Revised
SYLLABUS FOR
Bachelor of Science (Honours)

BOTANY

THREE YEAR DEGREE COURSE
SEMESTER SYSTEM

(Under New UGC CBCS Guidelines)

2021

COURSE STRUCTURE

Semester	Course	Course Name	Course Code	Credit
I	Core 1	Phycology and Microbiology (Theory)	BOC 1.11	4
		Phycology and Microbiology (Practical)	BOC 1.12	2
	Core 2	Biomolecules and Cell Biology (Theory)	BOC 1.21	4
		Biomolecules and Cell Biology (Practical)	BOC 1.22	2
II	Core 3	Mycology and Phytopathology (Theory)	BOC 2.11	4
		Mycology and Phytopathology (Practical)	BOC 2.12	2
	Core 4	Archegoniate (Theory)	BOC 2.21	4
		Archegoniate (Practical)	BOC 2.22	2
III	Core 5	Morphology and Anatomy (Theory)	BOC 3.11	4
		Morphology and Anatomy (Practical)	BOC 3.12	2
	Core 6	Economic Botany (Theory)	BOC 3.21	4
		Economic Botany (Practical)	BOC 3.22	2
	Core 7	Genetics (Theory)	BOC 3.31	4
		Genetics (Practical)	BOC 3.32	2
	Skill Enhancement Course I	Floriculture	BOS 3.11	2
IV	Core 8	Molecular Biology (Theory)	BOC 4.11	4
		Molecular Biology (Practical)	BOC 4.12	2
	Core 9	Plant Ecology and Phytogeography (Theory)	BOC 4.21	4
		Plant Ecology and Phytogeography (Practical)	BOC 4.22	2
	Core 10	Plant Systematics (Theory)	BOC 4.31	4
		Plant Systematics (Practical)	BOC 4.32	2
	Skill Enhancement Course II	Mushroom Culture Technology	BOS 4.11	2
V	Core 11	Reproductive Biology of Angiosperms (Theory)	BOC 5.11	4
		Reproductive Biology of Angiosperms (Practical)	BOC 5.12	2
	Core 12	Plant Physiology (Theory)	BOC 5.21	4
		Plant Physiology (Practical)	BOC 5.22	2
	Discipline Specific Elective I	Plant Breeding (Theory)	BOD 5.11	4
		Plant Breeding (Practical)	BOD 5.12	2
	Discipline Specific Elective I	Natural Resource Management (Theory)	BOD 5.21	4
		Natural Resource Management (Practical)	BOD 5.22	2
VI	Core 13	Plant Metabolism (Theory)	BOC 6.11	4
		Plant Metabolism (Practical)	BOC 6.12	2
	Core 14	Plant Biotechnology (Theory)	BOC 6.21	4
		Plant Biotechnology (Practical)	BOC 6.22	2
	Discipline Specific Elective III	Research Methodology (Theory)	BOD 6.11	4
		Research Methodology (Practical)	BOD 6.12	2
	Discipline Specific Elective IV	Biostatistics (Theory)	BOD 6.21	4
		Biostatistics (Practical)	BOD 6.22	2

GENERIC ELECTIVE COURSES

Semester	Course	Course Name	Course Code	Credit
I	GE 1	Biodiversity (Microbes, Algae, Fungi and Archegoniate) (Theory)	BOG 1.11	4
		Biodiversity (Microbes, Algae, Fungi and Archegoniate) (Practical)	BOG 1.12	2
II	GE 2	Plant Ecology and Taxonomy (Theory)	BOG 2.11	4
		Plant Ecology and Taxonomy (Practical)	BOG 2.12	2
III	GE 3	Plant Anatomy and Embryology (Theory)	BOG 3.11	4
		Plant Anatomy and Embryology (Practical)	BOG 3.12	2
IV	GE 4	Economic Botany and Plant Biotechnology (Theory)	BOG 4.11	4
		Economic Botany and Plant Biotechnology (Practical)	BOG 4.12	2

SEMESTER – I

CORE 1 (BOC 1.11)
PHYCOLOGY AND MICROBIOLOGY

Theory Credits: 4 *Teaching Hours: 60*

UNIT I Introduction to microbial world *(12 Hours)*
General account of the Darwin's theory of evolution; the evolution of populations, concepts of species, Mechanism of speciation; Microbial nutrition, growth and metabolism. Economic importance and scope of viruses and bacteria.

UNIT II Viruses *(12 Hours)*
Discovery, general structure, physiochemical and biological characteristics; classification (Baltimore), viroids and prions; replication (general account), DNA virus (T-phage), lytic (*T4 phage*) and lysogenic cycle (*Lambda phage*); RNA types: RNA virus (TMV), Retro virus *(HIV)*, DNA virus *(coliphage)*.

UNIT III Bacteria *(12 Hours)*
Discovery, general characteristics; Bergey's classification of bacteria; Shapes of bacteria; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction), bacterial genome and plasmid, gram positive and gram negative bacteria.

UNIT IV Algae I *(12 Hours)*
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; Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith). Economic importance of algae.

UNIT V Algae II *(12 Hours)*
General characteristics, occurrence, range of thallus organization, reproduction and life cycle of Cyanophyta (*Nostoc*), Xanthophyta (*Vaucheria*), Chlorophyta (*Oedogonium*), Charophyta (*Chara*), Phaeophyta (*Ectocarpus*) and Rhodophyta (*Polysiphonia*)

CORE 1 (BOC 1.12)
PHYCOLOGY AND MICROBIOLOGY

Practical Credit: 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.
3. Gram staining.
4. Endospore staining with malachite green using the (endospores taken from soil bacteria).

Phycology

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

Recommended Books and References:

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

CORE 2 (BOC 1.21)
BIOMOLECULES AND CELL BIOLOGY

Theory Credit: 4 *Teaching Hours: 60*

UNIT I Biomolecules 1 *(12 Hours)*

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 principle classes of lipids. Storage, metabolic and structural lipids; Fatty acids Types, structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.

UNIT II Biomolecules 2 *(12 Hours)*

Proteins: Structure and classification of amino acids; Levels of protein structureprimary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins.
Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, C and Z types of DNA; Types of RNA; Structure of tRNA.

UNIT III Bio energetic & enzymes *(12 Hours)*

Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as an energy currency molecule.
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 IV The cell *(12 Hours)*

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; 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. Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cyclecheckpoints, role of protein kinases.

UNIT V Cell organelles *(12 Hours)*

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: Endoplasmic Reticulum – Structure and function. Golgi Apparatus – structure and function. Lysosomes- structure and function.

CORE 2 (BOC 1.22)
BIOMOLECULES AND CELL BIOLOGY

Practical Credit: 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. Measurement of cell size by the technique of micrometry.
4. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
5. Study the effect of organic solvent and temperature on membrane permeability.
6. Study different stages of mitosis and meiosis.

Recommended Books and References:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

SEMESTER - II

CORE 3 (BOC 2.11)
MYCOLOGY AND PHYTOPATHOLOGY

Theory Credit: 4 *Teaching Hours: 60*

UNIT I: Introduction to true fungi (12 lectures):

General characteristics, Ecology, Nutrition, Classification, Economic importance of fungi and Mushroom cultivation.

Chytridiomycetes. Oomycetes and Zycomycetes: Characteristic features, Significance, Reproduction and Life cycle with reference to *Synchytrium, Pythium* and *Rhizopus.*

UNIT II: Ascomycetes and Basidiomycetes (12 lectures):

Ascomycetes: General characteristics, asexual and sexual fruiting bodies and Life cycle of *Saccharomyces*, *Aspergillus*, *Penicillium* and *Alternaria.*

Basidiomycetes: General characteristics, Life cycle of *Puccinia* (physiological specialization), loose and covered smut (symptoms only), *Agaricus*, Bioluminescence, Fairy rings.

UNIT III: Allied fungi (Myxomycotina) and Symbiotic associations (12 lectures):

Slime Molds: General characteristics, Status, Classification, Occurrence, Types of plasmodia and Types of fruiting bodies.

Lichens: Occurrence, General characteristics, Growth forms, and range of thallus organizations, Nature of associations of algal and fungal partners and Reproduction.

Mycorrhiza: Ectomycorrhiza, Endomycorrhiza and their significance.

UNIT IV: Applied Mycology *(12 Hours)*
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 V: Phytopathology *(12 Hours)*
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 Viral diseases – Tobacco Mosaic viruses. Algal disease- tea rust Fungal diseases – Early & late blight of potato, Black stem rust of wheat. Loose and covered smut (symptoms only)

CORE 3 (BOC 2.12)
MYCOLOGY AND PHYTOPATHOLOGY

Practical Credit: 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. *Alternaria:* Specimens/photographs and temporary mounts.
5. *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.
6. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
7. 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)
8. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Viral diseases: TMV, Fungal diseases: Early blight of potato, Black stem rust of wheat, Tea rust.

Recommended Books and References:

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

CORE 4 (BOC 2.21)
ARCHEGONIATE

Theory Credits: 4 *Teaching Hours: 60*

UNIT I Introduction to Bryophytes & Pteridophytes *(12 Hours)*
Unifying features of archegoniates; Transition to land habit; Alternation of generations. Bryophytes-General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Pteridophytes- General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*).

UNIT II Type Studies- Bryophytes *(12 Hours)*
Classification (up to family), morphology, anatomy, reproduction and evolutionary trends of *Marchantia, Anthoceros, Sphagnum and Funaria*; Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

UNIT III Type Studies- Pteridophytes *(12 Hours)*
Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Apogamy and apospory, heterospory and seed habit, telome theory, Stelar evolution; Ecological and economic importance.

UNIT IV Gymnosperms *(12 Hours)*
General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (Developmental details not to be included); Ecological and economic importance.

UNIT V Paleobotany *(12 Hours)*
Geological time scale, fossil types and their formation, general account of dominant fossil flora of different ages, paleobotany in relation to exploration of fossil fuels

CORE 4 (BOC 2.22)

ARCHEGONIATE

Practical Credit: 2

1. ***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).
2. ***Anthoceros***- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
3. ***Sphagnum***- Morphology of plant, whole mount of leaf (permanent slide only).
4. ***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.
5. ***Psilotum***- Study of specimen, transverse section of synangium (permanent slide).
6. ***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).
7. ***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).
8. ***Pteris***- Morphology, transverse section of rachis, vertical section of sporophyll, wholemount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).
9. ***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 slide).
10. ***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 slide).
11. ***Gnetum***- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide)
12. **Botanical excursion (Local).**

Recommended Books and References:

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

SEMESTER - III

CORE 5 (BOC 3.11)
MORPHOLOGY & ANATOMY

Theory Credits: 4 *Teachings Hours: 60*

UNIT I Introduction, Structure and Development of Plant Body *(12 Hours)*
Internal organization of plant body: The three tissue systems, types of cells and tissues. Development of plant body: Polarity, Cyto-differentiation and organogenesis during embryogenic development.

UNIT II Tissues *(12 Hours)*
Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

UNIT III Apical meristems *(12 Hours)*
Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory); Types of vascular bundles; Structure of dicot and monocot stem. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

UNIT IV Vascular Cambium and Wood *(12 Hours)*
Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.

UNIT V Adaptive and Protective Systems *(12 Hours)*
Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Morphological and Anatomical adaptations of xerophytes, hydrophytes, halophytes and epiphytes.

CORE 5 (BOC 3.12)
ANATOMY OF ANGIOSPERMS

Practical Credit: 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. Anomalous secondary growth.
9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
11. Adaptive Anatomy: xerophytes, hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.

Recommended Books and References:

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. 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.

CORE 6 (BOC 3.21)
ECONOMIC BOTANY

Theory Credits: 4 *Teaching Hours: 60*

UNIT I Origin of Cultivated Plants; Sources of sugars and starches *(12 Hours)*
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.
sugars and starches -Morphology and processing of sugarcane, products and byproducts of sugarcane industry. Potato – morphology, propagation & uses.

UNIT II Cereals & Legumes: Spices & Beverages *(12 Hours)*
Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.
Legumes- Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.
Listing of important spices, their family and part used. Economic importance with special reference to black pepper, ginger, turmeric and chillies.
Beverages- Tea, Coffee (morphology, processing & uses)

UNIT III Agro ecosystem *(12 Hours)*
Agro-ecosystem in Nagaland. Jhum cultivation, terrace cultivation, water management, cropping system, land use pattern and its importance to ecosystem.

UNIT IV Sources of oils and fats; Natural Rubber *(12 Hours)*
General description, classification, extraction, their uses of groundnut, soyabean, mustard and coconut.
Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.
Natural Rubber -Para-rubber: tapping, processing and uses.

UNIT V Drug-yielding plants, Timber plants & Fibers *(12 Hours)*
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, Nettle, Coir and Jute (morphology, extraction and uses).

CORE 6 (BOC 3.22)
ECONOMIC BOTANY

Practical Credit: 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), Nettle, Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

Recommended Books and References:

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, The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett_Publishers.

CORE 7 (BOC 3.31)
GENETICS

Theory Credits: 4 *Teaching Hours: 60*

UNIT I Mendelian genetics and its extension *(12 Hours)*
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 II Extrachromosomal Inheritance *(12 Hours)*
Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects- shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*

UNIT III Linkage, crossing over and chromosome mapping *(12 Hours)*
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 IV Variation in chromosome number and structure; Gene mutations *(12 Hours)*
Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy *Gene mutations* -Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Baseanalogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. Role of Transposons in mutation. DNA repair mechanisms.

UNIT V Fine structure of gene; Population and Evolutionary Genetics *(12 Hours)*
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.

CORE 7 (BOC 3.32)
GENETICS

Practical Credit: 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, redgreen Colour blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached ear lobe.

Recommended Books and References:
1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th 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.

SEMESTER - IV

CORE 8 (BOC 4.11)
MOLECULAR BIOLOGY

Theory Credit: 4 *Teaching Hours: 60*

UNIT I Nucleic acids: Structures of DNA and RNA *(12 Hours)*
Historical perspective; DNA as the carrier of genetic information, 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. Structure of RNA. Organellar DNA - mitochondria and chloroplast DNA. The Nucleosome: Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

UNIT II The replication of DNA *(12 Hours)*
Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semiconservative 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.

UNIT III Transcription *(12 Hours)*
General principles of Transcription; basic structure and organization of typical gene, mechanism of transcription in prokaryotes: initiation, chain elongation and termination. Key differences of transcription in prokaryotes and eukaryotes, transcription factors in eukaryotes. Products of transcription and their functions.

UNIT IV Transcription Regulation and RNA Processing *(12 Hours)*
General principles of gene regulation; operon concept: mechanism of lactose metabolism in *E.coli*; eukaryotic gene regulation: role of heat shock proteins, peptide and steroid hormones; Gene silencing. Eukaryotic mRNA processing: Splicing, splicing pathways, spliceosome machinery; group I and group II intron splicing, ribozymes, alternative splicing, 5' methylation and 3' polyadenylation ; eukaryotic mRNA editing and transport.

UNIT V Translation *(12 Hours)*
Central dogma, Genetic code (deciphering & salient features**)**. Mechanism: Translation machinery: ribosome assembly in prokaryotes and eukaryotes; Charging of tRNA; phases of translation process: initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications.

CORE 8 (BOC 4.12)
MOLECULAR BIOLOGY

Practical Credit: 2

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.
9. Nucleic acid separation through chromatography paper
10. Estimation of DNA size through electrophoresis

Recommended Books and References:

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. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. 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.

CORE 9 (BOC 4.21)
PLANT ECOLOGY AND PHYTOGEOGRAPHY

Theory Credit: 4 *Teaching Hours: 60*

UNIT I Introduction; soil & water *(12 Hours)*
Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis. Soil- Importance; Formation; Composition; Physical, Chemical and Biological components. Soil profile. Water- Importance; States of water in the environment, Atmospheric moisture, Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle, Water in soil, Water table.

UNIT II Light, temperature, wind and fire. Biotic interactions *(12 Hours)*
Light, temperature, wind and fire- adaptations of plants to their variation. *Biotic interactions*- mutualism, commensalism, parasitism.

UNIT III Population ecology and plant communities *(12 Hours)*
Characteristics and Dynamics. Ecological Speciation *Plant communities*-Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

UNIT IV Ecosystems & Functional aspects of ecosystem *(12 Hours)*
Structure; Trophic organization-basic source of energy, autotrophy, heterotrophy; Food chains and Food webs; Ecological pyramids. *Functional aspects of ecosystem*- Principles and models of energy flow, Productivity; Ecological efficiencies. Biogeochemical cycles- Cycling of Carbon, Nitrogen and Phosphorus.

UNIT V Phytogeography *(12 Hours)*
Principles of Continental drift, Theory of tolerance, Endemism. Brief description of major terrestrial biomes (one each from tropical, temperate & tundra). Phytogeographical division of India with special reference to North East region of India.

CORE 9 (BOC 4.22)
PLANT ECOLOGY AND PHYTOGEOGRAPHY

Practical Credit: 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 of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).
(b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
11. Local field visit to familiarize students with ecology of different sites.

Recommended Books and References:

1. Odum, E. P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J. S., Singh, S. P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

CORE 10 (BOC 4.31)
PLANT SYSTEMATICS

Theory Credit: 4 *Teaching Hours: 60*

UNIT I Significance of Plant systematics *(12 Hours)*
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 II Angiosperm taxonomy *(12 Hours)*
Critical study of the following families. *Dicots*; Magnoliaceae, Brassicaceae, Ranunculaceae, Rutaceae, Fabaceae, Meliaceae, Lamiaceae, Euphorbiaceae, Solanaceae, Cucurbitaceae, Asteraceae. *Monocots*; Orchidaceae, Poaceae, Zingiberaceae

UNIT III Taxonomic hierarchy & Taxonomical nomenclature *(12 Hours)*
Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). *Botanical nomenclature*- 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 IV Systems of classification *(12 Hours)*
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).

UNIT V Phylogeny of Angiosperms *(12Hours)*
Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals. Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

CORE 10 (BOC 4.32)
PLANT SYSTEMATICS

Practical Credit: 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*
Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Bidens*
Solanaceae - *Solanum /Withania*
Brassicaceae- *Brassica sp.*
Fabaceae- *Phaseolus/ Vigna/ Trifolium/ Pisum*
Lamiaceae - *Salvia/Leucus*
Euphorbiaceae – *Euphorbia/Ricinus/Jatropha*
Poaceae – *Oryza/Triticum/Hordeum/Avena*
Zingiberaceae- *Zingiber/ Curcuma/ Hedychium*
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).

Recommended Books and References:
1. Singh, (2012). *Plant Systematics:* Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
2. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy.* Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). *Flora* of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of *Plant Systematics*. Harper and Row, New York.

SEMESTER - V

CORE 11 (BOC 5.11)
REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

Theory Credit: 4 *Teaching Hours: 60*

UNIT I Introduction; reproductive biology *(12 Hours)*
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. *Reproductive development*-Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.

UNIT II Anther and pollen biology *(12 Hours)*
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.

UNIT III Ovule *(12 Hours)*
Structure; 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 IV Pollination and fertilization; self incompatibility *(12 Hours)*
Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization. *Self incompatibility* -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.

UNIT V Embryo, Endosperm, Seed, Polyembryony and apomixis *(12 Hours)*
Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Endosperm haustoria, Suspensor: structure and functions; Embryoendosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure, importance and dispersal mechanisms *Polyembryony and apomixis* -Introduction; Classification; Causes and applications.

CORE 11 (BOC 5.12)
REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

Practical Credit: 2

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, 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.
5. Intra-ovarian pollination; Test tube pollination through photographs.
6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
7. 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.

Recommended Books and References:

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

CORE 12 (BOC 5.21)
PLANT PHYSIOLOGY

Theory Credit: 4 *Teaching Hours: 60*

UNIT I Plant-water relations *(12 Hours)*
Water Potential and its components, water absorption by roots, pathway of water movement- symplast, apoplast, transmembrane pathways, aquaporins. Ascent of sap– cohesion-tension transpirational pull theory, Root pressure. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement, guttation.

UNIT II Mineral nutrition *(12 Hours)*
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 III Nutrient Uptake & translocation in the phloem *(12 Hours)*
Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport. *Translocation in the phloem* -Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

UNIT IV Plant growth regulators *(12 Hours)*
Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.

UNIT V Physiology of flowering: Phytochrome, cryptochromes and phototropins

(12 Hours)
Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy. *Phytochrome, cryptochromes and phototropins* - Discovery, chemical nature, role in photomorphogenesis, Low Energy Responses (LER) and High Irradiance Responses (HIR), mode of action.

CORE 12 (BOC 5.22)
PLANT PHYSIOLOGY

Practical Credit: 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. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/ leaf.
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).

Recommended Books and References:

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.

SEMESTER - VI

CORE 13 (BOC 6.11)
PLANT METABOLISM

Theory Credit: 4 *Teaching Hours: 60*

UNIT I Concept of metabolism: Carbohydrate metabolism *(12 Hours)*
Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).
Carbohydrate metabolism- Synthesis and catabolism of sucrose and starch.

UNIT II Carbon assimilation *(12 Hours)*
Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO2 reduction, photorespiration, C_3 & C4 pathways; Crassulacean acid metabolism; Factors affecting CO2 reduction.

UNIT III Carbon Oxidation *(12 Hours)*
Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

UNIT IV ATP-Synthesis & Lipid Metabolism *(12 Hours)*
Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.
Lipid metabolism: Synthesis and breakdown of triglycerides, β-oxidation, α-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination.

UNIT V Nitrogen metabolism & special modes of nutrition *(12 Hours)*
Nitrogen metabolism- Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.
Special modes of nutrition in angiosperm: parasitic angiosperms- total and partial stem and root parasites; insectivorous plants, saprophytic angiosperms.

CORE 13 (BOC 6.12)
PLANT METABOLISM

Practical Credit: 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. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. To demonstrate activity of Nitrate reductase in germinating leaves of different plant sources.

7. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
8. Demonstration of fluorescence by isolated chlorophyll pigments.
9. Demonstration of absorption spectrum of photosynthetic pigments.

Recommended Books and References:

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. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

CORE 14 (BOC 6.21)
PLANT BIOTECHNOLOGY

Theory Credit: 4 *Teaching Hours: 60*

UNIT I Plant Tissue Culture *(12 Hours)*
Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

UNIT II Recombinant DNA technology *(12 Hours)*
Restriction Endonucleases (History, Types, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic; Eukaryotic Vectors (YAC).

UNIT III Gene Cloning *(12 Hours)*
Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR

UNIT IV Methods of gene transfer *(12 Hours)*
Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

UNIT V Applications of Biotechnology *(12 Hours)*
Pest resistant (Bt-cotton); herbicide resistant plants (Round-Up Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

CORE 14 (BOC 6.22)
PLANT BIOTECHNOLOGY

Practical Credit: 2

1. (a) Preparation of MS medium.
(b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Isolation of plasmid DNA.
8. Restriction digestion and gel electrophoresis of plasmid DNA.

Recommended Books and References:

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

DISCIPLINE SPECIFIC ELECTIVE COURSES

DISCIPLINE SPECIFIC ELECTIVE 1 (BOD 5.11)
PLANT BREEDING

Theory Credit: 4 *Teaching Hours: 60*

UNIT I Plant Breeding *(12 Hours)*
Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

UNIT II Methods of crop improvement *(12 Hours)*
Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

UNIT III Quantitative inheritance *(12 Hours)*
Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings. Monogenic vs polygenic Inheritance.

UNIT IV Inbreeding depression and heterosis *(12 Hours)*
History, genetic basis of inbreeding depression and heterosis; Applications.

UNIT V Crop improvement and breeding *(12 Hours)*
Role of mutations; Polyploidy, Distant hybridization and role of biotechnology in crop improvement.

DISCIPLINE SPECIFIC ELECTIVE 1 (BOD 5.12)
PLANT BREEDING

Practical Credit: 2

1. Self pollination experiment
2. cross pollination experiment
3. emasculation, bagging and tagging
4. Grafting and layering experiment
5. Effect of light and temperature in pollen germination
6. Seed viability test

Recommended Books and References:
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.

DISCIPLINE SPECIFIC ELECTIVE 2 (BOD 5.21)
NATURAL RESOURCE MANAGEMENT

Theory Credit: 4 *Teaching Hours: 60*

UNIT I Natural resources & Sustainable utilization *(12 Hours)*
Definition and types. Sustainable utilization- Concept, approaches (economic,

ecological and socio-cultural) with special reference to sustainable agricultural methods and Jhum cultivation.

UNIT II Land & water *(12 Hours)*
Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management. *Water*- Fresh water (rivers, lakes, groundwater, aquifers, catchment area, watershed); Marine, Estuarine, Wetlands. Threats and management strategies.

UNIT III Biological Resources *(12 Hours)*
Biodiversity-definition and types, Significance, Threats, Management strategies, Bioprospecting, IPR, CBD, National Biodiversity Action Plan.

UNIT IV Forests & Energy *(12 Hours)*
Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion, Management.
Energy- Renewable and non-renewable sources of energy

UNIT V Contemporary practices in resource management *(12 Hours)*
EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

DISCIPLINE SPECIFIC ELECTIVE 2 (BOD 5.22)
NATURAL RESOURCE MANAGEMENT

Practical Credit: 2

1. Estimation of solid waste generated by a domestic system (biodegradable and nonbiodegradable) and its impact on land degradation.
2. Collection of data on forest cover 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. Field report

Recommended Books and References:
1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, 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.

DISCIPLINE SPECIFIC ELECTIVE 3 (BOD 6.11)
RESEARCH METHODOLOGY

Theory Credit: 4 *Teaching Hours: 60*

UNIT I Basic concepts of research *(12 Hours)*
Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs emperical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

UNIT II General laboratory practices *(12 Hours)*
Understanding the details on the label of reagent bottles. Knowledge about common toxic chemicals and safety measures in their handling. Common calculations in botany laboratories-
Molar, molal and normal solutions. Molarity and normality of common acids and bases.
Preparation of solutions. Dilutions. Percentage solutions.
Technique of handling micropipettes.

UNIT III Data collection and documentation of observations: Methods to study plant cell/ tissue structure *(12 Hours)*
Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.
Methods to study plant cell/tissue structure-Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.

UNIT IV Plant microtechniques *(12 Hours)*
Staining procedures, classification and chemistry of stains.
Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials.

UNIT V The art of scientific writing and its presentation *(12 Hours)*
Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. PowerPoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/ plagiarism.

DISCIPLINE SPECIFIC ELECTIVE 3 (BOD 6.12)
RESEARCH METHODOLOGY

Practical Credit: 2

1. Experiments based on chemical calculations.
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and field photography.
4. Poster presentation on defined topics.
5. Technical writing on topics assigned.

Recommended Books and References:
1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

DISCIPLINE SPECIFIC ELECTIVE 4 (BOD 6.21)
BIOSTATISTICS

Theory Credit: 4 *Teaching Hours: 60*

UNIT I Biostatistics *(12 Hours)*
Definition - statistical methods - basic principles. Variables - measurements,

functions, limitations and uses of statistics.

UNIT II Collection of data primary and secondary *(12 Hours)*
Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods.

UNIT III Measures of central tendency *(12 Hours)*
Mean, median, mode, geometric mean- merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.

UNIT IV Probability *(12 Hours)*
Priori probability, addition rule, multiplication rule

UNIT V Statistical inference *(12 Hours)*
Hypothesis- Simple hypothesis - student 't' test, chi square test.

DISCIPLINE SPECIFIC ELECTIVE 4 (BOD 6.22)
BIOSTATISTICS

Practical Credit: 2

1. Calculation of mean, standard deviation and standard error
2. Calculation of correlation coefficient values and finding out the probability
3. Calculation of 'F' value and finding out the probability value for the F value.

Recommended Books and References:
1. Biostatistic, Danniel, W.W., 1987.New York, John Wiley Sons.
2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore
3. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press.
4. Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.
5. The Principles of scientific research, Freedman, P. New York, Pergamon Press.
6. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.

SKILL ENHANCEMENT COURSE

SKILL ENHANCEMENT COURSE 1 (BOS 3.11)
FLORICULTURE

Theory Credits: 2 *Teaching Hours: 30*

UNIT I Introduction: History of gardening; Importance and scope of floriculture and landscape gardening. 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. *(6 Hours)*

UNIT II 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. *(6 Hours)*

UNIT III Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India. *(6 Hours)*

UNIT IV Landscaping Places of Public Importance: Landscaping highways and Educational institutions. *(6 Hours)*

UNIT V Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers and foliages (Carnation, Chrysanthemum, Alstromeria, Gerbera, Gladiolous, Marigold, Rose, Lilium, Orchids). Diseases and Pests of Ornamental Plants *(6 Hours)*

Recommended Books and References:

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

SKILL ENHANCEMENT COURSE 2 (BOS 4.11)
MUSHROOM CULTURE TECHNOLOGY

Theory Credits: 2 *Teaching Hours: 30*

UNIT I Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*. *(6 Hours)*

UNIT II Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. *(6 Hours)*

UNIT III 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. *(6 Hours)*

UNIT IV Storage and nutrition: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins. *(6 Hours)*

UNIT V 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. *(6 Hours)*

Recommended Books and References:

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.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

GENERIC ELECTIVE COURSES

Generic Elective
1. Biodiversity (Microbes, Algae, Fungi and Archegoniate)

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

Unit 1: Microbes (12 lectures)
Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV, HIV); Economic importance.
Bacteria– Discovery, General characteristics and cell structure; Reproduction– vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2: Algae (12 lectures)
General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Fucus*, *Polysiphonia*. Economic importance of algae.

Unit 3: Fungi (12 lectures)
Introduction- General characteristics, ecology and significance, nutrition, reproduction and classification; True Fungi. Life cycle of *Penicillium, Alternaria* (Ascomycota), *Puccinia, Agaricus* (Basidiomycota). General account and significance of lichens and Mycorrhizae (ectomycorrhiza and endomycorrhiza)

Unit 4: Introduction to Archegoniate & bryophytes (1**2 lectures)**
Unifying features of archegoniates, Transition to land habit, Alternation of generations. Bryophytes- General characteristics, adaptations to land habit, classification, range of thallus organization. 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 5: Pteridophytes & Gymnosperms (12 lectures)
Pteridophytes- General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes.
Gymnosperms- General characteristics; Classification. Morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included). Ecological and economical importance.

Practical
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), *Fucus and Polysiphonia* through temporary preparations and permanent slides. (**Fucus* - Specimen and permanent slides)
5. *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).

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

Generic Elective

2. Plant Ecology and Taxonomy

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Ecological factors (12 lectures)

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, epiphytes, halophytes and xerophytes

Unit 2: Plant communities, ecosystem & Phytogeography (12 lectures)

Characters; Ecotone and edge effect; Succession; Processes and types

Ecosystem- Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids, Productivity; Biogeochemical cycling; Cycling of carbon and nitrogen

Phytogeography- Principle biogeographical zones of India with special reference to North-East India; Endemism, Red Data list and Hot spots.

Unit 3: Introduction to Plant taxonomy, Taxonomic hierarchy & Botanical nomenclature (12 lectures)

Identification, Nomenclature and Classification.

Functions of Herbarium, important herbaria and botanical gardens of the world and India;

Ranks, categories and taxonomic groups

Botanical nomenclature - Principles and rules (ICN); Ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 4: Angiosperm taxonomy (**12 lectures)**

General characteristics of the following families- Magnoliaceae, Brassicaceae, Fabaceae, Asteraceae, Solanaceae, Lamiaceae, Liliaceae, Orchidaceae & Poaceae.

Unit 5: Classification, Biometrics, numerical taxonomy and cladistics (12 lectures)

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker

Biometrics, numerical taxonomy and cladistics- Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

Practical

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, epiphytes, halophytes and xerophytes
(b)Study of biotic interactions of the following: Stem parasite (*Cuscuta),* Root parasite (*Balanophora*),
Epiphytes (*Dendrobium/ Cymbidium*), 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– *Bidens, Sonchus/ Launaea, Vernonia/Ageratum, Eclipta/Tridax;* Solanaceae- *Solanum sp., Withania;* Lamiaceae -*Salvia, Leucus*; Liliaceae – *Lilium/ Asphodelus / Allium.*
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Suggested Readings

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
3. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

Generic Elective

3. Plant Anatomy and Embryology

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Meristematic and permanent tissues (12 lectures)

Root and shoot apical meristems; Simple and complex tissues. Structure of dicot and monocot root stem and leaf.

Unit 2: Secondary Growth (12 lectures)

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

Unit 3: Adaptive and protective systems (12 lectures)

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 4: Structural organization of flower- Pollination and fertilization (12 lectures)

Structure of a typical flower. Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 5: Embryo and endosperm : Apomixis and polyembryony (12 lectures)

Endosperm types, structure and functions; Dicot and monocot embryo.

Apomixis and polyembryony- Definition, types and Practical applications

Practical

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, circinotropous, 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.

Suggested Readings

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

Generic Elective

4. Economic Botany and Plant Biotechnology

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Origin of Cultivated Plants: Cereals (12 lectures)

Concept of centres of origin, their importance with reference to Vavilov's work.
Rice, Maize & Wheat- Origin, morphology, uses

Unit 2: Legumes & Spices (12 lectures)

General account with special reference to Gram and Soyabean
Spices- General account with special reference to ginger, chilli and black pepper (Botanical name, family, part used, morphology and uses)

Unit 3: Beverages: Oils and Fats: Fibre Yielding Plants (12 lectures)

Tea (morphology, processing, uses)
Oils and Fats- General description with special reference to groundnut/ mustard
Fibre Yielding Plants– General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)

Unit 4: Plant tissue culture (12 lectures)

Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications

Unit 5: Recombinant DNA (12 lectures)

DNA-its structure and function. Watson and Crick's Double helix DNA. RNA types and function. Restriction Endonucleases, cloning vectors. Restriction maps- PUC18, pBR322. Blue-white screening. Insertional inactivation.

Practical

1. Study of economically important plants: Rice, maize, Wheat, Gram, Soybean, Black pepper, Ginger, Mustard, 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. Double helix DNA model

Suggested Readings

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.