/6-3) (Credits 2, Lectures 30)** 1. Plant tissue culture- 1.1 Introduction and basic concepts, 1.2 Cellular potency, 1.3 Callus culture and plant regeneration. …….4 lectures 2. Micropropagation- 2.1 Somatic embryogenesis and artificial seed. …….4 lectures	**Programme Outcomes (POs):** 1. **Introduce students to modern biotechnological techniques** and their applications in plant sciences. 2. **Develop an understanding of plant tissue culture techniques** for micropropagation and genetic modification.

3. Protoplast culture and its application. …….6 lectures 4. Recombinant DNA technology- 4.1 Recombinant DNA, 4.2 Restriction enzymes, 4.3 Plasmids as vectors. …….8 lectures 5. Gene cloning (basic steps). …….4 lectures 6. Achievements in crop biotechnology- 6.1 Pest resistant plant (Bt cotton), 6.2 Transgenic crops with improved quality (flavr tomato and golden rice).	3. **Explain the fundamentals of recombinant DNA technology** and its role in genetic engineering. 4. **Provide insight into gene cloning techniques** and their application in crop improvement. 5. **Explore the significance of transgenic crops** and their contributions to agriculture and food security. **Course Outcomes (COs) for Theory (BOT-G-SEC-B-4/6-3-TH)** After completing this course, students will be able to: **1. Plant Tissue Culture** • Understand the **basic principles of plant tissue culture** and its applications. • Explain the **concept of cellular potency** and its significance in plant biotechnology. • Describe **callus culture and plant regeneration techniques**. **2. Micropropagation** • Learn about **somatic embryogenesis** and its role in plant propagation. • Understand the concept of **artificial seed production** and its potential applications. **3. Protoplast Culture and Its Applications** • Explain the **methods of protoplast isolation and culture**. • Discuss the **applications of protoplast culture in plant breeding and genetic engineering**. **4. Recombinant DNA Technology** • Understand the **structure and significance of recombinant DNA**. • Learn about **restriction enzymes and their role in DNA manipulation**. • Explain the **use of plasmids as vectors in genetic engineering**. **5. Gene Cloning**

	• Understand the **basic steps involved in gene cloning**. • Describe the **techniques used to insert foreign DNA into host cells**. **6. Achievements in Crop Biotechnology** • Explain the **development of pest-resistant plants like Bt cotton**. • Discuss the **importance of transgenic crops with improved quality**, such as **Flavr Savr tomato and Golden Rice**. --- **Conclusion:** This course provides students with **fundamental knowledge of plant biotechnology** and its applications in **agriculture, genetic engineering, and crop improvement**. It equips them with **practical skills for careers in biotechnology, research, and agribusiness**.

UNIVERSITY OF CALCUTTA

Course Structure- 3yr MDC (NEP 2020) BOTANY SYLLABUS

Semester I **Core PLANT DIVERSITY (THEORY)** **BOT-MD-CC1-1-Th Total marks 75;** **Credits 3, Class 45 hours**	**Programme Outcomes (POs):**

1. Introduction to plant kingdom. 1.1 Origin of life and evolution of plant cells, 1.2 Importance of plants as source of food, fuel and their role in ecosystem services (as carbon sink, sequestering etc.) (3 lectures) 2. Algae 2.1. Salient features of Cyanophyceae, Chlorophyceae, Charophyceae, Phaeophyceae, Rhodophyceae and Bacillariophyceae 2.2 Criteria and system of classification (Fritsch, 1935) 2.3. Economic importance of algae in environment, agriculture, biotechnology and industry. (6 lectures) 3. Fungi 3.1 Salient features of Myxomycota, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina. 3.2 System of classification up to Sub-division (Ainsworth, 1973), 3.3 Economic importance of fungi (food, medicine and agriculture), 3.4 Fungal symbioses: Mycorrhiza, Lichen and their importance. (6 lectures) 4. Bryophytes 4.1 Salient features of Hepaticopsida, Anthocerotopsida and Bryopsida, 4.2. System of classification up to Class (Proskauer 1957), 4.3 Amphibian nature of bryophytes, 4.4 Economic and ecological importance. (6 lectures) 5. Pteridophytes 5.1 Salient features of Psilophyta, Lycophyta, Sphenophyta and Filicophyta, 5.2 System of classification up to Division (Gifford & Foster 1989), 5.3 Economic importance (food, medicine & agriculture). (6 lectures) 6. Gymnosperms 6.1 Salient features of Cycadophyta, Coniferophyta and Gnetophyta, 6.2 Outline classification up to Division: Progymnospermophyta to Gnetophyta (Gifford & Foster 1989), 6.3 Economic importance (wood, resin, essential oil & drugs). (6 lectures) 7. Angiosperms 7.1 Types and morphology of leaf, stem and root, 7.2 Inflorescence types with examples, 7.3 Flower: Different parts and forms of calyx, corolla, androecium and gynoecium; aestivation and placentation, 7.4 Types with examples-fruits and seeds. (12 lectures)	1. **Introduce students to the diversity of plant life** from algae to angiosperms. 2. **Explain the evolutionary significance and classification of different plant groups**. 3. **Highlight the ecological and economic importance of various plant groups**. 4. **Develop an understanding of plant morphology, anatomy, and reproductive structures**. 5. **Enhance observational and practical skills** through laboratory work and field studies. **Course Outcomes (COs) for Theory (BOT-MD-CC1-1-Th)** After completing this course, students will be able to: **1. Introduction to Plant Kingdom** • Explain the **origin of life and plant evolution**. • Understand the **importance of plants in food, fuel production, and ecosystem services**. **2. Algae** • Describe the **salient features of major algal groups** (Cyanophyceae, Chlorophyceae, Charophyceae, Phaeophyceae, Rhodophyceae, Bacillariophyceae). • Understand **Fritsch's system of classification (1935)**. • Explain the **economic importance of algae in agriculture, biotechnology, and industry**. **3. Fungi** • Recognize the **characteristics of major fungal groups** (Myxomycota, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina). • Understand **Ainsworth's classification system (1973)**. • Discuss **the economic importance of fungi** in food, medicine, and agriculture.

PLANT DIVERSITY (PRACTICAL)
BOT-MD-CC1-1-P Total marks 25;
Credit 1, Class 30 hours

1. Flower- dissection, drawing and study a) Different parts, b) Adhesion and cohesion, c) Placentation, d) Aestivation
2. Study of ovules: types (Fresh specimens/ permanent slides/ photographs)
3. Fruits:different types- study from fresh/ preserved specimens
4. Inflorescence types: study from fresh/ preserved specimens
5. Identification on the basis of reproductive and structural features from preserved specimens/ permanent slides: Algae (Nostoc, Oedogonium and Ectocarpus), Fungi (Rhizopus, Ascobolus and Agaricus), Bryophytes (Marchantia, Anthoceros and Funaria), Pteridophytes (Selaginella, Equisetum and Pteris), Gymnosperms (male cone and female cone/ megasporophyll of Cycas, Pinus and Gnetum).
6. A field notebook supported with photographs taken during field study to be submitted giving comprehensive idea about different types of inflorescence, flowers and fruits.

- Explain **fungal symbioses (Mycorrhizae, Lichen) and their ecological roles**.

4. Bryophytes

- Describe the **characteristics of Hepaticopsida, Anthocerotopsida, and Bryopsida**.
- Understand **Proskauer's classification system (1957)**.
- Explain the **amphibian nature of bryophytes**.
- Discuss **the economic and ecological importance of bryophytes**.

5. Pteridophytes

- Identify the **key features of Psilophyta, Lycophyta, Sphenophyta, and Filicophyta**.
- Understand **Gifford & Foster's classification system (1989)**.
- Explain the **economic significance of pteridophytes in food, medicine, and agriculture**.

6. Gymnosperms

- Describe the **salient features of Cycadophyta, Coniferophyta, and Gnetophyta**.
- Understand **Gifford & Foster's classification of gymnosperms (1989)**.
- Discuss the **economic importance of gymnosperms in timber, resin, essential oils, and medicinal compounds**.

7. Angiosperms

- Identify and classify **leaf, stem, and root types**.
- Understand **various types of inflorescence with examples**.
- Describe the **structure and diversity of flowers, including calyx, corolla, androecium, and gynoecium**.
- Explain **fruit and seed types with examples**.

Course Outcomes (COs) for Practical (BOT-MD-CC1-1-P)

After completing the practical component, students will:

	1. **Dissect, analyze, and draw flowers**, studying their different parts, adhesion, cohesion, placentation, and aestivation. 2. **Examine ovule types** using fresh specimens, permanent slides, or photographs. 3. **Identify different types of fruits** from fresh or preserved specimens. 4. **Classify various types of inflorescence** using fresh or preserved specimens. 5. **Identify algae, fungi, bryophytes, pteridophytes, and gymnosperms** based on structural and reproductive features from preserved specimens or permanent slides. 6. **Document field studies** through a comprehensive notebook with photographs of different types of inflorescence, flowers, and fruits. **Conclusion:** This course provides **a foundational understanding of plant diversity**, their classification, and their **evolutionary significance**. It develops **practical identification skills** and **appreciation for the ecological and economic roles of plants**, preparing students for **advanced studies in botany, ecology, and plant sciences**.
<u>Semester II</u> <u>Core PLANT SYSTEMATICS</u> (THEORY) BOT-MD-CC2-2-Th Total marks 75; Credits 3, Class 45 hours 1. Introduction: Components of Systematics: Nomenclature, Identification, Classification; 1.2. Taxonomy and its phases - Pioneer, Consolidation, Biosystematic and Encyclopaedic; alpha- and omega-taxonomy, 1.3 Nomenclature: Type method, Publication, Rank of taxa, Rules of priority, Retention and rejection of names, Author Citation, Effective and valid publication, Elementary knowledge of ICN- Principles. (10 lectures)	**Programme Outcomes (POs):** 1. **Introduce students to plant classification, nomenclature, and taxonomy** for proper identification and categorization of plants. 2. **Familiarize students with different systems of classification**, including traditional and modern approaches. 3. **Develop an understanding of key angiosperm families**, their diagnostic features, and economic significance. 4. **Provide practical experience in plant identification and herbarium preparation**.

2. Systems of classification: 2.1 Broad outline of Bentham & Hooker (1862-1883) and Takhtajan (1997)- systems of classification with merits and demerits. Brief idea of angiosperm phylogeny group (APG IV classification), 2.2 Systematics in Practice: Herbaria and Botanic Gardens – their role in teaching and research; 2.3. Dichotomous keys – indented and bracketed. 2.4 Brief idea on Phenetics and cladistics: Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy; 2.5 Numerical taxonomymethods and significance; 2.6 Data sources in Taxonomy: Supportive evidences from Phytochemistry, Cytology, Palynology and Molecular biology data (Protein and Nucleic acid homology). (20 lectures)

3. Systematic study of angiosperm taxa: Diagnostic features, systematic position (Bentham & Hooker) and economically important plants (parts used and uses) of the following families: 3.1. Monocotyledons: Alismataceae, Gramineae (Poaceae), Cyperaceae, Palmae (Arecaceae), Liliaceae, Musaceae, Zingiberaceae, Cannaceae, Orchidaceae. 3.2. Dicotyledons: Nymphaeaceae, Magnoliaceae, Ranunculaceae, Leguminosae (subfamilies), Euphorbiaceae, Malvaceae, Umbelliferae (Apiaceae), Labiatae (Lamiaceae), Cruciferae (Brassicaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Compositae (Asteraceae). (15 lectures)

PLANT SYSTEMATICS (PRACTICAL)

BOT-MD-CC2-2-P Total marks 25;

Credit 1, Class 30 hours

ANGIOSPERMS

1. Work out, description, preparation of floral formula and floral diagram, identification up to genus with the help of suitable literature of wild plants and systematic position according to Benthum and Hooker system of classification from the following families: Malvaceae, Leguminosae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.

5. **Encourage fieldwork and firsthand observation of plant diversity**.

Course Outcomes (COs) for Theory (BOT-MD-CC2-2-Th)

After completing this course, students will be able to:

1. Introduction to Plant Systematics

- Define **systematics and its components**, including nomenclature, identification, and classification.
- Explain the **phases of taxonomy** (Pioneer, Consolidation, Biosystematic, Encyclopaedic).
- Differentiate between **alpha-taxonomy and omega-taxonomy**.
- Understand the **principles of the International Code of Nomenclature (ICN)**, including the Type method, rules of priority, author citation, and effective publication.

2. Systems of Classification

- Describe the **Bentham & Hooker (1862-1883) and Takhtajan (1997) systems**, including their merits and demerits.
- Understand the **Angiosperm Phylogeny Group (APG IV) classification**.
- Explain the **role of herbaria and botanical gardens in plant identification and research**.
- Differentiate between **dichotomous keys** (indented and bracketed).
- Gain a brief understanding of **phenetics and cladistics**, including monophyletic, polyphyletic, and paraphyletic groups.
- Explain **numerical taxonomy and its significance**.
- Understand **supporting data sources in taxonomy**, including phytochemistry, cytology, palynology, and molecular biology (protein and nucleic acid homology).

3. Systematic Study of Angiosperm Taxa

- Identify **diagnostic features, systematic position (Bentham &**

2. Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus. FIELD WORK At least three excursions including one excursion to Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur, Howrah) and one to Central National Herbarium (CNH). FIELD RECORDS 1. Field Note Book (authenticated) with field notes on the plants of the area of excursion and voucher specimen book. 2. Herbarium specimens: Preparation of 20 angiospermic specimens (identified with author citation, voucher number and arranged following Bentham and Hooker system of classification) to be submitted during examination.	**Hooker), and economic importance** of selected angiosperm families. • Recognize and describe **monocot families**, including Alismataceae, Poaceae, Cyperaceae, Arecaceae, Liliaceae, Musaceae, Zingiberaceae, Cannaceae, and Orchidaceae. • Recognize and describe **dicot families**, including Nymphaeaceae, Magnoliaceae, Ranunculaceae, Leguminosae (subfamilies), Euphorbiaceae, Malvaceae, Apiaceae, Lamiaceae, Brassicaceae, Solanaceae, Scrophulariaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, and Asteraceae. --- **Course Outcomes (COs) for Practical (BOT-MD-CC2-2-P)** After completing the practical component, students will: **Angiosperms Practical Work** 1. **Work out, describe, and prepare floral formulas and diagrams** for plants from selected families. 2. **Identify wild plants up to the genus level** using systematic literature and classify them based on the Bentham & Hooker system. 3. **Perform spot identification** of common wild plants and assign their binomial names and families. **Field Work** 1. Conduct at least **three field excursions**, including visits to: o **Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur, Howrah)**. o **Central National Herbarium (CNH)**. **Field Records** 1. **Maintain an authenticated Field Notebook**, documenting plant observations from excursions. 2. **Prepare a voucher specimen book**. 3. **Collect and submit 20 properly identified herbarium specimens**, labeled with author citation and voucher numbers, arranged

	according to the Bentham & Hooker system. **Conclusion:** This course provides **a comprehensive understanding of plant taxonomy, classification, and identification**, enhancing both **theoretical knowledge and practical skills**. The **fieldwork and herbarium preparation** offer hands-on experience in plant systematics, making it an essential foundation for **advanced botanical research, biodiversity studies, and conservation science**.
Semester II **SEC (To be opted in 1st or 2nd or 3rd Semester)** **MUSHROOM CULTIVATION TECHNOLOGY (THEORY)** **BOT-MD-SEC-1-Th Total marks 75; Credits 3, Class 45 hours** 1. 1.1 Introduction, History of mushroom cultivation,1.2 Current overview of mushroom production in the world, 1.3 Mushroom biology-classification of mushrooms, edible mushrooms in India, poisonous mushrooms, mushroom poisoning. (6 lectures) 2. 2.1 Infrastructure-structural design and layout of mushroom farm, substrates (locally available), 2.2 Appliances- weighing balance, autoclave, laminar air flow, incubator, hot air oven, spirit lamp, Bunsen burner, pH meter, laboratory heater, low-cost stoves, water bath, humidifier, water sprayer, vessels, inoculation hook and inoculation loop, sieves, culture racks, tray, polythene bags, 2.3 Methods of sterilization. (9 lectures) 3. 3.1 Cultivation technology-overview of cultivation strategies, composting technology in mushroom production, mushroom bed preparation, culture media, pure culture, maintenance and preservation of pure culture, 3.2 Production of spawn-cultivation of oyster mushroom, paddy-straw mushroom, milky mushroom and white button mushroom, 3.3 Cultivation of	**Programme Outcomes (POs):** 1. **Introduce students to the science and history of mushroom cultivation**, including its global and Indian perspectives. 2. **Develop practical skills in mushroom farming**, including infrastructure setup, sterilization, and spawn production. 3. **Provide hands-on training in the cultivation of edible and medicinal mushrooms**. 4. **Familiarize students with post-harvest techniques and value-added mushroom products**. 5. **Enhance knowledge of mushroom-based entrepreneurship**, including market trends and cost-benefit analysis. 6. **Highlight the nutritional, medicinal, and environmental benefits** of mushroom cultivation. **Course Outcomes (COs) for Theory (BOT-MD-SEC-1-Th)** After completing this course, students will be able to: **1. Introduction to Mushroom Cultivation** • Understand the **history and global scenario** of mushroom production.

medicinal mushroom (Cordyceps and Ganoderma). (12 lectures)
4. 4.1 Mushroom diseases and management strategies, 4.2 Post-harvest technology-short-term storage (Refrigeration- up to 24 hours), long-term storage (canning, pickles, papads etc.), drying, storage in salt solutions, 4.3 Food preparations from mushrooms. (9 lectures)
5. 5.1 Uses of spent mushroom substrate, 5.2 Strain improvements in cultivated mushroom; Nutritional and medicinal value of edible mushrooms, 5.3 Research centres-National level and regional level, 5.4 Cost-benefit ratio, 5.5 Mushroom based Industry, 5.6 Mushroom market in India and abroad. (9 lectures)
 	
<u>MUSHROOM CULTIVATION TECHNOLOGY (PRACTICAL)</u>
BOT-MD-SEC-1-P Total marks 25; Credits 1, Class 30 hours
1. Macro and microscopic identification of some common edible mushrooms (Agaricus, Pleurotus)
2. Media preparation
3. Fungal tissue culture
4. Sub-culturing for maintenance of culture
5. Spawn production
6. Cultivation of Pleurotus/Calocybe
	• Classify different types of **mushrooms**, including edible and poisonous varieties in India.
	• Identify symptoms and effects of **mushroom poisoning**.
	2. Infrastructure and Equipment for Mushroom Cultivation
	• Design a **mushroom farm layout**, considering **locally available substrates**.
	• Learn the functions and usage of **essential mushroom cultivation equipment**, including autoclaves, laminar airflow, incubators, humidifiers, and pH meters.
	• Understand different **sterilization methods** for maintaining aseptic conditions.
	3. Cultivation Technology
	• Gain knowledge about **composting technology, mushroom bed preparation, and culture media**.
	• Learn the **techniques for producing pure cultures and spawn**.
	• Understand the **cultivation process for edible mushrooms**, including:
	  ○ **Oyster mushroom (Pleurotus sp.)**
	  ○ **Paddy-straw mushroom (Volvariella volvacea)**
	  ○ **Milky mushroom (Calocybe indica)**
	  ○ **White button mushroom (Agaricus bisporus)**
	• Study the cultivation of **medicinal mushrooms** like **Ganoderma and Cordyceps**.
	4. Mushroom Diseases, Storage, and Food Processing
	• Identify **common diseases in mushrooms** and learn **management strategies**.
	• Learn **post-harvest storage techniques**, including refrigeration, drying, and preservation in salt solutions.
	• Understand methods for making **value-added mushroom products** like pickles, papads, and canned mushrooms.

	• Explore different **culinary applications of mushrooms**. **5. Mushroom-Based Industry and Market Analysis** • Understand the **uses of spent mushroom substrate** for sustainability. • Learn about **strain improvement techniques** for cultivated mushrooms. • Gain insights into **nutritional and medicinal benefits** of mushrooms. • Familiarize with **national and regional mushroom research centers**. • Analyze the **cost-benefit ratio** of mushroom farming. • Understand **mushroom market trends in India and abroad**. **Course Outcomes (COs) for Practical (BOT-MD-SEC-1-P)** After completing the practical component, students will: 1. **Identify edible mushrooms (Agaricus, Pleurotus) under macro and microscopic conditions**. 2. **Prepare culture media** for mushroom cultivation. 3. **Learn fungal tissue culture techniques**. 4. **Perform sub-culturing to maintain fungal cultures**. 5. **Understand spawn production techniques**. 6. **Cultivate mushrooms (Pleurotus/Calocybe) in a controlled environment**. **Conclusion:** This course equips students with **both theoretical knowledge and practical skills in mushroom cultivation**. It provides valuable insights into **commercial mushroom farming, post-harvest processing, and entrepreneurship**, making it an excellent choice for those interested in **agriculture, biotechnology, or food industries**.

Semester III **DSC/Core ECONOMIC BOTANY (THEORY) BOT-MD-CC3-3-Th (Total Marks 75, Credits 3, Lectures 45 hours)** 1. Introduction: Concepts of centre of origin, their importance with reference to Vavilov's work, Importance of germplasm diversity. 4 Lectures 2. Cereals, pulses and oils: 2.1 Cereals: Rice and Wheat- cultivation, processing and uses, Millets as future cereals. 2.2 Pulses and Legumes: Cultivation and uses of Gram and Mung Bean - Importance to man and environment, 2.3 Oil and fats: General description, classification, extraction, uses and health implications of Mustard and Coconut (Botanical name, family and uses). Essential oils- general account, extraction methods and their uses. 12 Lectures 3. Sugar, starch, spices and beverages: 3.1 Processing of sugarcane to products and byproducts. Extraction/ processing from Potato and Sugar beet. 3.2 Spices and condiments: Scientific names, family, economically important parts and uses of Ajwain, Cumin, Black Cumin, Mustard, Fenugreek, Coriander, Chillies, Bay leaf, Black Pepper, Cardamom (small and big), Clove, Cinnamon, Onion, Garlic and Ginger, 3.3 Beverages: Tea and coffee (plant habit, processing and uses). 9 Lectures 4. Narcotics, timbers and fibres: 4.1 Habit forming drugs with special reference to Cannabis and Tobacco (processing, uses and health hazards), 4.2 Timber: General account with special reference to Sal and Teak, 4.3 Fibers: Cotton and Jute - (extraction and uses). 16 Lectures 5. Vegetables and fruits: 5.1 Vegetables: Scientific names, family and edible parts- Potato, Pointed gourd, Brinjal, Tomato, Cauliflower, Cabbage, Lady´s finger, Ridge gourd, Cucumber, Spinach, Carrot, Pea, Beans, Drumstick, Radish and Sweet potato, 5.2 Fruits: Scientific names, family, types of fruits and edible parts: Mango, Papaya Custard apple, Pineapple, Tamarind, Jackfruit, Banana, Guava, Pomegranate,	**Programme Outcomes (POs):** 1. **Introduce students to the significance of plants in human civilization, agriculture, and industries**. 2. **Explain the concept of centers of origin, plant domestication, and germplasm diversity**. 3. **Provide knowledge about economically important plants** used as food, medicine, fibers, timber, and spices. 4. **Develop an understanding of plant-based industries**, including sugar, oil, beverage, and timber industries. 5. **Familiarize students with narcotic plants, their uses, and health hazards**. 6. **Enhance students' field-based learning and practical identification skills** through hands-on experience. --- **Course Outcomes (COs) for Theory (ECONOMIC BOTANY - DSC/Core - Theory)** After completing this course, students will be able to: **1. Introduction to Economic Botany** • Understand the **concept of centers of origin** and their role in plant domestication. • Discuss **Vavilov's work** on crop origin and the significance of germplasm diversity. **2. Cereals, Pulses, and Oil Crops** • Describe the **cultivation, processing, and uses** of major cereals like **Rice and Wheat**. • Recognize the importance of **millets** as future cereals. • Explain the **cultivation and environmental benefits** of **Gram and Mung Bean**. • Understand the **classification, extraction methods, and health**

Apple, Strawberry, Wood apple, Litchi and Grapes. 4 Lectures

ECONOMIC BOTANY (PRACTICAL)
BOT-MD-CC3-3-P (Total Marks 25, Credits 2, Class 30 hours)

1. Identification of economically important plants (as listed below) from fresh/ herbarium sheets/ preserved specimens: Cereals: Rice and Wheat Legume: Gram, Mung bean and Soybean (habit, fruit and seed structure) Spices and condiments: Coriander, Cumin, Bay leaf, Black pepper, Cinnamom Tea and coffee (plant habit and parts used) Common vegetables: Potato, Cucumber, Brinjal, Lady´s finger, Carrot, Sweet potato Fruits (only identify the type of fruit) as listed in theoretical syllabus Fibres: jute and cotton (plant and parts used)
2.Classroom performance: (lab records and field notebook)
3. Field visit to give an idea about cultivation of any one crop (viz. rice, jute, mustard, tea, potato)
4. Field record must be properly authenticated by escorting teacher and supported by photographs of the field.

implications of oil crops like **Mustard and Coconut**.
- Explain the **extraction and uses** of **essential oils**.

3. Sugar, Starch, Spices, and Beverages
- Describe the **processing of sugarcane, potato, and sugar beet** for sugar and starch production.
- Identify important **spices and condiments** (Ajwain, Cumin, Mustard, Fenugreek, Coriander, Chillies, etc.) and their botanical significance.
- Understand the **processing and uses** of beverages like **Tea and Coffee**.

4. Narcotics, Timber, and Fibers
- Discuss **habit-forming drugs** like **Cannabis and Tobacco**, their processing, uses, and health risks.
- Explain the **importance of timber-yielding trees** such as **Sal and Teak**.
- Identify **fiber crops like Cotton and Jute**, their extraction, and economic uses.

5. Vegetables and Fruits
- Identify major **vegetables** (Potato, Brinjal, Tomato, Carrot, etc.), their **scientific names, families, and edible parts**.
- Recognize economically significant **fruits** (Mango, Papaya, Pineapple, Banana, etc.), their **family classification, fruit type, and edible parts**.

Course Outcomes (COs) for Practical (ECONOMIC BOTANY - DSC/Core - Practical)

After completing the practical component, students will:

1. **Identify economically important plants** using fresh samples, herbarium sheets, and preserved specimens.
2. **Examine plant structure, habit, fruit, and seed characteristics** of cereals, legumes, vegetables, and fruits.

	3. **Distinguish fiber crops (Jute and Cotton) and their economic significance**. 4. **Study spices, condiments, tea, and coffee samples** to understand their botanical origin and parts used. 5. **Conduct field visits** to gain practical knowledge of crop cultivation (e.g., rice, jute, mustard, tea, potato). 6. **Prepare an authenticated field record** supported by field notes and photographs. **Conclusion:** This course provides **a deep understanding of plant-based resources** and their role in **agriculture, economy, and industry**. It equips students with **practical skills in plant identification, field research, and economic botany applications** for **sustainable agriculture and plant-based industries**.
Semester III **IDC (To be opted in 1st or 2nd or 3rd Semester) BIOSTATISTICS (Theory)** **Total marks- 75, Credits 3, Class 45 hours** 1. Biostatistics and Biometry: Basics-Definition, statistical methods, basic principles, variables measurements, functions, limitations and uses of statistics; Data, Sample, Population, Random sampling, Frequency distribution: Normal, Binomial and Poisson distribution. (8 lectures) 2. Central tendency: Arithmetic Mean, Mode and Median; Measurement of dispersion-Coefficient of variation, Standard Deviation, Standard error of Mean. (10 lectures) 3. Test of significance: Chi-square test for goodness of fit and Students' t test, Calculation of 'F' value and finding out the probability value for the 'F' value. (12 lectures) 4. Correlation coefficient: Calculations of 'r' values and finding out the probability. (3 lectures)	**Programme Outcomes (POs):** 1. **Introduce students to statistical concepts and their applications in biological sciences**. 2. **Equip students with data analysis skills**, including measures of central tendency, dispersion, and correlation. 3. **Provide a strong foundation in probability theory and its role in genetics and population studies**. 4. **Train students in hypothesis testing using statistical methods like Chi-square and t-tests**. 5. **Enable students to interpret experimental and research data effectively**. 6. **Develop problem-solving and analytical skills through practical statistical applications**. **Course Outcomes (COs) for Theory (BIOSTATISTICS - IDC - Theory)**

5. Probability: multiplicative and additive rules of probability: application and importance. (5 lectures) 6. Measurement of gene frequency: Hardy-Weinberg equilibrium- conditions applied for its implications (simple numerical problems to calculate genotypic and allelic frequencies). (7 lectures) **<u>BIOSTATISTICS (Practical)</u>** **Total marks-25, Credit 1, Class 30 hours** 1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population/ leaflet size), graphical representation of the data (frequency polygon, bar diagram, histogram). 2. Calculation of correlation coefficient values and finding out the probability. 3. Determination of goodness of fit in Mendelian mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1) by Chi-square analysis and comment on the nature of inheritance. 4.Calculation of 'F' value and finding out the probability for the F value.	After completing this course, students will be able to: **1. Introduction to Biostatistics and Biometry** • Define **biostatistics and statistical methods** in biological research. • Understand **key statistical principles** like sampling, population, and frequency distribution. • Differentiate between **Normal, Binomial, and Poisson distributions** and their significance. **2. Measures of Central Tendency and Dispersion** • Compute and interpret **Arithmetic Mean, Median, and Mode**. • Understand the importance of **Standard Deviation (SD), Standard Error (SE), and Coefficient of Variation (CV)** in data analysis. **3. Tests of Significance** • Perform **Chi-square tests** for goodness of fit in biological experiments. • Apply **Student's t-test** for comparing means in different datasets. • Calculate and interpret **F-values** to determine probability significance in experiments. **4. Correlation Analysis** • Calculate and interpret **correlation coefficient ('r' values)**. • Assess the relationship between two biological variables using correlation techniques. **5. Probability in Biological Sciences** • Understand **multiplicative and additive rules of probability**. • Apply probability rules in genetic and biological studies. **6. Genetic Data Analysis and Hardy-Weinberg Equilibrium** • Compute **genotypic and allelic frequencies** using the **Hardy-Weinberg principle**. • Solve simple numerical problems related to **population genetics**.

	Course Outcomes (COs) for Practical (BIOSTATISTICS - IDC - Practical) After completing the practical component, students will: 1. **Analyze statistical data using univariate techniques**, including mean, median, mode, standard deviation, and standard error. 2. **Represent biological data graphically** using frequency polygons, bar diagrams, and histograms. 3. **Calculate and interpret correlation coefficient values ('r' values) and their probability significance**. 4. **Perform Chi-square analysis for Mendelian mono- and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1) to assess inheritance patterns**. 5. **Compute F-values and determine probability significance for experimental datasets**. --- **Conclusion:** This course provides **a strong statistical foundation** for students in **biological sciences**, equipping them with **data analysis, hypothesis testing, and genetic frequency measurement skills**. These competencies are crucial for **biomedical research, bioinformatics, genetics, and ecological studies**.
(Semester IV) **DSC/Core** **BOT-MD-CC4-4-Th** **PHARMACOGNOSY & ETHNOBOTANY (THEORY)** **(Total Marks 75, Credits 3, Lectures 45 hours)** 1. Medicinal botany: History, scope and importance of medicinal plant in herbal drug industry, a brief idea about traditional systems of medicine- ayurveda, siddha and unani, Polyherbal formulations. 4 lectures 2. Pharmacognosy- General account: 2.1 Pharmacognosy and its introduction and importance in modern medicine, 2.2 Crude	**Programme Outcomes (POs):** 1. **Introduce students to the study of medicinal plants and their significance in traditional and modern medicine**. 2. **Provide an understanding of pharmacognosy, drug classification, and drug evaluation techniques**. 3. **Familiarize students with secondary metabolites, their biosynthesis, and pharmacological properties**.

drugs, 2.3 Classification of plant drugs-chemical and pharmacological action, 2.4 Drug evaluation– organoleptic, microscopic, chemical, physical and biological, 2.5. Major pharmacological groups of plant drugs and their uses, 2.6. Conservation of endangered and endemic medicinal plants. 12 lectures

3. Secondary metabolites: 3.1 Secondary metabolites and their differences with primary metabolites, 3.2 Interrelationship of basic metabolic pathways (Shikimate, Acetate, Mevalonate & MEP) with secondary metabolite biosynthesis (outlines only), 3.3 Major types and classification– terpenoids, phenolics, flavonoids, alkaloids and their pharmacological importance. 10 lectures

4. Pharmacologically active constituents: Source plants (one example) parts used and uses of: 4.1 Steroids (Solasodin, Diosgenin, Digitoxin), 4.2 Tannin (Catechin), 4.3 Resins (Gingerol, Curcuminoids), 4.4 Alkaloids (Quinine, Atropine. Pilocarpine, Strychnine, Reserpine, Vinblastine, Taxol, Pyrolizidine), 4.5. Phenols (Sennoside and Capsaicin). 4 lectures

5.Ethnobotany and folk medicine: Definition, methods of study, application, Indian scenario, national interacts, folk medicines in ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India, sacred groves, application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetes, blood pressure and skin diseases. 15 lectures

PHARMACOGNOSY & ETHNOBOTANY (PRACTICAL)

BOT-MD-CC4-4-P

Total Marks 25; Credit 1, Class 30 hours

PHARMACOGNOSY/ MEDICINAL PLANTS

1. Chemical tests for (a) Tannin (Camellia sinensis / Terminalia chebula), (b) Alkaloid (Catharanthus roseus).
2. Powder microscopy – Zingiber and Holarrhena.
3. Histochemical tests of (a) Curcumin (Curcuma longa), (b) Starch in non-lignified

4. **Explore the applications of ethnobotany, traditional medicine, and folk remedies in disease treatment**.
5. **Enhance students' practical knowledge in medicinal plant identification, powder microscopy, and histochemical testing**.

Course Outcomes (COs) for Theory (PHARMACOGNOSY & ETHNOBOTANY - DSC/Core - Theory)

After completing this course, students will be able to:

1. Medicinal Botany

- Explain the **history, scope, and importance of medicinal plants** in the herbal drug industry.
- Describe **traditional systems of medicine** (Ayurveda, Siddha, and Unani) and **polyherbal formulations**.

2. Pharmacognosy

- Understand **pharmacognosy** and its role in modern medicine.
- Define **crude drugs** and their classification based on **chemical and pharmacological action**.
- Explain **drug evaluation techniques** (organoleptic, microscopic, chemical, physical, and biological methods).
- Identify **major pharmacological groups** of plant-derived drugs and their medicinal uses.
- Discuss the **conservation of endangered and endemic medicinal plants**.

3. Secondary Metabolites

- Differentiate between **primary and secondary metabolites**.
- Describe the **interrelationship between primary metabolic pathways** (Shikimate, Acetate, Mevalonate & MEP) and **secondary metabolite biosynthesis**.
- Classify **terpenoids, phenolics, flavonoids, and alkaloids**, and

vessel (Zingiber), (c) Alkaloid (stem of Catharanthus and bark of Holarrhena). 4. Identification from fresh specimen/ herbarium of some commonly used medicinal plants: a. Azadirachta indica (Neem), b. Justicia adhatoda (Vasak), c. Andrographis paniculata (Kalmegh), d. Saraca asoca (Ashoka), e. Centella asiatica (Thankuni), f. Catharanthus roseus (Nayantara), g. Phyllanthus emblica (Amla), h. Terminalia chebula (Haritaki), i. Bacopa monnieri (Brahmi).	explain their **pharmacological importance**. **4. Pharmacologically Active Constituents** • Identify **source plants, plant parts used, and medicinal properties** of: o **Steroids** (Solasodin, Diosgenin, Digitoxin) o **Tannins** (Catechin) o **Resins** (Gingerol, Curcuminoids) o **Alkaloids** (Quinine, Atropine, Pilocarpine, Strychnine, Reserpine, Vinblastine, Taxol, Pyrolizidine) o **Phenols** (Sennoside, Capsaicin) **5. Ethnobotany and Folk Medicine** • Define **ethnobotany** and discuss its **methods of study and applications**. • Understand the **role of traditional medicine in Indian culture**. • Recognize **folk medicines** used for treating jaundice, cardiac disorders, infertility, diabetes, blood pressure, and skin diseases. • Explore the significance of **ethnomedicine, ethnoecology, ethnic communities, and sacred groves** in India. --- **Course Outcomes (COs) for Practical (PHARMACOGNOSY & ETHNOBOTANY - DSC/Core - Practical)** After completing the practical component, students will: 1. **Perform powder microscopy and histochemical tests** to analyze medicinal plant samples. 2. **Conduct chemical tests** for detecting tannins (Camellia sinensis, Terminalia chebula) and alkaloids (Catharanthus roseus). 3. **Examine powdered samples of medicinal plants** (Zingiber, Holarrhena). 4. **Perform histochemical tests** to identify Curcumin (Curcuma longa), starch in non-lignified vessels

	(Zingiber), and alkaloids in the stem of Catharanthus and bark of Holarrhena. 5. **Identify commonly used medicinal plants** from fresh specimens/herbarium, including: o **Azadirachta indica (Neem)** o **Justicia adhatoda (Vasaka)** o **Andrographis paniculata (Kalmegh)** o **Saraca asoca (Ashoka)** o **Centella asiatica (Thankuni)** o **Catharanthus roseus (Nayantara)** o **Phyllanthus emblica (Amla)** o **Terminalia chebula (Haritaki)** o **Bacopa monnieri (Brahmi)** --- **Conclusion:** This course provides students with **a strong foundation in medicinal plant studies**, **pharmacognosy**, and **ethnobotany**. It bridges the gap between **traditional knowledge and modern pharmaceutical applications**, offering insights into **plant-based drug development, conservation, and folk medicine practices**.
<u>Semester IV</u> <u>DSC/Core</u> <u>Plant Geography, Ecology and Evolution (THEORY) BOT-MD-CC5-4-Th</u> (Total Marks 75, Credits 3, Lectures 45 hours) PLANT GEOGRAPHY (15 marks) 1. Phytogeographical regions: 1.1. Phytogeographical regions of India (Chatterjee 1960); 1.2. Dominant flora of Eastern Himalaya, Western Himalaya, Indian deserts and Sundarban. 5 lectures 2. Endemism: 2.1. Endemism types and Factors; 2.2. Age & Area hypothesis and Epibiotic theory; 2.3. Endemism in Indian flora. 4 lectures ECOLOGY (30 marks)	**Programme Outcomes (POs):** 1. **Introduce students to plant distribution patterns and phytogeographical regions** with a special focus on India. 2. **Provide insights into ecological principles, plant interactions, and conservation strategies**. 3. **Develop an understanding of biodiversity, conservation methods, and plant adaptation mechanisms**. 4. **Explain the process of evolution, natural selection, speciation, and phylogenetic relationships**. 5. **Enhance students' practical knowledge through field**

1. Preliminary idea on: 1.1. Habitat and Niche (fundamental and realized), 1.2. Ecotone and Edge–effect, 1.3. Microclimate, 1.4. Ecads, Ecotypes and Ecoclines, 1.5. Carrying capacity. 3 lectures

2. Community ecology: 2.1. Community-Characteristics and diversity (α, β, γ), 2.2. Ecological succession –Primary and secondary, Seral stages (with reference to Lithosere and Hydrosere), autogenic and allogenic succession, Climax community. 4 lectures

3.1. Plant indicators (metallophytes); 3.2. Phytoremediation. 3 lectures

4. Conservation of Biodiversity: 4.1. Level of Biodiversity: genetic, species & ecosystem diversity, 4.2. Biodiversity hot spots- criteria, Indian hotspots, 4.3. In- situ and ex-situ conservation, 4.4. Causes of extinction, 4.5. IUCN Red List categories, 4.6. Seed-banks, 4.7. Cryopreservation, 4.8. Geographic Information System and Remote Sensing (brief idea). 10 lectures

EVOLUTION (30 marks)

1.1 Introduction, 1.2. Theories of evolution: Evidences, Natural selection, Group selection, Neutral theory of molecular evolution, 1.3. Phyletic gradualism, Punctuated equilibrium and Stasis 6 lectures

2.1 Brief idea on: Stabilizing directional, disruptive and sexual selection; Speciation: Sympatric and Allopatric; Coevolution, Adaptive radiation, Reproductive isolation 6 lectures

3.1. Simplified phylogeny of bacteria, algae, fungi, bryophyte, pteridophyte and gymnosperm, 3.2. Phylogenetic tree. 4 lectures

PLANT GEOGRAPHY, ECOLOGY AND EVOLUTION (PRACTICAL)

BOT-MD-CC5-4-P (Total Marks 25, Credit 1, Class 30 hours)

PLANT GEOGRAPHY

1. Field visit- at least one long excursion at any phytogeographical region of India.

2. Study of local flora and submission of a project report highlighting phytogeographical characteristics of the region.

excursions, ecological data collection, and analysis.

Course Outcomes (COs) for Theory (PLANT GEOGRAPHY, ECOLOGY, AND EVOLUTION - DSC/Core - Theory)

After completing this course, students will be able to:

Plant Geography (15 Marks)

1. **Phytogeographical Regions:**
   - Identify and describe **phytogeographical regions of India** as per **Chatterjee (1960)**.
   - Discuss the **dominant flora** of the **Eastern Himalaya, Western Himalaya, Indian Deserts, and Sundarbans**.
2. **Endemism:**
   - Understand **types and factors of endemism** and their role in plant distribution.
   - Explain theories like **Age & Area Hypothesis** and **Epibiotic Theory**.
   - Discuss **endemism in Indian flora** and its significance.

Ecology (30 Marks)

1. **Ecological Principles:**
   - Explain key ecological concepts such as **habitat, niche, ecotone, edge-effect, microclimate, ecads, ecotypes, ecoclines, and carrying capacity**.
2. **Community Ecology:**
   - Describe **community characteristics** and the concepts of **α, β, and γ diversity**.
   - Explain the process of **ecological succession** (primary and secondary) with reference to **Lithosere and Hydrosere**.
   - Differentiate between **autogenic and allogenic succession** and define **climax community**.

ECOLOGY 1. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Estimation of frequency, density and abundance (to be done during excursion/ field visit). 2. Estimation of foliar dust deposition. 3. Measurement of dissolved O_2 by azide modification of Winkler's method. 4. Determination of chemical properties of soil by rapid spot test (carbonate, iron, nitrate) 5. Estimation of organic carbon percentage present in soil sample.	3. **Plant Indicators and Phytoremediation:** o Define **plant indicators**, focusing on **metallophytes**. o Explain the concept and applications of **phytoremediation** in environmental management. 4. **Conservation of Biodiversity:** o Explain **different levels of biodiversity** (genetic, species, ecosystem). o Identify **biodiversity hotspots in India** and their criteria. o Differentiate between **in-situ and ex-situ conservation** strategies. o Analyze **causes of species extinction** and explain **IUCN Red List categories**. o Describe techniques like **seed banks and cryopreservation** for plant conservation. o Understand the role of **Geographic Information Systems (GIS) and Remote Sensing** in biodiversity studies. **Evolution (30 Marks)** 1. **Introduction to Evolution:** o Explain **major theories of evolution** and their supporting evidence. o Understand **natural selection, group selection, and the neutral theory of molecular evolution**. o Compare **phyletic gradualism, punctuated equilibrium, and stasis**. 2. **Mechanisms of Evolution and Speciation:** o Describe **stabilizing, directional, disruptive, and sexual selection**. o Explain **speciation processes** (sympatric and allopatric) and the role of **coevolution and adaptive radiation**.

	o Discuss **reproductive isolation** and its evolutionary significance. 3. **Phylogeny and Evolutionary Relationships:** o Understand the **phylogenetic relationships** of **bacteria, algae, fungi, bryophytes, pteridophytes, and gymnosperms**. o Interpret **phylogenetic trees** and their importance in evolutionary biology. --- **Course Outcomes (COs) for Practical (PLANT GEOGRAPHY, ECOLOGY, AND EVOLUTION - DSC/Core - Practical)** After completing the practical component, students will: **Plant Geography:** 1. **Conduct a field visit** to at least one **phytogeographical region** in India. 2. **Study local flora** and prepare a **project report** highlighting **phytogeographical characteristics**. **Ecology:** 1. **Assess community structure** using the **quadrat method**, including: o Determining the **minimal quadrat size**. o Estimating **frequency, density, and abundance** of plant species during fieldwork. 2. **Measure foliar dust deposition** to study environmental pollution effects. 3. **Determine dissolved oxygen** in water samples using **Winkler's method (azide modification)**. 4. **Analyze soil properties** using rapid spot tests for **carbonate, iron, and nitrate content**. 5. **Estimate organic carbon percentage** in soil samples. **Evaluation Criteria:** • **Work out on ecological parameters (10 marks)**

	• **Classroom performance (5 marks)** • **Field records (5 marks)** - Field notebook on phytogeographical and ecological studies • **Viva-voce (5 marks)** **Conclusion:** This course provides **a comprehensive understanding of plant distribution, ecological interactions, biodiversity conservation, and evolutionary processes**. It equips students with both **theoretical knowledge and practical skills** necessary for careers in **plant sciences, environmental conservation, and research**.