CHOICE BASED CREDIT SYSTEM

B.Sc. (Honours) Botany
(Under the Framework of Honours School System)

SEMESTER
I & II
PREAMBLE

Today plant science is a fusion of the traditional components with the modern aspects of biochemistry, molecular biology and biotechnology. Over the years, plant science (Botany) has shown enormous gain in information and applications owing to tremendous inputs from research in all its aspects. With global recognition of the need for conservation, field plant biologists have contributed significantly in assessing plant diversity. Taxonomists have explored newer dimensions for the classification of plants. New insights have been gained in functional and structural aspects of plant development by utilizing novel tools and techniques for botanical research. Challenging areas of teaching and research have emerged in ecology and reproductive biology. Concern for ever increasing pollution and climate change is at its highest than ever before. Keeping these advancements in view, a revision of the curriculum at the undergraduate level is perfectly timed. The Botany students across Indian Universities shall have the benefit of a balanced, carefully-crafted course structure taking care of different aspects of plant science, namely plant diversity, physiology, biochemistry, molecular biology, reproduction, anatomy, taxonomy, ecology, economic botany and the impact of environment on the growth and development of plants. All these aspects have been given due weightage over the six semesters. It is essential for the undergraduate students to acquaint themselves with various tools and techniques for exploring the world of plants up to the subcellular level. A paper on this aspect is proposed to provide such an opportunity to the students before they engage themselves with the learning of modern tools and techniques in plant science.

Keeping the employment entrepreneurship in mind, applied courses have also been introduced. These courses shall provide the botany students hands on experience and professional inputs. On the whole, the curriculum is a source of lot of information and is supported by rich resource materials. It is hoped that a student graduating in Botany with the new curriculum will be a complete botanist at Honours level.

Students should be encouraged to opt for atleast 1 or 2 Generic Electives from other Life Sciences like Zoology/Microbiology/Biochemistry/Biotechnology and Chemistry courses.
OUTLINES OF TESTS

OBJECTIVE OF THE COURSE
To teach the fundamental concepts of Botany and their applications. The syllabus pertaining to B.Sc. (Honours) Botany (3 Year course & 6 Semesters) in the subject of Botany under Honours School Framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills according to UGC module for CHOICE BASED CREDIT SYSTEM pertaining to B.Sc. Honours (Botany).

Semester I

CORE COURSE (BOTANY)

Theory Papers:
Core Course-1 (C 1): Phycology & Microbiology 100 Marks (4 credits)
Core Course-2 (C 2): Biomolecules & Cell Biology 100 Marks (4 credits)

Practicals:
Core Course-1 Practical (C 1 Lab): 50 Marks (2 credits)
Core Course-2 Practical (C 2 Lab): 50 Marks (2 credits)

GENERIC ELECTIVE (BOTANY)
For students of other departments (offered by Botany Deptt)

Theory Papers:
Generic Elective -1 (GE-1) Biodiversity (Microbes, Algae, Fungi and Archegoniates) 100 Marks (4 credits)

Practicals:
Generic Elective -1 Practical (GE-1 Lab) 50 Marks (2 credits)

Semester II

CORE COURSE (BOTANY)

Theory Papers:
Core Course-3 (C 3): Mycology & Phytopathology 100 Marks (4 credits)
Core Course-4 (C 4): Archegoniates 100 Marks (4 credits)

Practicals:
Core Course-3 Practical (C 3 Lab): 50 Marks (2 credits)
Core Course-4 Practical (C 4 Lab): 50 Marks (2 credits)
GENERIC ELECTIVE (BOTANY)
For students of other departments (offered by Botany Deptt)

Theory Papers:
Generic Elective -2 (GE-2) Plant Anatomy and Embryology 100 Marks (4 credits)

Practicals:
Generic Elective -2 Practical (GE-2 Lab) 50 Marks (2 credits)

EVALUATION
1. There shall be one Mid Term Examination of 20% Marks (20 marks) in each semester.
2. End-semester examination will be of 80% of total marks (80 marks).
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% marks (10 marks). The final examination will be of 80% marks (40 marks).

Pattern of end-semester question paper

(i) Nine questions in all with equal weightage (16 marks). The candidate will be asked to attempt five questions
(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
(iii) The remaining eight questions will have Four Units comprising two questions from each Unit.
(iv) Students will attempt one question from each unit and the compulsory question.

ABILITY ENHANCEMENT COMPULSORY COURSE FOR BOTANY STUDENTS

Each student of Botany Department has to opt one Ability Enhancement Compulsory Course of the following:

1. English Communication (2 credits)
2. Environmental Science (2 credits)

SEMESTER II

Outlines for Semester II will be same as for Semester I

A Department will run a particular Generic Elective Course only if the minimum number of students opting for that course is 10.
## COURSE STRUCTURE

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</table>

C: Core Courses; GE: General Elective; AECC: Ability Enhancement Compulsory Courses; DSE: Discipline Specific Elective; SEC: Skill Enhancement Courses

*: GE subjects are to be selected by the students from various Departments of the University.
**SKILL ENHANCEMENT COURSES (any one per semester in semesters 3-4)**

1. BOT-SEC1: Biofertilizers
2. BOT-SEC2: Herbal Technology
3. BOT-SEC3: Nursery and Gardening
4. BOT-SEC4: Floriculture
5. BOT-SEC5: Medicinal Botany
6. BOT-SEC6: Plant Diversity and Human Welfare
7. BOT-SEC7: Ethnobotany
8. BOT-SEC8: Mushroom Culture Technology

**DISCIPLINE CENTRIC SUBJECTS (any two per semester in semester 5-6)**

1. BOT-DSE-1: Analytical techniques in Plant Sciences
2. BOT-DSE-2: Bioinformatics
3. BOT-DSE-3: Stress Biology
4. BOT-DSE-4: Plant Breeding
5. BOT-DSE-5: Natural Resource Management
7. BOT-DSE-7: Research Methodology
8. BOT-DSE-8: Industrial and Environmental Microbiology
9. BOT-DSE-9: Biostatistics

**Courses under these will be offered only if a minimum of 10 students opt for the same**

**GENERIC ELECTIVE SUBJECTS (Offered by BOTANY Department) for students of other departments**

1. BOT-C-GE-1: Biodiversity (Microbes, Algae, Fungi and Archegoniate)
2. BOT-C-GE-2: Plant Anatomy and Embryology
3. BOT-C-GE-3: Economic Botany and Plant Biotechnology
4. BOT-C-GE-4: Plant Ecology and Taxonomy
Semester I

BOT-C1: (Phycology and Microbiology)

THEORY

Total Lectures: 60

Objective: To provide knowledge about various kinds of microbes starting with viruses followed by bacteria and various kind of algae.

Instructions for the Paper Setters and Examiners:

Question paper will have four sections. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT 1: (Microbiology) (15 hrs)

Introduction to microbial world: Microbial nutrition, growth and metabolism. Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases. Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

Viruses: Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV).

Bacteria: Discovery, general characteristics; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction).

UNIT 2: (Algae) (15 hrs)

Algae: General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar). Role of algae in the environment, agriculture, biotechnology and industry.

UNIT 3: (Cyanophyta, Xanthophyta, Chlorophyta and Bacillariophyta) (15 hrs)

Cyanophyta and Xanthophyta: Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of Nostoc and Vaucheria. Evolutionary significance of Prochloron.

Chlorophyta and Bacillariophyta: General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of Chlamydomonas, Volvox, Oedogonium, Coleochaete, Chara, Pinnularia.
UNIT 4: (Phaeophyta and Rhodophyta) (15 hrs)

**Phaeophyta and Rhodophyta:** Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus, Fucus* and *Polysiphonia.*

**BOT-C1: (Phycology and Microbiology)**

**PRACTICALS**

Total Lectures: 60 Credits: 2

**Microbiology**
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
3. Gram staining.
4. Endospore staining with malachite green using the (endospores taken from soil bacteria).

**Phycology**
   Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), *Volvox, Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia, Prochloron* through electron micrographs, temporary preparations and permanent slides.

**ESSENTIAL READING**

**SUGGESTED READING**
Semester I
BOT-C2: (Biomolecules and Cell Biology)

THEORY

Total Lectures: 60  
Credits : 4

Objectives: To provide knowledge about various kinds of biomolecules, process of bioenergetics, structure and functions of enzymes, cell and its organelles.

Instructions for the Paper Setters and Examiners:
Question paper will have four sections. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT 1: (Biomolecules)  
(15 hrs)

Biomolecules: Types and significance of chemical bonds; Structure and properties of water; pH and buffers.
Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.
Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.
Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins.
Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

UNIT 2: (Bioenergetics and Enzymes)  
(15 hrs)

Bioenergetics: Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule.
Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

UNIT 3: (Cell)  
(15 hrs)

The cell: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory). (4 lectures)
Cell wall and Plasma Membrane: Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.
UNIT 4: (Cell Organelles)  
(15 hrs)

**Nucleus:** Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

**Cytoskeleton:** Role and structure of microtubules, microfilaments and intermediary filament.

**Chloroplast, mitochondria and peroxisomes:** Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.

**Endomembrane system:** Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes.

**Cell division:** Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role of protein kinases.

**BOT –C2: (Biomolecules and Cell Biology)**

**PRACTICALS**

**Total Lectures:** 60  
**Credits:** 2

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum.
3. Demonstration of the phenomenon of protoplasmic streaming in Hydrilla leaf.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
6. Study of cell and its organelles with the help of electron micrographs.
7. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff’s (PAS) staining technique.
8. Study the phenomenon of plasmolysis and deplasmolysis.
9. Study the effect of organic solvent and temperature on membrane permeability.
10. Study different stages of mitosis and meiosis.

**ESSENTIAL READING**


**FURTHER READING**

2. Campbell, PN and Smith AD (2011) *Biochemistry Illustrated, 4th edition*. Published by Churchill Livingstone
Semester II

BOT-C3: (Mycology and Phytopathology)

THEORY

Total Lectures: 60                                                                                                     Credits: 4

Objectives: To provide knowledge about various classes of fungi and their significance, fungal diseases and their effects on plants.

Instructions for the Paper Setters and Examiners:
Question paper will have four sections. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT 1: (Introduction) (15 hrs)

Introduction to true fungi: General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification.

Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; Life cycle and classification with reference to Saccharomyces, Aspergillus, Penicillium, Alternaria, Neurospora and Peziza.

UNIT 2: (Chitridio-, Zygo-, Basidio- and Oomycota) (15 hrs)

Chytridiomycota and Zygomycota: Characteristic features; Ecology and significance; Thallus organisation; Reproduction; Life cycle with reference to Synchytrium, Rhizopus.

Basidiomycota: General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat Puccinia (Physiological Specialization), loose and covered smut (symptoms only), Agaricus; Bioluminescence, Fairy Rings and Mushroom Cultivation.

Oomycota: General characteristics; Ecology; Life cycle and classification with reference to Phytophthora, Albugo.

UNIT 3: (Allied, Symbiotic, Applied Mycology) (15 hrs)

Allied Fungi: General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.

Symbiotic associations: Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.
Applied Mycology
Role of fungi in biotechnology; Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycfungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.

UNIT 4: (Phytopathology) (15 hrs)

Phytopathology: Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine.


BOT-C3: (Mycology and Phytopathology)

PRACTICALS

Total Lectures: 60 Credits: 2
1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).
2. Rhizopus: study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. Aspergillus and Penicillium: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
4. Peziza: sectioning through ascocarp.
5. Alternaria: Specimens/photographs and temporary mounts.
6. Puccinia: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
7. Agaricus: Specimens of button stage and full grown mushroom; sectioning of gills of Agaricus, fairy rings and bioluminescent mushrooms to be shown.
8. Study of phaneroplasmodium from actual specimens and /or photograph. Study of Stemonitis sporangia.
9. Albugo: Study of symptoms of plants infected with Albugo; asexual phase study through section/ temporary mounts and sexual structures through permanent slides.
10. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
ESSENTIAL READING

FURTHER READING
Objective: To provide knowledge about Bryophytes, Pteridophytes and Gymnosperms involving their habits, reproductive cycle and economic importance.

Instructions for the Paper Setters and Examiners:
Question paper will have four sections. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT 1: (Introduction) (15 hrs)

Introduction: Unifying features of archegoniates; Transition to land habit; Alternation of generations.
General characteristics of Bryophytes, Pteridophytes and Gymnosperms; Adaptations to land habit; Classification; Range of thallus organization.

UNIT 2: (Bryophytes) (15 hrs)

Type Studies: Classification (up to family), morphology, anatomy and reproduction of Riccia, Marchantia, Pellia, Porella, Anthoceros, Sphagnum and Funaria; Reproduction and evolutionary trends in Riccia, Marchantia, Anthoceros and Funaria (developmental stages not included). Ecological and economic importance of bryophytes with special reference to Sphagnum.

UNIT 3: (Pteridophytes) (15 hrs)

Pteridophytes: Classification; Early land plants (Cooksonia and Rhynia).

Type Studies: Classification (up to family), morphology, anatomy and reproduction of Psilotum, Selaginella, Equisetum and Pteris (Developmental details not to be included). Apogamy, and apospory, heterospory and seed habit, telome theory, stelar evolution; Ecological and economic importance.

UNIT 4: (Gymnosperms) (15 hrs)

Type Studies: Classification (up to family), morphology, anatomy and reproduction of Cycas, Pinus and Gnetum (Developmental details not to be included); Ecological and economic importance.
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<td>1.</td>
<td><strong>Riccia</strong> – Morphology of thallus.</td>
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<td>2.</td>
<td><strong>Marchantia</strong>- Morphology of thallus, whole mount of rhizoids &amp; Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).</td>
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<td>3.</td>
<td><strong>Anthoceros</strong>- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).</td>
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<td>4.</td>
<td><strong>Pellia, Porella</strong>- Permanent slides.</td>
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<td>5.</td>
<td><strong>Sphagnum</strong>- Morphology of plant, whole mount of leaf (permanent slide only).</td>
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<td>6.</td>
<td><strong>Funaria</strong>- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.</td>
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<td>7.</td>
<td><strong>Psilotum</strong>- Study of specimen, transverse section of synangium (permanent slide).</td>
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<td>8.</td>
<td><strong>Selaginella</strong>- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).</td>
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<td>9.</td>
<td><strong>Equisetum</strong>- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).</td>
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<td>10.</td>
<td><strong>Pteris</strong>- Morphology, transverse section of rachis, vertical section of sporophyll, whole mount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).</td>
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<td>11.</td>
<td><strong>Cycas</strong>- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).</td>
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<td>12.</td>
<td><strong>Pinus</strong>- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stem, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section &amp; radial longitudinal sections stem (permanent slide).</td>
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<tr>
<td>13.</td>
<td><strong>Gnetum</strong>- Morphology (stem, male &amp; female cones), transverse section of stem, vertical section of ovule (permanent slide)</td>
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<td><strong>Botanical excursion.</strong></td>
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ESSENTIAL READING

FURTHER READING
B.Sc. (Hons.) BOTANY

(Generic Elective Courses)
BOT-C-GE1: Biodiversity
(Microbes, Algae, Fungi and Archegoniates)

THEORY

Total Lectures: 60 Credits: 4

Objectives: To provide knowledge about various kinds of microbes, algae, fungi followed by Bryophytes, Pteridophytes and Gymnosperms involving their life cycle.

Instructions for the Paper Setters and Examiners:
Question paper will have four sections. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Unit 1: Microbes and Algae (15 hrs)
Microbes: Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Algae: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia. Economic importance of algae.

Unit 2: Fungi (15 hrs)
Fungi: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of Rhizopus (Zygomycota) Penicillium, Alternaria (Ascomycota), Puccinia, Agaricus (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

Unit 3: Introduction to Archegoniates (15 hrs)
Unifying features of archegoniates, Transition to land habit, Alternation of generations.
Bryophytes: General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Marchantia and Funaria. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of Sphagnum.

Unit 4: Pteridophytes and Gymnosperms (15 hrs)
Pteridophytes: General characteristics, classification, Early land plants (Cooksonia and Rhynia). Classification (up to family), morphology, anatomy and reproduction of Selaginella, Equisetum and Pteris. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes.
**Gymnosperms**: General characteristics; Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included). Ecological and economical importance.

**BOT-C-GE1: Biodiversity**  
*(Microbes, Algae, Fungi and Archegoniates)*

**PRACTICALS**

**Total Lectures: 60**  
**Credits: 2**

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), *Oedogonium, Vaucheria, Fucus* and *Polysiphonia* through temporary preparations and permanent slides. (*Fucus* - Specimen and permanent slides)
5. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structure through permanent slides.
7. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
11. Marchantia- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
12. Funaria- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
13. Selaginella- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
14. Equisetum- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophere, w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
15. Pteris- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
16. Cycas- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
17. *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m.dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

**ESSENTIAL READING**


**FURTHER READING**

Objectives: To provide knowledge about various kinds of tissues and their functions, secondary growth and reproductive aspects in higher plants.

Instructions for the Paper Setters and Examiners:
Question paper will have four sections. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Unit 1: Meristematic, Permanent Tissues and Organs (15 hrs)
Meristematic and Permanent Tissues: Root and shoot apical meristems; Simple and complex tissues.
Organs: Structure of dicot and monocot root stem and leaf.

Unit 2: Secondary Growth; Adaptive and Protective System (15 hrs)
Adaptive and protective systems: Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 3: Flower; Pollination and Fertilization (15 hrs)
Structural organization of flower: Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.
Pollination and fertilization: Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 4: Embryo and endosperm; Apomixis and Polyembryony (15 hrs)
Embryo and endosperm: Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm Relationship.
Apomixis and Polyembryony: Definition, types and Practical applications.

BOT-C-GE2: Plant Anatomy and Embryology
PRACTICALS
Total Lectures: 60 Credits: 2
1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

**ESSENTIAL READING**


**FURTHER READING**

SEMESTER

III & IV
Semester III
CORE COURSE (BOTANY)

Theory Papers:
Core Course-5 (C 5): Morphology & Anatomy 100 Marks (4 credits)
Core Course-6 (C 6): Economic Botany 100 Marks (4 credits)
Core Course-7 (C 7): Basics of Genetics 100 Marks (4 credits)

Practicals:
Core Course-5 Practical (C 5 Lab): Morphology & Anatomy 50 Marks (2 credits)
Core Course-6 Practical (C 6 Lab): Economic Botany 50 Marks (2 credits)
Core Course-7 Practical (C 7 Lab): Basics of Genetics 50 Marks (2 credits)

GENERIC ELECTIVE (BOTANY)
Each student from other disciplines may opt any one of the generic electives in semester offered by the Science Departments of Panjab University out of following:

Theory Papers:
Generic Elective -5 (GE-5) 100 Marks (4 credits)

Practicals:
Generic Elective -5 Practical (GE-5 Lab) 50 Marks (2 credits)

SKILL ENHANCEMENT COURSE
Each student of the department may opt any one course in each semester offered by the Department.
Skill Enhancement Course -1 (SEC-1) 50 Marks (2 credits)

Semester IV
CORE COURSE (BOTANY)

Theory Papers:
Core Course-8 (C 8): Molecular Biology 100 Marks (4 credits)
Core Course-9 (C 9): Plant Ecology & Phytogeography 100 Marks (4 credits)
Core Course-10 (C 10): Plant Systematics 100 Marks (4 credits)

Practicals:
Core Course-8 Practical (C 8 Lab): Molecular Biology 50 Marks (2 credits)
Core Course-9 Practical (C 9 Lab): Plant Ecology & Phytogeography 50 Marks (2 credits)
Core Course-10 Practical (C 10 Lab): Plant Systematics 50 Marks (2 credits)

GENERIC ELECTIVE (BOTANY)
Each student from other disciplines may opt any one of the generic electives one in each semester offered by the Science Departments of Panjab University out of following:
**Theory Papers:**
Generic Elective -6 (GE-6) 100 Marks (4 credits)

**Practicals:**
Generic Elective -6 Practical (GE-6 Lab) 50 Marks (2 credits)

**SKILL ENHANCEMENT COURSE**
Each student of the department may opt any one course in each semester offered by the Department.
Skill Enhancement Course -1 (SEC-2) 50 Marks (2 credits)

**EVALUATION**
5. There shall be one Mid Term Examination of 20% Marks (20 marks) in each semester.
6. End-semester examination will be of 80% of total marks (80 marks).
7. Each practical examination shall be of 3 hours duration.
8. There shall be continuous internal assessment for practical of 20% marks (10 marks). The final examination will be of 80% marks (40 marks).

**Pattern of End-Semester Question Paper:**
   i. Nine questions in all with equal weight-age (16 marks). The candidate will be asked to attempt five questions
   ii. One compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
   iii. The remaining eight questions will have **Four Units** comprising two questions from each Unit.
   iv. Students will attempt one question from each unit and the compulsory question.
BOT-C5: Morphology & Anatomy  
(Credits: Theory-4, Practical-2)  

THEORY  
Lectures: 60

Objectives:  To provide knowledge about the internal organization of the plant body-tissue systems and the type of cells.

Instructions for the Paper Setters and Examiners:  
Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I  
Introduction and scope of Plant Anatomy:  Applications in systematics, forensics and pharmacognosy.  
Structure and Development of Plant Body: Internal organization of plant body: The three tissue systems, types of cells and tissues. Development of plant body: Polarity, Cyto-differentiation and organogenesis during embryogenic development. Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and non-glandular, two examples of each), stomata (classification).  
(14 Lectures)

UNIT-II  
Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); cyto-differentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers. Anatomical adaptations of xerophytes and hydrophytes.  
(16 Lectures)

UNIT-III  
Apical meristems: Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.  
(15 Lectures)

UNIT-IV  
Vascular Cambium and Wood: Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.  
(15 Lectures)
Practicals:
1. Study of anatomical details through permanent slides/temporary stain mounts/macerations/museum specimens with the help of suitable examples.
3. Distribution and types of parenchyma, collenchyma and sclerenchyma.
4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsi-ventral, C4 leaves (Kranz anatomy).

ESSENTIAL READINGS
3. Pandey, B.P. *Plant Anatomy*. S. Chand and Company Ltd.

SUGGESTED READINGS
OBJECTIVES: To provide knowledge about the economics and utilization of different plants and crops.

Instructions for the Paper Setters and Examiners:
Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I
Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov’s work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.

UNIT-II
Legumes: Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.

Sources of sugars and starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

Spices: Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper

UNIT-III
Beverages: Tea, Coffee (morphology, processing & uses)

Sources of oils and fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.

Natural Rubber: Para-rubber: tapping, processing and uses.

UNIT-IV
Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis; Tobacco (Morphology, processing, uses and health hazards).

Timber plants: General account with special reference to teak and pine.

Fibers: Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).
Practicals:

1. **Cereals**: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests) Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. **Legumes**: Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. **Sources of sugars and starches**: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
4. **Spices**: Black pepper, Fennel and Clove (habit and sections).
5. **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
6. **Sources of oils and fats**: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.
7. **Essential oil-yielding plants**: Habit sketch of *Rosa, Vetiveria, Santalum* and *Eucalyptus* (specimens/photographs).
8. **Rubber**: specimen, photograph/model of tapping, samples of rubber products.
9. **Drug-yielding plants**: Specimens of *Digitalis, Papaver* and *Cannabis*.
10. **Tobacco**: specimen and products of Tobacco.
11. **Woods**: *Tectona, Pinus*: Specimen, Section of young stem.
12. **Fiber-yielding plants**: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

**ESSENTIAL READING**


**SUGGESTED READINGS**

BOT-C7: Basics of Genetics  
(Credits: Theory-4, Practical-2)

THEORY  
Lectures: 60

Objectives: To provide knowledge about the study of chromosomes, genes and their inheritance.

Instructions for the Paper Setters and Examiners:  
Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I  
Mendelian genetics and its extension: Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and co-dominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.  
(16 lectures)

UNIT-II  
Extrachromosomal Inheritance: Chloroplast mutation: Variegation in Four-o’-clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity-Kappa particles in Paramecium.  
(6 lectures)

Linkage, crossing over and chromosome mapping: Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.  
(12 lectures)

UNIT-III  
Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy  
(8 lectures)

Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation.DNA repair mechanisms.  
(6 lectures)

UNIT-IV  
Fine structure of gene: Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.  
(6 lectures)

(6 lectures)
Practicals:

1. Meiosis through temporary squash preparation.
2. Mendel’s laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Chromosome mapping using point test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
7. Study of aneuploidy: Down’s, Klinefelter’s and Turner’s syndromes.
8. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.

ESSENTIAL READINGS


SUGGESTED READINGS

Semester-IV

BOT-C8: Molecular Biology
(Credits: Theory-4, Practical-2)
Lectures: 60

Objectives: To provide knowledge about the genes and carriers of genetic information.

Instructions for the Paper Setters and Examiners:
Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I
Nucleic acids : Carriers of genetic information: Historical perspective; DNA as the carrier of genetic information (Griffith’s, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat’s experiment. (4 lectures)
The Structures of DNA and RNA / Genetic Material: DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA-Prokaryotes, Viruses, Eukaryotes.RNA Structure Organelle DNA -- mitochondria and chloroplast DNA. The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. (10 lectures)

UNIT-II
The replication of DNA: Chemistry of DNA synthesis (Kornberg’s discovery); General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5’end of linear chromosome; Enzymes involved in DNA replication. (10 lectures)
Central dogma and genetic code: Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features). (2 lectures)

UNIT-III
Transcription: Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in E.coli. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing. (18 lectures)

UNIT-IV
Processing and modification of RNA: Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing(5’ cap, 3’ polyA tail); Ribozymes; RNA editing and mRNA transport. (8 lectures)
Translation: Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins. (8 lectures)

Practicals:
1. Preparation of LB medium and raising E.Coli.
2. Isolation of genomic DNA from E.Coli.
3. DNA isolation from cauliflower head.
4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
7. Photographs establishing nucleic acid as genetic material (Messelon and Stahl’s, Avery et al, Griffith’s, Hershey & Chase’s and Fraenkel & Conrat’s experiments)
8. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

ESSENTIAL READINGS

SUGGESTED READINGS
BOT-C9: Plant Ecology and Phytogeography  
(Credits: Theory-4, Practical-2)

THEORY
Lectures: 60

Objectives: To provide knowledge about the habit and habitat of the plant systems and their interactive studies.

Instructions for the Paper Setters and Examiners:
Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I
Introduction: Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.

Biotic Interactions: autotrophy, heterotrophy; symbiosis, commensalism and parasitism etc. (10 lectures)

UNIT-II
Abiotic Components and Biotic Interactions: Soil: Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development; Importance of Soil. Water: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table; Importance of Water Other abiotic factors viz: Light, temperature, wind and fire; Variations; adaptations of plants to their variation. (20 lectures)

UNIT-III
Population and Community Ecology: Characteristics and Dynamics of Population; Ecological Speciation; Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts. (12 lectures)

UNIT-IV
Ecosystem Ecology & Phytogeography: Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids. Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

Phytogeographical principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation. (18 lectures)
Practicals:

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.

2. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)

3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.

4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.

5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.

6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.

7. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each).
   (b). Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche) Epiphytes, Predation (Insectivorous plants).

8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).

9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer’s frequency distribution law.

10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.

11. Field visit to familiarise students with ecology of different sites.

ESSENTIAL READINGS


**SUGGESTED READINGS**


BOT-C10: Plant Systematics  
(Credits: Theory-4, Practical-2)

THEORY
Lectures: 60

Objectives: To provide knowledge about the identification, classification and nomenclature of the plant systems.

Instructions for the Paper Setters and Examiners: Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I
Significance of Plant Systematics: Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access. (12 lectures)

UNIT-II
Taxonomic Hierarchy and Botanical Nomenclature: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids. (16 lectures)

UNIT-III
Systems of Classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification. (12 lectures)

UNIT-IV
Biometrics, Numerical Taxonomy, Cladistics and Phylogeny: Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences). Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram). (22 lectures)
Practicals:
1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker’s system of classification):

   Ranunculaceae - *Ranunculus, Delphinium*
   Brassicaceae - *Brassica, Alyssum / Iberis*
   Myrtaceae - *Eucalyptus, Callistemon*
   Umbelliferae - *Coriandrum /Anethum / Foeniculum*
   Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax*
   Solanaceae - *Solanum nigrum/Withania*
   Lamiaceae - *Salvia/Ocimum*
   Euphorbiaceae - *Euphorbia hirta/E.milii, Jatropha*
   Liliaceae - *Asphodelus/Lilium/Allium*
   Poaceae - *Triticum/Hordeum/Avena*

2. Field visit (local) – Subject to grant of funds from the university.
3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

ESSENTIAL READINGS

SUGGESTED READINGS
Generic Elective Courses

Economic Botany and Plant Biotechnology
(Credits: Theory-4, Practical-2)

THEORY
Lectures: 60

Objectives: To provide knowledge about the economics of cultivated species and the technical advances in their propagation and utilization.

Instructions for the Paper Setters and Examiners:
Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I
Origin of Cultivated Plants: Concept of centres of origin, History Primary and Secondary Centres- Properties, uses and type of wood. (4 lectures)

Cereals: Rice, Wheat -Origin, morphology, uses (4 lectures)

Legumes: General account with special reference to Gram and soybean (6 lectures)

UNIT-II
Spices: General account with special reference to classification according to part used with 2 examples each, clove and black pepper (Botanical name, family, part used, morphology and uses). (6 lectures)

Beverages: Coffee, Tea (morphology, processing, uses) (4 lectures)

UNIT-III
Oils and Fats: General description with special reference to groundnut. Classification of oils with examples (detailed) (4 lectures)

Fibre Yielding Plants: General description with special reference to Cotton, Jute, Coir (Botanical name, family, part used, morphology and uses). (4 lectures)

UNIT-IV
Introduction to biotechnology (2 lecture)

Plant tissue culture: Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications. (8 lectures)

Recombinant DNA Techniques: Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies,
ELISA and Immuno detection. Molecular diagnosis of human disease, Human gene therapy. (18 lectures)

Practicals:
1. Sections of wood.
2. Study of economically important plants: Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical tests
3. Familiarization with basic equipments in tissue culture.
4. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
5. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

ESSENTIAL READINGS

SUGGESTED READINGS
Generic Elective
Environmental Biotechnology
(Credits: Theory-4, Practical-2)

theory

Lectures: 60

Objectives: To provide knowledge about the environment, its conservation with the help of technical advances.

Instructions for the Paper Setters and Examiners:
Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I

Environment: Basic concepts and issues, global environmental problems - ozone depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management. (4 lectures)

Environmental problems: Environmental pollution - types of pollution, sources of pollution, measurement of pollution, methods of measurement of pollution, fate of pollutants in the environment, Bioconcentration, bio/geomagnification. (6 lectures)

Microbiology of waste water treatment: Aerobic process - activated sludge, oxidation ponds, trickling filter, towers, rotating discs, rotating drums, oxidation ditch. Anaerobic process - anaerobic digestion, anaerobic filters, up-flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar and antibiotic industries. (8 lectures)

UNIT-II

Xenobiotic compounds: Organic (chlorinated hydrocarbons, substituted simple aromatic compounds, polycyclic hydrocarbons, pesticides, surfactants) and inorganic (metals, radionuclides, phosphates, nitrates). Bioremediation of xenobiotics in environment - ecological consideration, decay behavior and degradative plasmids, molecular techniques in bioremediation. (10 lectures)

Role of immobilized cells/enzymes in treatment of toxic compounds: Biopesticides, bioreactors, bioleaching, biomining, biosensors, biotechniques for air pollution abatement and odour control. (6 lectures)

UNIT-III

Sustainable Development: Economics and Environment: Economic growth, Gross National Productivity and the quality of life, Tragedy of Commons, Economics of Pollution control, Cost-benefit and cost effectiveness analysis, WTO and Environment, Corporate Social Responsibility, Environmental awareness and Education; Environmental Ethics. (8 lectures)


UNIT-IV

Public Participation for Environmental Protection: Environmental movement and people’s participation with special references to Gandhamardan, Chilika and Narmada Bachao Andolan, Chipko and Silent valley Movement; Women and Environmental Protection, Role of NGO in bringing environmental awareness and education in the society. (6 lectures)

Practicals:
1. Water/Soil analysis - DO, salinity, pH, chloride, total hardness, alkalinity, acidity, nitrate, calcium, Magnesium and phosphorus.
2. Gravimetric analysis-Total solid, dissolved solid, suspended solid in an effluent
3. Microbial assessment of air (open plate and air sample) and water

ESSENTIAL READINGS

SUGGESTED READINGS
Skill Enhancement Courses

Biofertilizers
(Credits 2)
Lectures: 30

Objectives: To provide knowledge about the plant resources as growth promoters and fertilizers.

Instructions for the Paper Setters and Examiners:
Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I
(8 lectures)

UNIT-II
General account about the microbes used as biofertilizer, Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.
(8 lectures)

UNIT-III
(8 lectures)

UNIT-IV
(6 lectures)

ESSENTIAL READINGS

SUGGESTED READINGS
Skill Enhancement Course

Floriculture

(Credits 2)
Lectures: 30

Objectives: To provide knowledge about the landscaping, gardening and commercial propagation of flowers.

Instructions for the Paper Setters and Examiners:
Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I
Introduction: History of gardening; Importance and scope of floriculture and landscape gardening. (2 Lectures)
Ornamental Plants: Flowering annuals; Herbaceous perennials; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai. (4 lectures)

UNIT-II
Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators. (8 lectures)

UNIT-III
Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India. (4 lectures)
Landscaping Places of Public Importance: Landscaping highways and educational institutions. (4 lectures)

UNIT-IV
Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium, Orchids). (6 lectures)
Diseases and Pests of Ornamental Plants. (2 lectures)

SUGGESTED READINGS
Skill Enhancement Course
Medicinal Botany
(Credits 2)
Lectures: 30

Objectives: To provide knowledge about the utilization of plant resources with medicinal benefits.

Instructions for the Paper Setters and Examiners:
Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I
History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e-tabiya, tumors treatments/therapy, polyherbal formulations. (8 Lectures)

UNIT-II
Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; ex-situ conservation: Botanic Gardens, Ethno-medicinal plant Gardens. (8 Lectures)

UNIT-III
Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany, folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases. (7 Lectures)

UNIT-IV
Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases. (7 Lectures)

ESSENTIAL READINGS

SUGGESTED READINGS
Skill Enhancement Course

Mushroom Culture Technology
(Credits 2) Lectures: 30

Objectives: To provide knowledge about the nutritional status and cultivation practices of mushrooms as a food.

Instructions for the Paper Setters and Examiners:
Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I
Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus.* (5 Lectures)

UNIT-II
Cultivation Technology: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production. (12 Lectures)

UNIT-III
Storage and nutrition: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in saltsolutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins. (8 Lectures)

UNIT-IV
Food Preparation: Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value. (5 lectures)

ESSENTIAL READINGS

SUGGESTED READINGS

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SEMESTER

V & VI
OUTLINES OF TESTS

OBJECTIVE OF THE COURSE: To teach the fundamental concepts of Botany and their applications. The syllabus pertaining to B.Sc. (Honours) Botany (3 Year course & 6 Semesters) in the subject of Botany under Honours School Framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills according to UGC module for CHOICE BASED CREDIT SYSTEM pertaining to B.Sc. Honors (Botany).

Semester V
CORE COURSE (BOTANY)

Theory Papers:
Core Course-11 (BOT-C11): Reproductive Biology of Angiosperms 100 Marks (4 credits)
Core Course-12 (BOT-C12): Plant Biotechnology 100 Marks (4 credits)

Practicals:
Core Course-11 (BOT-C11): Reproductive Biology of Angiosperms 50 Marks (2 credits)
Core Course-12 (BOT-C12): Plant Biotechnology 50 Marks (2 credits)

DISCIPLINE SPECIFIC ELECTIVE

Theory Papers:
DSE-1: 100 Marks (4 credits)
DSE-2: 100 Marks (4 credits)

Practicals
DSE-1: 50 Marks (2 credits)
DSE-2: 50 Marks (2 credits)

Semester VI
CORE COURSE (BOTANY)

Theory Papers:
Core Course-13 (BOT-C13): Plant Metabolism 100 Marks (4 credits)
Core Course-14 (BOT-C14): Plant Physiology 100 Marks (4 credits)

Practicals:
Core Course-13 (C13 Lab): Plant Metabolism 50 Marks (2 credits)
Core Course-14 (C 14 Lab): Plant Physiology 50 Marks (2 credits)

DISCIPLINE SPECIFIC ELECTIVE

Theory Papers:
DSE-3: 100 Marks (4 credits)
DSE-4: 100 Marks (4 credits)

Practicals
DSE-3: 50 Marks (2 credits)
DSE-4: 50 Marks (2 credits)
**EVALUATION**

1. There shall be one Mid Term Examination of 20% Marks (20 marks) in each semester.
2. End-semester examination will be of 80% of total marks (80 marks).
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practical of 20% marks (10 marks). The final examination will be of 80% marks (40 marks).

**Pattern of End-Semester Question Paper:**

i. Nine questions in all with equal weight-age (16 marks). The candidate will be asked to attempt five questions

ii. One compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.

iii. The remaining eight questions will have **Four Units** comprising two questions from each Unit.

iv. Students will attempt one question from each unit and the compulsory question.
Core Course XI: Reproductive Biology of Angiosperms  
(Credits: Theory-4, Practical-2)  

THEORY (Lectures: 60)  

Unit-I  
Introduction  
(10 lectures)  

Unit-II  
Anther and Ovule  
(18 lectures)  
Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.  
Structure of the Ovule; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of Polygonum type); Organization and ultrastructure of mature embryo sac.  

Unit-III  
Pollination, fertilization and Seed  
(16 lectures)  
Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.  
Embryo Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in Paeonia. Seed structure, importance and dispersal mechanisms  

Unit-IV  
Self incompatibility, Polyembryony and apomixis  
(16 lectures)  
Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization; Cybrids, in vitro fertilization.  
Polyembryony and Apomises: Introduction; Classification; Causes and applications
Practical

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, pseudomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test. germination: Calculation of percentage germination in different media using hanging drop method.
3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
4. Female gametophyte through permanent slides/photographs: Types, ultrastructure of mature egg apparatus.
6. Intra-ovarian pollination; Test tube pollination through photographs.
7. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
8. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

Essential Readings


Suggested Readings

Core Course XII: Plant Biotechnology
(Credits: Theory-4, Practical-2)

THEORY
Lectures: 60

Unit-I

Plant Tissue Culture
Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Unit-II

Recombinant DNA technology
Recombinant DNA, Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

Unit-III

Methods of gene transfer
Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Bacterial Transformation, PCR-mediated gene cloning; Selection of transgenics— selectable marker and reporter genes (Luciferase, GUS, GFP).Construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; colony hybridization.

Unit-IV

Applications of Biotechnology
Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Amylase, Protease, Lipase); Genetically Engineered Products–Human Growth Hormone; Humulin; overview of Biosafety concerns.

Practical
1. Preparation of MS medium and demonstration of in vitro sterilization and inoculation using leaf and nodal explants.
2. Study of anther, embryo and endosperm culture, protoplast isolation, micropropagation, somatic embryogenesis and artificial seeds through photographs.
3. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs.
6. Isolation of plasmid DNA.
7. Restriction digestion and gel electrophoresis of plasmid DNA.

**Essential Readings**

**Suggested Readings**
Core Course XIII: Plant Metabolism  
(Credits: Theory-4, Practical-2)

THEORY  
Lectures: 60

Unit-I  
Concepts of metabolism and Carbon assimilation  
(15 Lectures) 
Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes);

Composition of Biomolecules – shape, chemical properties, major classes of macromolecules and building block molecules;

Photosynthesis – pigments and carbon assimilation pathways, factors affecting CO₂ reduction.

Unit-II  
Carbohydrate and Lipid Metabolism  
(15 Lectures) 
Carbohydrate – chemistry and classification of mono-, di- and polysaccharides units, cellulose, glycoproteins, synthesis and catabolism of sucrose and starch;

Lipid – classification and importance, properties of fatty acids and fats, lipid oxidation pathways.

Unit-III  
Carbon oxidation and ATP Synthesis  
(12 Lectures) 
Glycolysis, TCA cycle, electron transport chain in mitochondria, factors affecting respiration;

ATP synthesis – mechanism, ATP synthase, chemiosmotic mechanism- oxidative and photophosphorylation.

Unit-IV  
Nitrogen metabolism, Proteins and Enzymes  
(18 lectures) 
Nitrate assimilation, biological nitrogen fixation, ammonia assimilation;
Proteins and Amino acids- classification, structure and properties of peptides;
Enzymes – classification, properties, substrate specificity, inhibition and coenzymes.
Practical

1. Chemical separation of photosynthetic pigments.
2. Experimental demonstration of Hill’s reaction.
3. To study the effect of light intensity on the rate of photosynthesis.
4. To compare the rate of respiration in different parts of a plant.
5. To study the activity of enzymes amylase and lipase in germinating seeds.
7. Qualitative tests for the presence of carbohydrates with Molish test, Anthrone reagent, Fehling reagent for reducing sugars.
8. Qualitative tests for the presence of amino acids with Ninhydrin reagent, Lee and Takahashi test.
9. Qualitative tests for the presence of proteins with spectrophotometry using Folin-Ciocalteau reagent.
10. Test of lipids and saponification test of fats.

Essential Readings


Suggested Readings

Core Course XIV: Plant Physiology  
(Credits: Theory-4, Practical-2)

THEORY  
Lectures: 60

Unit-I

Plant-water relations (18 lectures)  

Mineral nutrition  
Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

Unit-II  
Nutrient Uptake (16 lectures)  
Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

Translocation in the phloem  
Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

Unit-III  
Plant growth regulators (14 lectures)  
Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.

Unit-IV  
Physiology of flowering (12 lectures)  
Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

Phytochrome, crytochromes and phototropins  
Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Practical  
1. Determination of osmotic potential of plant cell sap by plasmolytic method.  
2. Determination of water potential of given tissue (potato tuber) by weight method.  
3. Determination of water potential of given tissue by falling drop method.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the effect of different concentrations of IAA on Avena coleoptile elongation (IAA Bioassay).
8. To study the induction of amylase activity in germinating barley grains.

**Demonstration experiments**

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).
3. Bolting experiment/Avena coleoptile bioassay (demonstration).

**Essential Readings**


**Suggested Readings**

Discipline Specific Elective Courses
Discipline Specific Elective

Plant Breeding
(Credits: Theory-4, Practical-2)
THEORY (Lectures: 60)

Unit-I

Plant Breeding (15 lectures)
Introduction, history and objectives. Discipline related to plant breeding; Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding. Centres of origin and domestication of crop plants.

Unit-II

Methods of crop improvement (15 lectures)
Plant genetic resources; Introduction and Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated crops; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

Unit-III

Quantitative inheritance, Inbreeding depression and heterosis (15 lectures)
Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings. Monogenic vs polygenic Inheritance. History, genetic basis of inbreeding depression and heterosis; Applications.

Unit-IV

Crop improvement and breeding (15 lectures)
Role of mutations, Polyploidy, Distant hybridization and biotechnology in crop improvement.

Practicals
1. Hybridization experiments in self and cross pollinated crops.
3. Identification of plant genetic resources.
4. Cultivation practices of crop plants.
5. Study of quantitative and qualitative traits in crops.
8. Study of equipments used in biotechnology.

Essential Readings

Suggested Reading
Discipline Specific Elective

Research Methodology
Credit: Theory 4; Practical 2
Theory (Lectures: 60)

Unit-I

Concepts of research, laboratory practices and data management: (15 lectures)
Research-definition and types of research, Literature-review and its consolidation.
Percentage solutions. Molar, molal and normal solutions. Technique of handling micropipettes;
Knowledge about common toxic chemicals and safety measures in their handling.
Maintaining a laboratory record; Imaging of tissue specimens and application of scale bars.

Unit-II

Biology Research areas, methods to study plant cells and tissues (15 lectures)
History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics,
Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-
Transcriptional regulatory network.
Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue
preparation: living vs fixed, physical vs chemical fixation.

Unit-III

Floriculture and Post-harvest technology (15 lectures)
Staining procedures, classification and chemistry of stains.
Cut flowers and bonsai – methods and market
Importance of post harvest technology in horticultural crops; Principles, methods of preservation
and processing; Methods of minimizing losses during storage and transportation.

Unit-IV

Disease management and conservation of horticultural crops (15 lectures)
Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and
nutritional management practices; Crop sanitation; IPM strategies and quarantine practices.
Documentation and conservation of germplasm; Role of micropropagation and tissue culture
techniques; varieties and cultivars of various horticultural crops IPR issues; National,
International and professional societies and sources of information on horticulture.
Practicals

1. Field trips
2. Preparation of solution
3. Whole mount and sectioning of tissues
4. Tissue culture methods.

Essential Readings


Suggested Readings

Discipline Specific Elective
Bioinformatics

(Credits: Theory-4, Practical-2)

THEORY (Lectures: 60)

Unit-I
Introduction to Bioinformatics & Databases-I (15 Lectures)
Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Nucleotide Database, Protein Database.

UNIT-II
Databases-II (18 Lectures)
EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.

DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ.

Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR.

Swiss-Prot: Introduction and Salient Features.

Unit-III
Sequence Alignments (12 Lectures)
Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM), Basic local alignment search tool (BLAST).

Unit-IV
Molecular Phylogeny & Applications of Bioinformatics (15 Lectures)
Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.
Practical

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.

Essential Readings


Suggested Readings

Discipline Specific Elective

Natural Resource Management
(Credits: Theory-4, Practical-2)

THEORY (Lectures: 60)

Unit-1
Natural resources and its Conservation (18 lectures)

Definition and types of natural resources: Land resources such as minerals and ores production in India and its contribution to the world; Land utilization (agricultural, pastoral, horticultural and silvicultural aspects); Soil degradation and management.

Water resources: fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies fresh and saline water bodies in India. Energy resources: Renewable and non-renewable sources of energy.

Unit-II
Biological Resources and its Conservation (18 lectures)

Concept, definition(s), Scope and limitations of Biodiversity, Scales and composition of Biodiversity: Genetic, Species, Ecological/Ecosystem Diversity, cultural and rituals role in biodiversity saving.

Biodiversity threats and measurements; Values and applications with humankind; National and International organizations involved in conservation practices, case study particularly from India.

Forest: Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.

Unit-III
Sustainable utilization of Natural Resources (12 lectures)

Concept, approaches (economic, ecological and socio-cultural), Sustainable Development and Ecological economics: concept, scope, objectives and principles.

Unit-IV
Contemporary practices in resource management and conservation (12 lectures)
EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.
IPR; CBD; National Biodiversity Action Plan), National and international approaches for Biodiversity Conservation.
Practical

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Collection of data on forest covers of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Ecological modeling.
6. Estimation of biodiversity indices such as species richness and evenness indices.

Suggested Readings


Further Readings


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