

CHOICE BASED CREDIT SYSTEM

B.Sc. (Honours) Botany

(Under the Framework of Honours School System)

SEMESTER I to VI

(Session 2019-2020)

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 3 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.

PANJAB UNIVERSITY, CHANDIGARH
OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR
CHOICE BASED CREDIT SYSTEM B.Sc. (HONOURS) BOTANY UNDER THE
FRAMEWORK OF HONOURS SCHOOL SYSTEM (SEMESTER SYSTEM)
EXAMINATION, 2019-2020

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- (BOT-C1):	Phycology & Microbiology	100 Marks (4 credits)
Core Course -(BOT-C2):	Biomolecules & Cell Biology	100 Marks (4 credits)

Practicals:

Core Course-Practical (BOT-C1 Lab)	50 Marks (2 credits)
Core Course-Practical (BOT-C2 Lab)	50 Marks (2 credits)

GENERIC ELECTIVE (BOTANY)

For students of other departments (offered by Botany Deptt)

Theory Papers:

Generic Elective-(BOT-C-GE1): Biodiversity (Microbes, Algae, Fungi and Archegoniates)	100 Marks (4 credits)
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Practicals:

Generic Elective - Practical (BOT-C-GE1 Lab)	50 Marks (2 credits)
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Semester II

CORE COURSE (BOTANY)

Theory Papers:

Core Course- (BOT-C3):	Mycology & Phytopathology	100 Marks (4 credits)
Core Course- (BOT-C4):	Archegoniates	100 Marks (4 credits)

Practicals:

Core Course- (BOT-C3 Lab)	50 Marks (2 credits)
Core Course- (BOT-C4 Lab)	50 Marks (2 credits)

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

Theory Papers:

Generic Elective - (BOT-C-GE2): Plant Anatomy and Embryology 100 Marks (4 credits)

Practicals:

Generic Elective -(BOT-C-GE2 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) (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)

B.Sc. (Honours) Botany
Session 2019-2020

COURSE STRUCTURE

SEMESTER I		SEMESTER II	
C1	BOT-C1: Phycology & Microbiology	C3	BOT-C3: Mycology & Phytopathology
C2	BOT-C2: Biomolecules & Cell Biology	C4	BOT-C4: Archegoniates
AECC1	AECC1: English	AECC2	AECC2: Environmental Science
GE1*	Biodiversity (Microbes, Algae, Fungi and Archegoniates)	GE2*	Plant Anatomy and Embryology

SEMESTER III		SEMESTER IV	
C5	BOT-C5: Morphology & Anatomy	C8	BOT-C7: Molecular Biology
C6	BOT-C6: Economic Botany	C9	BOT-C8: Plant Ecology & Phytogeography
C7	BOT-C7: Basics of Genetics	C10	BOT-C10: Plant Systematics
SEC1**	Biofertilizers	SEC5 **	Medicinal Botany
GE3*	Economic Botany and Plant Biotechnology	GE4*	Plant Ecology and Taxonomy

SEMESTER V		SEMESTER VI	
C11	BOT-C11: Reproductive Biology of Angiosperms	C13	BOT-C13: Plant Metabolism
C12	BOT-C12: Plant Biotechnology	C14	BOT-C14: Plant Physiology
DSE4***	Plant Breeding	DSE2***	Bioinformatics
DSE7***	Research Methodology	DSE5***	Natural Resource Management

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
- 9. BOT-SEC9: Intellectual Property Rights

*****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
- 6. BOT-DSE-6: Horticultural Practices and Post-Harvest Technology
- ***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 Archegoniates)
- *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

Credits: 4

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-archaeobacteria, 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* and *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*, *Dictyota*, *Fucus*, *Batrachospermum* and *Polysiphonia*.

BOT-C1: Phycology and Microbiology PRACTICALS

Total Lectures: 60

Credits: 2

Microbiology

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
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*, *Polysiphonia* and *Prochloron* through electron micrographs, temporary preparations and permanent slides.

ESSENTIAL READINGS

1. Kumar, H.D. (1999). *Introductory Phycology*. Affiliated East-West Press, Delhi.
2. Lee, R.E. (2008). *Phycology*. Cambridge University Press, Cambridge. 4th edition.
3. Pelczar, M.J. (2001) *Microbiology*. 5th edition. Tata McGraw-Hill Co, New Delhi.
4. South, G.R. and Whittick, A. (1987). *Introduction to Phycology*. Blackwell Scientific Publications, Oxford.

SUGGESTED READINGS

1. Campbell, N.A., Reece, J.B., Urry, L.A., Cain, M.L., Wasserman, S.A. Minorsky, P.V. and Jackson, R.B. (2008). *Biology*. Pearson Benjamin Cummings, USA. 8th edition.
2. Van Den Hock, C., Mann, D.G. and Johns, H.M. (1995). *An Introduction to Phycology*, Cambridge University Press, Cambridge.
3. Wiley, J. M, Sherwood, L.M. and Woolverton, C.J. (2013). *Prescott's Microbiology*. 9th Edition. McGraw Hill International.

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 quaternary; 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 theory), 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).

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 READINGS

1. Campbell, M.K. (2012) *Biochemistry*, 7th edition. Published by Cengage Learning
2. Karp, G. (2010) *Cell and Molecular Biology*, 6th edition. John Wiley & Sons, U.S.A.
3. Nelson, D.L. and Cox, M.M. (2008) *Lehninger Principles of Biochemistry*, 5th Edition, W.H. Freeman and Company.

FURTHER READINGS

1. Campbell, P.N. and Smith, A.D. (2011) *Biochemistry Illustrated*, 4th edition. Published by Churchill Livingstone
2. Cooper, G.M. and Hausman, R.E. (2009) *The Cell: A Molecular Approach*, 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. Hardin, J., Becker, G. and Skliensmith, L.J. (2012) *Becker's World of the Cell*, 8th edition. Pearson Education Inc. U.S.A.
4. Tymoczko J.L., Berg J.M. and Stryer, L. (2012) *Biochemistry: A short course*, 2nd edition. W.H. Freeman.

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: Chytridio-, Zygo-, Basidio- and Oomycota (15 hrs)

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

Bacterial diseases – Citrus canker and angular leaf spot of cotton. **Viral diseases** – Tobacco Mosaic viruses and vein clearing. **Fungal diseases** – Early blight of potato, Black stem rust of wheat, White rust of crucifers.

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)
11. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.

ESSENTIAL READINGS

1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). *Introductory Mycology 4th edition*. John Wiley & Sons (Asia) Singapore.
2. Sharma, P.D. (2011). *Plant Pathology*. Rastogi Publication, Meerut, India.

FURTHER READINGS

1. Agrios, G.N. (1997). *Plant Pathology, 4th edition*. Academic Press, U.K.
2. Sethi, I.K. and Walia, S.K. (2011). *Text book of Fungi and their Allies*. Macmillan Publishers India Ltd.
3. Webster, J. and Weber, R. (2007). *Introduction to Fungi, 3rd edition*. Cambridge University Press, Cambridge.

Semester II

BOT-C4: Archegoniates

THEORY

Total Lectures: 60

Credits: 4

Objectives: 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, reproduction and evolutionary trends in *Riccia*, *Marchantia*, *Pellia*, *Porella*, *Anthoceros*, *Sphagnum* 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 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 included); Ecological and economic importance.

BOT-C4: Archegoniates PRACTICALS

Total Lectures: 60

Credits: 2

1. ***Riccia*** – Morphology of thallus.
2. ***Marchantia***- Morphology of thallus, whole mount of rhizoids & 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).
3. ***Anthoceros***- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slides), vertical section of thallus (permanent slide).
4. ***Pellia, Porella***- Permanent slides.
5. ***Sphagnum***- Morphology of plant, whole mount of leaf (permanent slide only).
6. ***Funaria***- 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.
7. ***Psilotum***- Study of specimen, transverse section of synangium (permanent slide).
8. ***Selaginella***- 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).
9. ***Equisetum***- 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).
10. ***Pteris***- 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 slides).
11. ***Cycas***- 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 slides).
12. ***Pinus***- 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 & radial longitudinal sections stem (permanent slides).
13. ***Gnetum***- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slides)
14. **Botanical excursion.**

ESSENTIAL READINGS

1. Bhatnagar, S.P. and Moitra, A. (1996). *Gymnosperms*. New Age International (P) Ltd Publishers, New Delhi, India.
2. Parihar, N.S. (1991). *An Introduction to Embryophyta: Vol. I. Bryophyta*. Central Book Depot. Allahabad.
3. Rashid, A. (1998). *An Introduction to Bryophyta*. Vikas Publishing House Pvt. Ltd. New Delhi.
4. Vashistha, P.C., Sinha, A.K. and Kumar, A. (2010) *Pteridophyta*. S. Chand. Delhi, India.

FURTHER READINGS

1. Raven, P.H., Johnson, G.B., Losos, J.B. and Singer, S.R. (2005). *Biology*. Tata McGraw Hill, Delhi.
2. Vanderpoorten, A. and Goffinet, B. (2009) *Introduction to Bryophytes*. Cambridge University Press.

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); Lytic and lysogenic cycle; Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination; 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* and *Vaucheria*. 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*, *Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

UNIT-3: Introduction to Archegoniate (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 (*Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Stellar 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 structures through permanent slides.
6. *Alternaria*: Specimens/photographs and tease mounts.
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. sporangiophore, 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 READINGS

1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996) *Introductory Mycology*, 4th edition. John Wiley and Sons (Asia), Singapore.
2. Bhatnagar, S.P. and Moitra, A. (1996) *Gymnosperms*. New Age International (P) Ltd Publishers, New Delhi, India.
3. Kumar, H.D. (1999) *Introductory Phycology*, 2nd edition. Affiliated East-West. Press Pvt. Ltd. Delhi.
4. Parihar, N.S. (1991). *An introduction to Embryophyta. Vol. I. Bryophyta*. Central Book Depot, Allahabad.
5. Tortora, G.J., Funke, B.R. and Case, C.L. (2010). *Microbiology: An Introduction*, 10th edition. Pearson Benjamin Cummings, U.S.A.
6. Vashishta, P.C., Sinha, A.K. and Kumar, A., (2010). *Pteridophyta*, S. Chand. Delhi, India.

FURTHER READINGS

1. Raven, P.H., Johnson, G.B., Losos, J.B. and Singer, S.R. (2005). *Biology*. Tata McGraw Hill, Delhi, India.
2. Sethi, I.K. and Walia, S.K. (2011). *Text book of Fungi & Their Allies*. MacMillan Publishers Pvt. Ltd., Delhi.
3. Vanderporten, A. and Goffinet, B. (2009). *Introduction to Bryophytes*. Cambridge University Press, Cambridge.

BOT-C-GE2: Plant Anatomy and Embryology

THEORY

Total Lectures: 60

Credits: 4

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)

Secondary Growth: Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).

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).

3. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
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, circumscissile, amphitropous/ campylotropous.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
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 READINGS

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011) *Embryology of Angiosperms, 5th edition*. Vikas Publication House Pvt. Ltd. New Delhi.
2. Dickison, W.C. (2000) *Integrative Plant Anatomy*. Academic Press USA.
3. Esau, K. (1977) *Anatomy of Seed Plants*, John Wiley, New York

FURTHER READINGS

1. Fahn, A. (1990). *Plant Anatomy*, Pergamon Press, Oxford.
2. Johri, B.M. (Ed.). (1984). *Embryology of Angiosperms*, Springer - Verlag, Berlin.
3. Mauseth, J.D. (1988). *Plant Anatomy*. The Benjamin/Cummings Publisher, USA.

Semester III

CORE COURSE (BOTANY)

Theory Papers:

Core Course- (BOT-C5):	Morphology & Anatomy	100 Marks (4 credits)
Core Course- (BOT-C6):	Economic Botany	100 Marks (4 credits)
Core Course- (BOT-C7):	Basics of Genetics	100 Marks (4 credits)

Practicals:

Core Course-Practical (BOT-C5 Lab):	Morphology & Anatomy	50 Marks (2 credits)
Core Course-Practical (BOT-C6 Lab):	Economic Botany	50 Marks (2 credits)
Core Course-Practical (BOT-C7 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 - (BOT-C-GE3):	Economic Botany & Plant Biotechnology	100 Marks (4 credits)
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Practicals:

Generic Elective -Practical (BOT-C-GE3 Lab)	50 Marks (2 credits)
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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):	Biofertilizers	50 Marks (2 credits)
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Semester IV

CORE COURSE (BOTANY)

Theory Papers:

Core Course- (BOT-C8):	Molecular Biology	100 Marks (4 credits)
Core Course- (BOT-C9):	Plant Ecology & Phytogeography	100 Marks (4 credits)
Core Course- (BOT-C10):	Plant Systematics	100 Marks (4 credits)

Practicals:

Practical (BOT-C8 Lab):	Molecular Biology	50 Marks (2 credits)
Practical (BOT-C9 Lab):	Plant Ecology & Phytogeography	50 Marks (2 credits)
Practical (BOT-C10 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 - (BOT-C-GE4):	Plant Ecology and Taxonomy	100 Marks (4 credits)
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Practicals:

Generic Elective - Practical (BOT-C-GE4 Lab)	50 Marks (2 credits)
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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)	Medicinal Botany	50 Marks (2 credits)
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Semester-III

BOT-C5: Morphology & Anatomy THEORY

Total Lectures: 60

Credits: 4

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-1 (15 hrs)

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. Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni- and multicellular, glandular and non-glandular, two examples of each), stomata (classification).

UNIT-2 (15 hrs)

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. Diversity in size and shape of leaves.

UNIT-3 (15 hrs)

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. 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.

UNIT-4 (15 hrs)

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.

BOT-C5: Morphology & Anatomy Practical

Total Lectures: 60

Credits: 2

1. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.
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.
8. Root: monocot, dicot, secondary growth.
9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsio-ventral, C₄ leaves (Kranz anatolomy).
11. Adaptive Anatomy: xerophytes, hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.

ESSENTIAL READINGS

1. Fahn, A. (1974). *Plant Anatomy*. Pergmon Press, USA.
2. Esau, K. (1977). *Anatomy of Seed Plants*. John Wiley & Sons, Inc., Delhi
3. Pandey, B.P. *Plant Anatomy*. S. Chand and Company Ltd.

SUGGESTED READINGS

1. Dickison, W.C. (2000). *Integrative Plant Anatomy*. Harcourt Academic Press, USA.
2. Mauseth, J.D. (1988). *Plant Anatomy*. The Benjamin/Cummings Publisher, USA.
3. Evert, R.F. (2006). Esau's *Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development*. John Wiley and Sons, Inc.

BOT-C6: Economic Botany THEORY

Total Lectures: 60

Credits: 4

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-1 (15 hrs)

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-2 (15 hrs)

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-3 (15 hrs)

Beverages: Tea and 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-4 (15 hrs)

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).

BOT-C6: Economic Botany Practicals

Total Lectures: 60

Credits: 2

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 READINGS

1. Kochhar, S.L. (2012). *Economic Botany in Tropics*. MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). *Economic Botany: Principles & Practices*. Kluwer Academic Publishers, Netherlands.
3. Singh, Pandey and Jain (2014). *Economic Botany*. Rastogi Publications, Meerut.

SUGGESTED READINGS

1. Chrispeels, M.J. and Sadava, D.E. (1994). *Plants, Genes and Agriculture*. Jones & Bartlett Publishers.

BOT-C7: Basics of Genetics

THEORY

Total Lectures: 60

Credits: 4

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-1 (15 hrs)

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.

UNIT-2 (15 hrs)

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*.

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.

UNIT-3 (15 hrs)

Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy

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

UNIT-4 (15 hrs)

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

Population and Evolutionary Genetics: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

BOT-C7: Basics of Genetics Practicals

Total Lectures: 60

Credits: 2

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.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
6. Blood Typing: ABO groups & Rh factor.
7. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
8. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
9. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism, red-green Colour blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached ear lobe.

ESSENTIAL READINGS

1. Gupta, P.K. (2009). *Genetics*. Rastogi Publications, Meerut (India)
2. Snustad, D.P. and Simmons, M.J. (2010). *Principles of Genetics*. John Wiley & Sons Inc., India. 5th edition.

SUGGESTED READINGS

1. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). *Concepts of Genetics*. Benjamin Cummings, U.S.A. 9th edition.
2. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). *Introduction to Genetic Analysis*. W. H. Freeman and Co., U.S.A. 10th edition.

Semester-IV

BOT-C8: Molecular Biology THEORY

Total Lectures: 60

Credits: 4

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-1 (15 hrs)

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).

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.

UNIT-2 (15 hrs)

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.

Central dogma and genetic code: Key experiments establishing- The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features).

UNIT-3 (15 hrs)

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.

UNIT-4 (15 hrs)

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.

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.

BOT-C8: Molecular Biology Practical

Total Lectures: 60

Credits: 2

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 (Messelson 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

1. Snustad, D.P. and Simmons, M.J. (2010). *Principles of Genetics*. John Wiley and Sons Inc., U.S.A. 5th edition.
2. Gerald Karp (2002). *Cell and Molecular Biology*. John Wiley & Sons, 6th Edition.
3. Lehninger, Nelson and Cox (2010). *Principles of Biochemistry*.

SUGGESTED READINGS

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). *Molecular Biology of the Gene*. Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). *Concepts of Genetics*. Benjamin Cummings. U.S.A. 9th edition.
3. Russell, P. J. (2010). *i-Genetics- A Molecular Approach*. Benjamin Cummings, U.S.A. 3rd edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). *Introduction to Genetic Analysis*. W. H. Freeman and Co., U.S.A. 10th edition.

BOT-C9: Plant Ecology and Phytogeography

THEORY

Total Lectures: 60

Credits: 4

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-1 (15 hrs)

Introduction : Basic concepts and scope of ecology, ecology history and relevance to mankind; transcending functions and control processes, ecological interfacing; Levels of organization.

Abiotic Components: Water - States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Light, Temperature, Wind and Fire.

UNIT-2 (15 hrs)

Soil: Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile.

Ecosystem Ecology: Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids. Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles - carbon, nitrogen and phosphorus.

UNIT-3 (15 hrs)

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; Biological spectrum; Life forms.

UNIT-4 (15 hrs)

Species Interactions: Autotrophy, Heterotrophy; Symbiosis, Commensalism, Parasitism, Ammensalism, Mutualism and Protocooperation, *etc.*

Succession: Processes; Types; Climax concepts.

Phytogeography: Phytogeographical principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (tropical rain forest, temperate rain forest & tundra); Local Vegetation.

BOT-C9: Plant Ecology and Phytogeography Practicals

Total Lectures: 60

Credits: 2

1. Determination of pH of various soil and water samples (pH meter and pH paper).
2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
3. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
4. Study of morphological adaptations of hydrophytes and xerophytes (four each).
5. Study of morphological adaptations of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobancha*) Epiphytes, Predation (Insectivorous plants).
6. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
7. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
8. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
9. Field visit to familiarise students with ecology of different sites.

ESSENTIAL READINGS

1. Odum, E.P. (2005). *Fundamentals of ecology*. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P. and Gupta, S. (2014). *Ecology, Environment Science and Conservation*. S. Chand Publications, New Delhi, India.
3. Sharma, P.D. (2016). *Ecology and Environment*. Rastogi Publications, Meerut, India. 12th edition.
4. Chapman, J.L. and Reiss, M.J. *Ecology-Principles and Applications* (2nd Edition), Cambridge University Press, UK.

SUGGESTED READINGS

1. Wilkinson, D.M. (2007). *Fundamental Processes in Ecology: An Earth Systems Approach*. Oxford University Press. U.S.A.
2. Kormondy, E.J. (1996). *Concepts of ecology*. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.
3. Schulze, E.D., Beck, E. and Mueller-Hohenstein, K. (2005). *Plant Ecology*. Springer-
4. Singh, H.R. and Kumar, N. (1990). *Ecology and Environmental Science*. Vishal Publishing Co. Jalandhar, Punjab.
5. Odum, E.P. and Barrett, G.W. (2005). *Fundamentals of Ecology*. Cengage Learning India Private Limited, New Delhi
6. Mackenzie, A., Ball, A. S. and Virdee, S.R.(2001). *Instant Notes Ecology*. Viva Books Private Limited, New Delhi, India.
7. Molles Jr., M.C. (2005). *Ecology-Concept and Application*. McGraw Hill, Higher Education, New York, USA.

BOT-C10: Plant Systematics

THEORY

Total Lectures: 60

Credits: 4

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-1 (15 hrs)

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.

UNIT-2 (15 hrs)

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.

UNIT-3 (15 hrs)

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.

UNIT-4 (15 hrs)

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; Phylogenetic diagrams (phylogenetic tree, cladogram).

BOT-C10: Plant Systematics

Practicals

Total Lectures: 60

Credits: 2

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

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

1. Singh, G. (2012). *Plant Systematics: Theory and Practice* (3rd edition). Oxford & IBH Pvt. Ltd., New Delhi.
2. Pandey, B.P. (2012). *Taxonomy of Angiosperms*. S. Chand & Company Ltd., New Delhi
3. Naik, V.K. (1984). *Taxonomy of Angiosperms*. Tata McGraw Hill Publishing Company, New Delhi.

SUGGESTED READINGS

1. Jeffrey, C. (1982). *An Introduction to Plant Taxonomy*. Cambridge University Press, Cambridge.
2. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). *Plant Systematics-A Phylogenetic Approach* (2nd edition). Sinauer Associates Inc., U.S.A.
3. Maheshwari, J.K. (1963). *Flora of Delhi*. CSIR, New Delhi.
4. Radford, A.E. (1986). *Fundamentals of Plant Systematics*. Harper and Row, New York.

Generic Elective
BOT-C-GE3: Economic Botany and Plant Biotechnology
THEORY

Total Lectures: 60

Credits: 4

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-1 (15 hrs)

Origin of Cultivated Plants; Cereals and Legumes

Origin of Cultivated Plants: Concept of centres of origin (De Candolle, Vavilov, Zhukovsky), History Primary and Secondary Centres.

Cereals: Rice, Wheat -Origin, morphology, uses.

Legumes: General account with special reference to Gram and Pea.

UNIT-2 (15 hrs)

Spices; Beverages; Oils and Fats; Fibre Yielding Plants

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).

Beverages: Coffee, Tea (morphology, processing, uses).

Oils and Fats: General description with special reference to groundnut. Classification of oils with examples (detailed).

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

UNIT-3 (15 hrs)

Introduction to biotechnology; Plant tissue culture;

PCR Introduction to biotechnology

Plant tissue culture: Micropropagation; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications. **PCR:** PCR and Reverse Transcriptase-PCR.

UNIT-4 (15 hrs)

Recombinant DNA Techniques

Recombinant DNA Techniques: Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, Use of molecular markers in plant breeding- Marker Assisted selection and Gene Pyramiding.

BOT-C-GE3: Economic Botany and Plant Biotechnology

Practicals

Total Lectures: 60

Credits: 2

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

ESSENTIAL READINGS

1. Bhojwani, S.S. and Razdan, M.K., (1996). *Plant Tissue Culture: Theory and Practice*. Elsevier Science Amsterdam. The Netherlands.
2. Kochhar, S.L. (2011) *Economic Botany in the Tropics, 4th edition*. MacMillan Publishers India Ltd., New Delhi.
3. Wilson, K. And Walker, J. (2010) *Principles and Techniques of Biochemistry and Molecular Biology*, Cambridge University Press, New York.

SUGGESTED READINGS

1. Glick, B.R., Pasternak, J.J. (2003). *Molecular Biotechnology- Principles and Applications of recombinant DNA*. ASM Press, Washington.

BOT-C-GE4: Plant Ecology and Taxonomy THEORY

Total Lectures: 60

Credits: 4

Objectives: *To provide information about various ecological effects, ecosystems as well as taxonomy and classification systems.*

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)

Ecological factors: Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.

UNIT-2: Plant communities, Ecosystem and Phytogeography (15 hrs)

Plant communities: Characters; Ecotone and edge effect; Succession; Processes and types.

Ecosystem: Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous.

Phytogeography: Principle biogeographical zones; Endemism.

UNIT-3: Introduction to Plant Taxonomy, Identification, Taxonomic Evidence (15 hrs)

Introduction: Identification, Classification, Nomenclature.

Identification: Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access.

Taxonomic Evidence: Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.

Taxonomic hierarchy: Ranks, categories and taxonomic groups.

UNIT-4: Botanical nomenclature, Classification and Biometrics (15 hrs)

Nomenclature: Principles and rules (ICN); ranks and names; binominal system, typification.

Classification: Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

Biometrics, numerical taxonomy and cladistics: Characters; variations; OTUs, character weighting and coding.

BOT-C-GE4: Plant Ecology and Taxonomy Practicals

Total Lectures: 60

Credits: 2

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, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (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).
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
7. 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): Brassicaceae - *Brassica*, *Alyssum* / *Iberis*; Asteraceae - *Sonchus*/*Launaea*, *Vernonia*/*Ageratum*, *Eclipta*/*Tridax*; Solanaceae - *Solanum nigrum*, *Withania*; Lamiaceae - *Salvia*, *Ocimum*; Liliaceae - *Asphodelus* / *Lilium* / *Allium*.
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

ESSENTIAL READINGS

1. Singh, J.S., Singh S.P. and Gupta, S.R. *Ecology, Environment Science and Conservation*, S. Chand & Company, Private Ltd., New Delhi, 2014.
2. Sharma, P.D. (2010) *Ecology and Environment*. Rastogi Publications, Meerut, India. 8th edition.
3. Singh, G. (2012) *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

SUGGESTED READINGS

1. Ambasht, R.S. and Ambasht, N.K. (2011). *A Text Book of Plant Ecology*, 15th Edition, CBS Publishers & Distributors Pvt. Ltd. New Delhi
2. Kormondy, E.J. (1996). *Concepts of Ecology*. Prentice Hall, U.S.A. 4th edition.
3. Naik, V. N. (1984). *Taxonomy of Angiosperms*. The McGraw Hill, New Delhi.

Skill Enhancement Course

Biofertilizers

Total Lectures: 30

Credits: 2

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-1 (8 hrs)

Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. *Azospirillum*: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

UNIT-2 (7 hrs)

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.

UNIT-3 (8 hrs)

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

UNIT-4 (7 hrs)

Organic farming–Green manuring and organic fertilizers, Re-cycling of bio-degradable municipal, agricultural and Industrial wastes–biocompost making methods, types and method of vermicomposting–field Application.

ESSENTIAL READINGS

1. Dubey, R.C. (2005). *A Text book of Biotechnology*. S.Chand & Co, New Delhi.
2. Subha Rao, N.S. (2000). *Soil Microbiology*. Oxford & IBH Publishers, New Delhi.
3. Vayas, S.C, Vayas, S. and Modi, H.A. (1998). *Bio-fertilizers and organic Farming*. Akta Prakashan, Nadiad

SUGGESTED READINGS

1. Kumaresan, V. (2005). *Biotechnology*. Saras Publications, New Delhi.
2. John Jothi Prakash, E. (2004). *Outlines of Plant Biotechnology*. Emkay Publication, New Delhi.
3. Sathe, T.V. (2004). *Vermiculture and Organic Farming*. Daya publishers.

Skill Enhancement Course

Floriculture

Total Lectures: 30

Credits: 2

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-1 (7 hrs)

Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.
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.

UNIT-2 (8 hrs)

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.

UNIT-3 (8 hrs)

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.

Landscaping Places of Public Importance: Landscaping highways and educational institutions.

UNIT-4 (7 hrs)

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); Diseases and Pests of Ornamental Plants.

SUGGESTED READINGS

1. Randhawa, G.S. and Mukhopadhyay, A. (1986). Floriculture in India. Allied Publishers (Pvt.) Ltd., New Delhi.

Skill Enhancement Course Medicinal Botany

Total Lectures: 30

Credits: 2

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-1 (8 hrs)

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.

UNIT-2 (8 hrs)

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.

UNIT-3 (7 hrs)

Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany (ethnomedicines), ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac and infertility.

UNIT-4 (7 hrs)

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- diabetics, Blood pressure and skin diseases.

ESSENTIAL READINGS

1. Thakur, R.S., Puri, H.S. and Hussain, A. (1989). *Major Medicinal Plants of India*. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.
2. Walter, K.S. and Gellett, H.J. (1998). *IUCN Red List of Threatened Plants*. The World Conservation Union, IUCN, Gland, Switzerland and Cambridge, U.K.
3. Dey, S.C. (1994). *Gardening for Pleasure*. Sterling Publishers Pvt. Ltd., Noida (India)

SUGGESTED READINGS

1. Trivedi P C.(2006). *Medicinal Plants: Ethnobotanical Approach*, Agrobios, India.
2. Purohit and Vyas, (2008). *Medicinal Plant Cultivation: A Scientific Approach*, 2nd edn. Agrobios, India.
3. Blumethal M., Goldberg, A and Brinckmann, J. (2000). *Herbal Medicine : Expanded Commission E Monographs*, Integrative Medicinal communication Newton, M.A., U.S.A.
4. Sharma, V. and Alam, A. (2018). *Ethnobotany*. Rastogi Publications, Meerut (UP), India.

Skill Enhancement Course

Mushroom Culture Technology

Total Lectures: 30

Credits: 2

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-1 (7 hrs)

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

UNIT-2 (8 hrs)

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.

UNIT-3 (8 hrs)

Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

UNIT-4 (7 hrs)

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.

ESSENTIAL READINGS

1. Tiwari, S.C. and Kapoor, P. (2018). *Mushroom cultivation*. Mittal Publications, Delhi.
2. Bahl Nita (1984-1988). *Hand book of Mushrooms*. II Edition, Vol. I & Vol. II.

SUGGESTED READINGS

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) *Oyster Mushrooms*, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) *Food and Nutrition*. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.

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: Plant Breeding 100 Marks (4 credits)

DSE-2: Research Methodology 100 Marks (4 credits)

Practicals

DSE-1: Plant Breeding 50 Marks (2 credits)

DSE-2: Research Methodology 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 (C14 Lab): Plant Physiology 50 Marks (2 credits)

DISCIPLINE SPECIFIC ELECTIVE

Theory Papers:

DSE-3: Bioinformatics 100 Marks (4 credits)

DSE-4: Natural Resource Management 100 Marks (4 credits)

Practicals

DSE-3: Bioinformatics 50 Marks (2 credits)

DSE-4: Natural Resource Management 50 Marks (2 credits)

Semester-V

BOT-C11: Reproductive Biology of Angiosperms THEORY

Total Lectures: 60

Credits: 4

UNIT-1: Introduction (15 hrs)

History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.

Flower: Structure and Development; Induction of Flowering, Photoperiodism, Vernalization.

UNIT-2: Anther and Ovule (15 hrs)

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-3: Pollination, fertilization and Seed (15 hrs)

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-4: Self incompatibility, Polyembryony and apomixis (15 hrs)

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 Apomixis: Introduction; Classification; Causes and applications

BOT-C11: Reproductive Biology of Angiosperms Practicals

Total Lectures: 60

Credits: 2

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehiscent 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

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). *The Embryology of Angiosperms*, Vikas Publishing House. Delhi. 5th edition.
2. Johri, B.M. (1984). *Embryology of Angiosperms*, Springer-Verlag, Netherlands.

SUGGESTED READINGS

1. Shivanna, K.R. (2003). *Pollen Biology and Biotechnology*. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
2. Raghavan, V. (2000). *Developmental Biology of Flowering plants*, Springer, Netherlands.

BOT-C12: Plant Biotechnology

THEORY

Total Lectures: 60

Credits: 4

UNIT-1: Plant Tissue Culture (15 hrs)

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-2: Recombinant DNA technology (15 hrs)

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-3: Methods of gene transfer (15 hrs)

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-4: Applications of Biotechnology (15 hrs)

Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (Flavr Savr 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.

BOT-C12: Plant Biotechnology

Practicals

Total Lectures: 60

Credits: 2

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.
4. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
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

1. Bhojwani, S.S. and Razdan, M.K., (1996). *Plant Tissue Culture: Theory and Practice*. Elsevier Science Amsterdam. The Netherlands.
2. Brown, T.A. (2015). *Gene Cloning and DNA Analysis: An Introduction*, 7th Edition. Wiley

SUGGESTED READINGS

1. Glick, B.R. and Pasternak, J.J. (2003). *Molecular Biotechnology-Principles and Applications of recombinant DNA*. ASM Press, Washington.
2. Snustad, D.P. and Simmons, M.J. (2010). *Principles of Genetics*. John Wiley and Sons, U.K. 5th edition.
3. Stewart, C.N. Jr. (2008). *Plant Biotechnology & Genetics: Principles, Techniques and Applications*. John Wiley & Sons Inc. U.S.A.

Semester-VI

BOT-C13: Plant Metabolism THEORY

Total Lectures: 60

Credits: 4

UNIT-1: Concepts of metabolism and Carbon assimilation (15 hrs)

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-2: Carbohydrate and Lipid Metabolism (15 hrs)

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-3: Carbon oxidation and ATP Synthesis (15 hrs)

Glycolysis, TCA cycle, electron transport chain in mitochondria, factors affecting respiration; ATP synthesis – mechanism, ATP synthase, chemiosmotic mechanism- oxidative and photophosphorylation.

UNIT-4: Nitrogen metabolism, Proteins and Enzymes (15 hrs)

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.

BOT-C13: Plant Metabolism Practicals

Total Lectures: 60

Credits: 2

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.
6. Demonstration of absorption spectrum of photosynthetic pigments.
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-Ciocalteu* reagent.
10. Test of lipids and saponification test of fats.

ESSENTIAL READINGS

1. Verma, S.K. and Verma, M. (2007). *A text book of Plant Physiology, Biochemistry and Biotechnology*. S. Chand & Company Ltd., New Delhi.
2. Sinha, R.K. (2007). *Modern Plant Physiology*. Narosa Publishing House, New Delhi.
3. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A. (2015). *Plant Physiology and Development*. Sinauer Associates Inc. USA. 6th edition.

SUGGESTED READINGS

1. Hopkins, W.G. and Huner, A. (2008). *Introduction to Plant Physiology*. John Wiley and Sons. U.S.A. 4th edition.
2. Harborne, J.B. (1973). *Phytochemical Methods*. John Wiley & Sons. New York.

BOT-C14: Plant Physiology THEORY

Total Lectures: 60

Credits: 4

UNIT-1: Plant-water relations and Mineral nutrition (15 hrs)

Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap— cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.

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-2: Nutrient Uptake and Translocation in the phloem (15 hrs)

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.

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

UNIT-3: Plant growth regulators (15 hrs)

Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Absciscic acid, Ethylene, Brassinosteroids and Jasmonic acid.

UNIT-4: Physiology of flowering and Phytochrome, cryptochromes and phototropins (15 hrs)

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy. Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Bot-C14: Plant Physiology Practicals

Total lectures: 60

Credits: 2

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* coleptile bioassay (demonstration).

ESSENTIAL READINGS

1. Hopkins, W.G. and Huner, A. (2008). *Introduction to Plant Physiology*. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A. (2015). *Plant Physiology and Development*. Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). *Experiments in Plant Physiology-A Laboratory Manual*. Narosa Publishing House, New Delhi.

SUGGESTED READINGS

1. Mohr, H. and Scopfer, P. (2006). *Plant Physiology*. Springer Ist Indian Reprint.
2. Marschner, P. (2012). *Mineral Nutrition of Higher Plants*. 3rd Edition. Elsevier Ltd.
3. Noggle, G.R. and Fritz, G.J. (1986). *Introductory Plant Physiology*. 2nd Edition, Prentice Hall.

Discipline Specific Elective

BOT-DSE1: Plant Breeding

THEORY

Total Lectures: 60

Credits: 4

UNIT-1: Plant Breeding (15 hrs)

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-2: Methods of crop improvement (15 hrs)

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-3: Quantitative inheritance, Inbreeding depression and heterosis (15 hrs)

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-4: Crop improvement and breeding (15 hrs)

Role of mutations, Polyploidy, Distant hybridization and biotechnology in crop improvement.

BOT-DSE1: Plant Breeding

Practicals

Total Lectures: 60

Credits: 2

1. Hybridization experiments in self and cross pollinated crops.
2. Methods of vegetative propagation.
3. Identification of plant genetic resources.
4. Cultivation practices of crop plants.
5. Study of quantitative and qualitative traits in crops.
6. Study of pollen fertility in crop plants
7. Study of floral biology of wheat/rice/maize/cotton.
8. Study of equipments used in biotechnology.
9. Introduction with seasonal field crops.
10. Induction of mutation using chemical mutagen in crop plants.

ESSENTIAL READINGS

1. Singh, B.D. (2005). *Plant Breeding: Principles and Methods*. Kalyani Publishers. 7th edition.
2. Chaudhari, H.K. (1984). *Elementary Principles of Plant Breeding*. Oxford – IBH. 2nd edition.
3. Acquaah, G. (2007). *Principles of Plant Genetics & Breeding*. Blackwell Publishing.

SUGGESTED READINGS

1. Allard, R.W. (1960). *Principles of Plant Breeding*. John Wiley & Sons, New York
2. Chaudhary, R.C. (1994). *Introduction to Plant Breeding*. Oxford & IBH Publishing Co., New Delhi.
3. Singh, P. (2002). *Objective Genetics and Plant Breeding* (2nd Ed.). Kalyani Publishers, New Delhi.

BOT-DSE2: Research Methodology THEORY

Total Lectures: 60

Credits: 4

UNIT-1: Concepts of research, laboratory practices and data management (15 hrs)

Research-definition and types of research, Literature-review and its consolidation.

Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions. Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.

UNIT-2: Biology Research areas, methods to study plant cells and tissues (15 hrs)

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.

Maintaining a laboratory record; Imaging of tissue specimens and application of scale bars.

UNIT-3: Floriculture and Post-harvest technology (15 hrs)

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-4: Disease management and conservation of horticultural crops (15 hrs)

Staining procedures, classification and chemistry of stains.

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.

BOT-DSE2: Research Methodology Practicals

1.

Total Lectures: 60

Credits: 2

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

ESSENTIAL READINGS

1. Kader, A.A. (2002). *Post-Harvest Technology of Horticultural Crops*. UCANR Publications, USA.
2. Singh, D. and Manivannan, S. (2009). *Genetic Resources of Horticultural Crops*. Ridhi International, Delhi, India.

SUGGESTED READINGS

1. Swaminathan, M.S. and Kochhar, S.L. (2007). *Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India*. Macmillan Publishers, India.
2. NIIR Board (2005). *Cultivation of Fruits, Vegetables and Floriculture*. National Institute of Industrial Research Board, Delhi.
3. Capon, B. (2010). *Botany for Gardeners*. 3rd Edition. Timber Press, Portland, Oregon.

BOT-DSE3: Bioinformatics

THEORY

Total Lectures: 60

Credits: 4

UNIT-1: Introduction to Bioinformatics & Databases-I (15 hrs)

Introduction, branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.
Biological Databases: functions and features, Sequence and Molecular File formats;
Classification of Biological Databases.

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

UNIT-2: Databases-II (15 hrs)

EMBL- Nucleotide Sequence Database: 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.

PDB: Introduction, Data Retrieval and Submission tools

UNIT-3: Sequence Alignment (15 hrs)

Introduction, Concept of Alignment; Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM); Pairwise Sequence Alignment: Global and Local; Alignment algorithms: Dot matrix, Dynamic programming, Heuristic; Basic local alignment search tool (BLAST) and its types; Multiple Sequence Alignment (MSA)

UNIT-4: Molecular Phylogeny (15 hrs)

Introductions, Types of Phylogenetic trees; Methods of Phylogeny [Maximum Parsimony, Maximum Likelihood, Distance methods (UPGMA, Neighbour joining)]

BOT-DSE3: Bioinformatics

Practicals

Total Lectures: 60

Credits: 2

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

ESSENTIAL READINGS

1. Attwood, T. and Parry-Smith, D.J. (1999). Introduction to Bioinformatics, Pearson Education India.
2. Ghosh, Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
3. Xiong, J. (2006). Essential Bioinformatics. Cambridge University Press.

SUGGESTED READINGS

1. Thompson, S.M. and Thompson, S. (2009). Introduction to Bioinformatics
2. Pevsner J. (2009). Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell, A.M. and Heyer, L.J. (2006). Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.
4. Mount, D.W. (2004). Bioinformatics: Sequence and Genome Analysis 2nd Edition, CSHL Press.
5. Baxevanis, A.D. and Ouellette, F. B. F. (2001). Bioinformatics: a practical guide to the analysis of genes and proteins, 2nd Edition, John Wiley.

BOT-DSE4: Natural Resource Management

THEORY

Total Lectures: 60

Credits: 4

UNIT-1: Natural resources and its Conservation (15 hrs)

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-2: Biological Resources and its Conservation (15 hrs)

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.

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

UNIT-3: Sustainable utilization of Natural Resources (15 hrs)

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

UNIT-4: Contemporary practices in resource management and conservation (15 hrs)

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.

BOT-DSE4: Natural Resource Management

Practicals

Total Lectures: 60

Credits: 2

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.

ESSENTIAL READINGS

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. R. (2014). Ecology, Environment Science and Conservation. S. Chand & Company, Private Ltd. New Delhi.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

SUGGESTED READINGS

1. Sharma, P.D. (2015). Ecology and Environment (12th Revised Edition). Rastogi Publications, Gangotri, Shivaji Road, Meerut-250002, India.
2. Pandey, S.N. and Mishra, S.P. (2011). Environment and Ecology. Anne Books Pvt. Ltd. 4821, Parwana Bhawan, 1st Floor, 24 Ansari Road, Darya Ganj, New Delhi-110222, India.
3. Martha, J.G. (2006). Principles of Conservation Biology, Sinaur Associates, Inc., Publishers, USA.