

BOTANY (HONOURS)

SEMESTER-I

CC-1 : MICROBIOLOGY & PHYCOLOGY
(Credits-6: Theory-4, Practical-2)-Max. Marks: 100
THEORY (Each class 1 hr.): Marks-70
PRACTICAL (Each class 2 hrs.): Marks-30
Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Introduction to microbial world, microbial nutrition, growth and metabolism (2 lectures)
Viruses :- Discovery, Characteristics, Classification, General structure, replication, DNA virus (T-phage), lytic and lysogenic cycle, RNA virus (TMV), Economic importance of viruses. (4 lectures)

Unit-II

Bacteria: Discovery, general characteristics, types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts), cell structure, nutritional types, reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine). (5 lectures)

Unit-III

Agella : 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; and 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). Role of algae in the environment, agriculture, biotechnology and industry. (6 lectures).

Unit-IV

Cyanophyta: Ecology and occurrence, range of thallus organization, cell structure, heterocyst, re-production economic importance; role in biotechnology. Morphology and life-cycle of Nostoc. (5 lectures)
Chlorophyta:- General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of Chlamydomonas, Volvox, Oedogonium, Coleochaete. (5 lectures)

Unit-V

Charophyta: General characteristics; occurrence, morphology, cell structure and life-cycle of Chara; evolutionary significance. (2 lectures)
Xanthophyta: General characteristics; range of thallus organization; Occurrence, morphology and life-cycle of Vaucheria. (3 lectures)
Phaeophyta: Characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of Ectocarpus and Fucus. (3 lectures)
Rhodophyta: General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycle of Polysiphonia. (4 lectures)

PRACTICAL

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.

Phycology (Prochloron):

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

Suggested Readings:

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition.
3. Kumar, H.D. (1999). Introductory Phycology. Allied 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.

SEMESTER-I

CC-2 : BIOMOLECULES & CELL BIOLOGY (Credits-6: Theory-4, Practical-2)-Max. Marks: 100 THEORY (Each class 1 hr.): Marks-70 PRACTICAL (Each class 2 hrs.): Marks-30 Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Biomolecules: Types and significance of chemical bonds; Structure and properties of water; pH and buffers. (2 lectures)

Carbohydrates: Nomenclature and classification; Role of monosaccharides (glucose, fructose); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage, starch, insulin) (3 lectures)

Lipids: Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. (2 lectures)

Proteins: Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, tertiary and quaternary; biological roles of proteins. (2 lectures)

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. (4 lectures)

Unit-II

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. (3 lectures)

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. (4 lectures)

Unit-III

The cell: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell. (2 lectures)

Cell wall and plasma membrane: Chemistry, structure and function of Plant Cell Wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport Passive, active and facilitated transport, endocytosis and exocytosis. (3 lectures)

Unit-IV

Cell organelles: Nucleus; Structure-nuclear envelope, nuclear pore complex, nuclear filamina, molecular organization of chromatin; nucleolus. (3 lectures)

Cytoskeleton: Role and structure of microtubules, micro filaments and intermediary lument. (2 lectures)

Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. (2 lectures)

Endoplasmic Reticulum, Golgi Apparatus, Lysosomes (2 lectures)

Unit-V

Cell division: Eukaryotic cell cycle, different stages of mitosis and meiosis. Cell cycle. (6 lectures)

PRACTICAL

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. Study of cell and its organelles with the help of electron micrographs.
5. Study the phenomenon of plasmolysis and deplasmolysis.
6. Study different stages of mitosis and meiosis using aceto carmine and aceto orcine method.

Suggested Readings:

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). Beckers 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

CC-3 : MYCOLOGY & PHYTOPATHOLOGY
(Credits-6: Theory-4, Practical-2)-Max. Marks: 100
THEORY (Each class 1 hr.): Marks-70
PRACTICAL (Each class 2 hrs.): Marks-30
Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Introduction to true fungi: Definition, General characteristics; Affinities with plants and animals; Cellwall composition; Nutrition; Classification. (5 lectures)

Zygomycota: General characteristics; Ecology; Thallus organisation; Life cycle with reference to Rhizopus. (4 lectures)

Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to Saccharomyces, Aspergillus, Penicillium and Neurospora. (5 lectures)

Unit-II

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; Mushroom Cultivation. (5 lectures)

Allied Fungi: General characterises; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies. (3 lectures)

Oomycota: General characteristic; Ecology; Life cycle and classification with reference to Phytophthora, Albugo. (4 lectures)

Unit-III

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. (4 lectures)

Unit-IV

Applied Mycology: Role of fungi in biotechnology, Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes); Secondary metabolites. Agriculture (Biofertilizers); Mycotoxins; Biological control (Myco-fungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology (5 Lectures)

Unit-V

Phytopathology: Terms and concepts; General symptoms; 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 disease of Cotton. Viral diseases Tobacco Mosaic viruses. Fungal diseases Early blight of potato, Black stem rust of wheat, white rust of crucifers. (5 lectures)

PRACTICAL

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, asocarps & 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. Puccinia: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
5. Agaricus: Specimens of button stage and full grown mushroom; sectioning of gills of Agaricus to be shown.
6. Albugo: Study of symptoms of plants infected with Albugo; asexual phase study through section/temporary mounts and sexual structures through permanent slides.
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 endo mycorrhiza (Photographs).
8. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Viral diseases: TMV, Fungal diseases: Early blight of potato, and White rust of crucifers.

Suggested Readings:

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.

SEMESTER-II

CC-4 : ARCHEGONIATE

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Introduction: Unifying features of archegoniates; Transition to land habit; Alternation of generations. (2 lectures)

Unit-II

Bryophytes: General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Classification (up to family). Riccia, Marchantia, Anthoceros, Sphagnum and Funaria; Reproduction and evolutionary trends in Riccia, Marchantia, Anthoceros and Funaria (developmental stages not included). Ecological and economic importance of bryophytes with special reference to Sphagnum. (12 lectures)

Unit-III

Pteridophytes: General characteristics, 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. (10 lectures)

Unit-IV

Gymnosperms: General characteristics, classification (up to family), morphology, anatomy and re-production of Cycas, Pinus, Ginkgo and Gnetum. (Developmental details not to be included). Ecological and economic importance. (8 lectures)

Unit-V

Fossils: Geographical time scale, fossils and fossilization process. Morphology, anatomy and affinities of Rhynia, Lepidodendron, Lyginopteris and Cycadeoidea. (8 lectures)

PRACTICAL

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, pseudopeltates, columella) (temporary slide), vertical section of thallus (permanent slide).
4. Sphagnum- Morphology of plant, whole mount of leaf (permanent slide only).
5. 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.
6. Psilotum- Study of specimen, transverse section of synangium (permanent slide).
7. 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).
8. 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).
9. 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 slide).
10. 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).
11. 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).
12. Gnetum- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide)
13. Botanical excursion.

Suggested Readings:

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 Pub-lishers, 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. Vander-Poorteri 2009 Introduction to Bryophytes. COP.

SEMESTER-III

CC-5: ANATOMY OF ANGIOSPERMS
(Credits-6: Theory-4, Practical-2)-Max. Marks: 100
THEORY (Each class 1 hr.): Marks-70
PRACTICAL (Each class 2 hrs.): Marks-30
Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Introduction and scope of Plant Anatomy: Applications in systematics. (2 Lectures)
Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. (5 Lectures)

Unit-II

Stem: 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. (5 Lectures)
Leaf: Structure of dicot and monocot leaf, Kranz anatomy. (4 Lectures)
Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescentcentre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root. (4 Lectures)

Unit-III

Vascular Cambium: Structure, function and seasonal activity of cambium; Secondary growth in root and stem. (4 Lectures)
Wood: 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. (5 Lectures)

Periderm: Development and composition of periderm, rhytidome and lenticels. (3 Lectures)

Unit-IV

Adaptive and Protective Systems Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes. (5 Lectures)

Unit-V

Secretory System: Hydathodes, cavities, lithocysts and laticifers. (3 Lectures)

PRACTICAL

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, dorsiventral, C4 leaves (Kranz anatomy).
11. Adaptive Anatomy: xerophytes, hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.

Suggested Readings:

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 Benjamin/Cummings Publisher, USA.
4. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.

SEMESTER-III

CC-6: ECONOMIC BOTANY

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties. (3 Lectures)

Unit-II

Cereals : Wheat and Rice (origin, morphology, processing & uses), brief account of millets. (3 lectures)

Legumes: General account, importance to man and ecosystem. (3 Lectures)

Sugars & Starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato morphology, propagation & uses. (3 lectures)

Unit-III

Spices : Listing of important spices, their family and part used, economic importance with special reference to fennel, saffron, clove and black pepper. (4 Lectures)

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

Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis. (4 Lectures)

Tobacco: Tobacco (Morphology, processing, uses and health hazards) (2 Lectures)

Unit-IV

Oils & Fats: General description, classification, extraction, their uses and health implications ground-nut, Brassica and Coconut (Botanical name, family & uses) (4 lectures)

Essential Oils: General account, extraction methods, comparison with fatty oils & their uses. (4 Lectures)

Unit-V

Timber plants: General account with special reference to teak and pterocarpus. (2 Lectures)

Fibres: Classification based on the origin of fibres, Cotton and Jute (morphology, extraction and uses). (2 Lectures)

PRACTICAL

1. Cereals: Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. Legumes: Soya bean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. Sugars & 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. Oils & Fats: Coconut- T.S. nut, Mustardplant specimen, seeds; tests for fats in crushed seeds.
7. Essential oil-yielding plants: Habit sketch of Rosa, Vetiveria, Santalum and Eucalyptus (specimens/photographs).
8. Drug-yielding plants: Specimens of Digitalis, Papaverand Cannabis.
9. Tobacco: specimen and products of Tobacco.
10. Woods: Tectona, pterocarpus Specimen, Section of young stem.
11. Fibre-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fibre and test for cellulose), Jute (specimen, transverse section of stem).

Suggested 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 Publish-ers, The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. (2003). Plants, Genes and Agriculture. Jones & Bartlett Publishers.

SEMESTER-III

CC-7: GENETICS

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Mendelian genetics and its extension Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Polygenic inheritance. (14 lectures)

Unit-II

Extra chromosomal Inheritance: Chloroplast mutation: Variegation in Four O'clock plant; Mitochondrial mutations in yeast; Infective heredity- Kappa particles in Paramecium. (6 lectures)

Unit-III

Linkage, crossing over and chromosome mapping: Coupling & repulsion phases, incomplete and complete linkage, linkage group, sex linkage. Crossing over : Theories, mechanism, cytological basis of crossing over, two factor and three factor crosses, interference and coincidence, chromosome mapping. (12 lectures)

Unit-IV

Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy (8 lectures)
Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation. DNA repair mechanisms. (6 lectures)

Unit-V

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

Population and Evolutionary Genetics: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation. (6 lectures)

PRACTICAL

1. Meiosis through temporary squash preparation.
2. Mendels laws through seed ratios. Laboratory exercises in probability and chi-square analysis.
3. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
4. Blood Typing: ABO groups & Rh factor.
5. Study of aneuploidy: Downs, Klinefelters and Turners syndromes.
6. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.

Suggested Readings:

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. (2012). Concepts of Genetics. Benjamin Cum-mings, U.S.A. 10th edition.
4. Gri ths, 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

CC-8: MOLECULAR BIOLOGY

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Nucleic acids : Carriers of genetic information: Historical perspective; DNA as the carrier of genetic information (Griffiths, Hershey & Chase, Avery, McLeod & McCarty, experiment). (4 lectures)

Unit-II

The Structures of DNA and RNA / Genetic Material: DNA Structure: Miescher, 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. (8 lectures)

The replication of DNA: Chemistry of DNA synthesis (Kornbergs discovery); General principles bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, (theta) mode of replication, Enzymes involved in DNA replication. (5 lectures)

Unit-III

Central dogma and genetic code: Key experiments establishing-The Central Dogma (Adaptor hy-pothesis and discovery of mRNA template), Genetic code (deciphering & salient features) (2 lectures)

Mechanism of Transcription: Transcription in prokaryotes; Transcription in eukaryotes (4 lectures)

Processing and modification of RNA: Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I & group II intron splicing, alternative splicing eukaryotic mRNA processing(5 cap, 3 poly A tail); Ribozymes. (4 lectures)

Unit-IV

Translation (Prokaryotes and eukaryotes): 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; Inhibitors of protein synthesis; Post-translational modifications of proteins. (6 lectures)

Unit-V

Regulation of 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, Gene silencing. (4 lectures)

PRACTICAL

1. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
2. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
3. Photographs establishing nucleic acid as genetic material (Messelson and Stahls, Avery et al, Griffiths, Hershey & Chases experiments)
4. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

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. 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). iGenetics- 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.

SEMESTER-IV

CC-9: PLANT ECOLOGY & PHYTOGEOGRAPHY

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Introduction Concept of ecology, Autoecology, Synecology, system ecology, Levels of organization. Inter-relationships between the living world and the environment, the components of environmental, concept of hydrosphere and lithosphere and dynamism, homeostasis. (2 lectures)

Unit-II

Soil: Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development. (5 lectures)

Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table. (2 lectures)

Light, temperature, wind and variations; adaptations of plants to their variation. (4 lectures)

Unit-III

Biotic interactions: 2 lectures

Population ecology: Characteristics and Dynamics Ecological Specification 4 lectures

Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession processes, types; climax concepts. (4 lectures)

Unit-IV

Ecological pyramids. (4 lectures)

Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus. (5 lectures)

Unit-V

Phytogeography: Principles; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation. (8 lectures)

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 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. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
6. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each). (b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobancha*) Epiphytes, Predation (Insectivorous plants).
7. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
8. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaers frequency distribution law.
9. Quantitative analysis of herbaceous vegetation for density and abundance in the college cam-pus.
10. Field visit to familiarise students with ecology of different sites.

Suggested 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., 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.

SEMESTER-IV

CC-10: PLANT SYSTEMATICS

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I Identification:

Plant identification, Classification, Nomenclature; Biosystematics. (2 lectures)

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. (5 lectures)

Unit-II

Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). (5 lectures)

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. (5 lectures)

Unit-III

Systematics an interdisciplinary science: Evidence from palynology, cytology, phytochemistry and molecular data. (6 lectures)

Systems of classification: Major contributions of Theophrastus, Bauhin, Linnaeus, 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. (6 lectures)

Unit-IV

Biometrics, numerical taxonomy and cladistics : Characters; Variations; OTUs, character weighting and coding; cluster analysis; Phenograms (definitions and differences). (4 lectures)

Unit-V

Phylogeny of Angiosperms: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades).origin & evolution of an-giosperms; coevolution of angiosperms and animals; methods of illustrating evolutionary relationship (phylogenetic tree, cladogram). (7 lectures)

PRACTICAL

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 & Hookers system of classification):
 - Nymphaeaceae - Nymphaea
 - Brassicaceae - Brassica,
 - Myrtaceae - Eucalyptus, Callistemon
 - Umbelliferae - Coriandrum / Foeniculum.
 - Asteraceae - Launaea, Vernonia/ Ageratum /Tridax
 - Solanaceae - Solanum nigrum/Withania
 - Lamiaceae - Salvia/Ocimum
 - Euphorbiaceae - Euphorbia Jatropha
 - Liliaceae - Asphodelus/Lilium/ Allium
 - Poaceae - Triticum/Hordeum/ Avena
2. Field visit (local) Subject to grant of funds from the university.
3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book)

Suggested Readings:

1. Singh, G. (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, Cam-bridge.
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

CC-11: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Introduction: History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri,) and scope. (2 lectures)

Unit-II

Anther: Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. (2 lectures)

Pollen biology: 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. (5 lectures)

Unit-III

Ovule: Structure; Types; Special structure sendothelium, obturator, aril, caruncle and hypostase; Female gametophyte megasporogenesis (monosporic, bisporic and tetrasporic) and megagameto-genesis (details of Polygonum type); Organization and ultra-structure of mature embryo sac. (5 lectures)

Endosperm: Types, development, structure and functions. (3 lectures)

Embryo: Six types of embryogeny; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryoendosperm relationship; Nutrition of embryo; Unusual features; Embryo development in Paeonia. (6 lectures)

Unit-IV

Pollination and fertilization: Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization. (4 lectures)

Self incompatibility: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self incompatibility: mixed pollination, bud pollination, stub pollination; Intraovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization; Cybrids, in vitro fertilization. (5 lectures)

Unit-V

Seed: Structure, importance and dispersal mechanisms (3 lectures)

Polyembryony and apomixes: Introduction; Classification; Causes and applications. (4 lectures)

Germline transformation: Pollen grain and ovules through pollen tube pathway method/ Agrobac-terium/ electrofusion/ foral dip/biolistic. (4 lectures)

PRACTICAL

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, pseudomonades, 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.

Suggested Readings:

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. I (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

SEMESTER-V

CC-12: PLANT PHYSIOLOGY

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Plant water relationship : Water Potential and its components, water absorption by roots, 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.

(6 lectures)

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.

(5 lectures)

Unit-II

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

(5 lectures)

Unit-III

Nutrient Uptake: 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.

(5 lectures)

Unit-IV

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

(9 lectures)

Unit-V

Physiology of flowering: Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

(4 lectures)

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

(5 lectures)

PRACTICAL

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. 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 induction of amylase activity in germinating barley grains.

Demonstration experiments:

- a) To demonstrate suction due to transpiration.
- b) Fruit ripening/Rooting from cuttings (Demonstration).
- c) Bolting experiment/Avena coleptile bioassay (demonstration).

Suggested 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., Mller, 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

CC-13: PLANT METABOLISM

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Concept of metabolism: Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes). (5 lectures) Carbohydrate metabolism: Synthesis and catabolism of sucrose and starch. (1 lecture)

Unit-II

Carbon assimilation: 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, C₄ pathways; Crassulacean acid metabolism; Factors affecting CO₂ reduction. (10 lectures)

Unit-III

Carbon Oxidation: 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, cyanideresistant respiration, factors affecting respiration. (6 lectures)

ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase. (3 lectures)

Unit-IV

Lipid metabolism: Synthesis and breakdown of triglycerides, β -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, L-oxidation. (5 lectures)

Unit-V

Nitrogen metabolism: Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination. (5 lectures)
Mechanisms of signal transduction: Calcium, phospholipids, cGMP, NO. (4 lectures)

PRACTICAL

1. Chemical separation of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis.
4. 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.

Suggested 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., Mller, 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.

SEMESTER-VI

CC-14: PLANT BIO-TECHNOLOGY

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

Unit-I

Plant Tissue Culture: Historical perspective; Aseptic tissue culture techniques, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones). (3 lectures)

Unit-II

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). (7 lectures)

Unit-III

Recombinant DNA technology-I: 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 and brie y PAC, MAC, HAC). Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning). (10 lectures)

Unit-IV

Recombinant DNA technology-II: Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; Probes-oligonucleotide, heterologous, PCR; Methods of gene transfer- Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics selectable marker and reporter genes (Luciferase, GUS, GFP). (10 lectures)

Unit-V

Applications of Biotechnology: 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); Genetically Engineered Products Human Growth Hormone; Humulin; Biosafety concerns. (10 lectures)

PRACTICAL

1. a) Preparation of MS medium.
b) Demonstration of in vitro sterilization and inoculation methods using leaf and nodal ex-plants 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.

Suggested Readings:

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.
6. Chawla, H.S. (2010). Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
7. Singh, B. D. (2010) Biotechnology: Expanding Horizon. Kalyani Publishers. New Delhi.

SKILL ENHANCEMENT COURSES (SEC)

SEMESTER-IV

SEC-2 : BIO-FERTILIZERS

(Credits-6 : Lectures: 30)

THEORY (Each class 1 hr.)-Marks: 100.

Unit-I: General account about the microbes used as biofertilizer Rhizobium isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. (4 lectures)

Unit-II: 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. (8 lectures)

Unit-III: Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation. (4 lectures)

Unit-IV: 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. (8 lectures)

Unit-V: Organic farming Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes bio-compost making methods, types and method of vermicomposting and Application. (6 lectures)

Suggested Readings:

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay, Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas, S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic, Farming Akta Prakashan, Nadiad

DISCIPLINE SPECIFIC ELECTIVE COURSES

SEMESTER-V

DSE-1 : ANALYTICAL TECHNIQUES IN PLANT SCIENCES

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

UNIT-I:

Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching. (10 lectures)

UNIT-II:

Cell fractionation: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl₂ gradient, analytical centrifugation, ultracentrifugation. (5 lectures)

UNIT-III:

Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment. (3 lectures)

Spectrophotometry: Principle and its application in biological research. 3 lectures
Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography. (6 lectures)

UNIT-IV:

Characterization of proteins and nucleic acids: Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE. (5 lectures)

UNIT-V:

Biostatistics: Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit. (8 lectures)

PRACTICAL

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
9. Preparation of permanent slides (double staining).
10. Estimation of plant pigments.
11. Determination of mean, median and mode of given plant material (No. of seeds/Pod/ No. of leaves / Plant (herb)/ Internodal Length of twig).
12. Determination of mean deviation and standard deviation of the plant materials in internodal length of plants / number of seeds / Pod.

Suggested Readings:

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th ed

SEMESTER-V

DSE-2 : NATURAL RESOURCE MANAGEMENT

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

UNIT-I:

Natural resources: Definition and types. 2 lectures Sustainable utilization : Concept, approaches (economic, ecological and socio-cultural). (5 lectures)

UNIT-II:

Land: Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management. (5 lectures)

Water: Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies. (4 lectures)

UNIT-III:

Biological Resources: Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan). (8 lectures)

Forests: Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management. (4 lectures)

UNIT-IV:

Energy: Renewable and non-renewable sources of energy (4 lectures)

Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint. (6 lectures)

UNIT-V:

Resource Accounting; Waste management. National and international efforts in resource management and conservation. (4 lectures)

PRACTICAL

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.

Suggested Readings:

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.

SEMESTER-VI

DSE-3 : HORTICULTURAL PRACTICES & POST-HARVEST TECHNOLOGY

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

UNIT-I: Introduction: Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism. (2 lectures)

Ornamental plants: Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (opuntia, agave)] Ornamental flowering trees (Indian laburnum, gulmohar, Lagerstroemia, fishtail and areca palms, semul, Coral tree). (3 lectures)

UNIT-II: Fruit and vegetable crops: Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits). (4 lectures)

Horticultural techniques: Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations. (6 lectures)

UNIT-III: Landscaping and garden design : Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices. (4 lectures)

Floriculture: Cutflowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions. (4 lectures)

UNIT-IV: Post-harvest technology: Importance of post harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cutflowers; Principles, methods of preservation and processing; Methods of minimizing losses during storage and transportation; Food irradiation - advantages and disadvantages; food safety. (6 lectures)

Disease control and management : Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; IPM

strategies (genetic, biological and chemical methods for pest control); Quarantine practices; Identification of common diseases and pests of ornamentals, fruits and vegetable crops. (5 lectures)

UNIT-V: Horticultural crops - conservation and management: 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. (6 lectures)

Field Trip: Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at IARI or other suitable locations.

PRACTICAL

1. Practical related to theory.

Suggested Readings:

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi Inter-national, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
5. Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.

SEMESTER-VI

DSE-4 : HORTICULTURAL PRACTICES & POST-HARVEST TECHNOLOGY

(PROJECTS)

(Credits-6)-Max. Marks: 100

GENERIC ELECTIVE COURSES SEMESTER-I & III

GE-1 : BIODIVERSITY

(Microbes, Algae, Fungi And Archegoniate)

(Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

UNIT-I:

Microbes : Viruses Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria Discovery, General characteristics and cell structure; Reproduction vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance. (8 lectures)

UNIT-II:

Algae: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and lifecycles of the following: Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia. Economic importance of algae. (10 lectures)

Fungi : Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of Rhizopus (Zygomycota) Penicillium, Alternaria (Ascomycota), Puccinia, Agaricus (Basidiomycota); Symbiotic Associations-Lichens: (6 lectures)

UNIT-III:

Introduction to Archegoniate : Unifying features of archegoniate, Transition to land habit, Alternation of generations. (2 lectures)

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. (6 lectures)

UNIT-IV:

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). Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes. (5 lectures)

UNIT-V:

Gymnosperms: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of Cycas and Pinus. (Developmental details not to be included). Ecological and economical importance. (6 lectures)

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 micro-graphs), 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. leaf, 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. A liated 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.

SEMESTER-II & IV

GE-2 : PLANT ANATOMY & EMBRIOLOGY (Credits-6: Theory-4, Practical-2)-Max. Marks: 100

THEORY (Each class 1 hr.): Marks-70

PRACTICAL (Each class 2 hrs.): Marks-30

Lectures: 60 (40 Theory + 20 Practical classes)

UNIT-I: Introduction: (2 lectures)
Meristematic and permanent tissues : Root and shoot apical meristems; Simple and complex tissues (5 lectures)
Organs : Structure of dicot and monocot root stem and leaf. (3 lectures)

UNIT-II:
Secondary Growth : Vascular cambium structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood) (6 lectures)
Adaptive and protective systems: Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes. (5 lectures)

UNIT-III: 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. (5 lectures)
Pollination and fertilization : Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms. (6 lectures)

UNIT-IV: Embryo and endosperm : Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship (5 lectures)

UNIT-V: Apomixis and polyembryony : Definition, types and Practical applications. (5 lectures)

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.