B.Sc. (Hons.) Botany Syllabus

CHOICE BASED CREDIT SYSTEM (CBCS)

S.C.S. (A) College, Puri

Academic Session

2017 – 2020

CBCS - B.Sc. Botany (Hons.) Syllabus

Website: www.scscollege.nic.in

SEMESTER – I
CORE COURSE – I
MICROBIOLOGY AND PHYCOLOGY

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I

Introduction to microbial world, microbial nutrition, growth and metabolism **2 lectures**

Viruses:- Discovery, characteristics, classification, general structure, DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV), Economic importance of viruses with reference to vaccine production, as causal organisms of plant diseases. **5 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

Algae:- General characteristics; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), methods of reproduction, classification; (only up to groups); significant contributions of important phycologists (F.E. Fritsch, M.O.P. Iyengar), 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, reproduction.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

(20 classes, each class of 2hour)

FM – 30 marks

Microbiology:

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
3. Gram staining.
4. Endospore staining with malachite green using the (endospores taken from soil bacteria).

Phycology: Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Volvox, Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia, Procholoron 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. 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.

SEMESTER – I
CORE COURSE – II
BIOMOLECULES AND CELL BIOLOGY

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

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, sugar alcohols – mannitol and sorbitol); 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 Protein amino acids; Peptide bonds; Levels of protein structure-primary, secondary, tertiary and quarternary; Isoelectric point; Protein denaturation and 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

Bioenergenetics: Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions, ATP: structure, its role as an 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 theroy), 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 (Endosymbiotic theory). **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 lamina, molecular organization of chromatin, nucleolus. **3 lectures**

Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament. **2 lectures**

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

UNIT – V

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

PRACTICAL

(20 classes, each class of 2hour)

FM – 30 marks

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum.
3. Demonstration of the phenomenon of protoplasmic streaming in Hydrilla leaf.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
6. Study of cell and its organelles with the help of electron micrographs.
7. Study the phenomenon of plasmolysis and deplasmolysis.
8. 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). 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 COURSE – III
MYCOLOGY AND PHYTOPATHOLOGY

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I

Introduction to true fungi: Definition, General characteristics; Affinities; Thallus organization; 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. **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; Bioluminescence, Fairy Rings. **5 lectures**

Allied Fungi: General characteristics, Status of Occurrence of Slime molds. **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: Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins), secondary metabolites (Pharmaceutical preparations), Agriculture (Biofertilizers), Mycotoxins, Biological control (Mycoherbicides, Mycoinsecticides). **5 lectures**

UNIT – V

Phytopathology: Terms and concepts; General symptoms; 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, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, white rust of crucifers. **5 lectures**

PRACTICAL

(20 classes, each class of 2hour)

FM – 30 marks

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. **Peziza:** sectioning through ascocarp.
5. **Alternaria:** Specimens/photographs and temporary mounts.
6. **Puccinia:** Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
7. **Agaricus:** Specimens of button stage and full grown mushroom; sectioning of gills of Agaricus, fairy rings and bioluminescent mushrooms to be shown.
8. **Albugo:** Study of symptoms of plants infected with Albugo; asexual phase study through section/ temporary mounts and sexual structures through permanent slides.
9. **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)
10. **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
CORE COURSE – IV
ARCHEGONIATE

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I

Introduction: Unifying features of archegoniates; Transition to land habit; Alternation of generations. Economic importance of Bryophytes, Pteridophytes and Gymnosperms. **2 lectures**

UNIT – II

Bryophytes: General characteristics; Adaptations to land habit; Classification (upto family); Range of thallus organization. In bryophytes structure, Reproduction and evolutionary trends in Riccia, Marchantia , Anthoceros and Funaria (developmental stages not included) **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 andseed habit, telome theory, stelar evolution.
10 lectures

UNIT – IV

Gymnosperms: General characteristics, classification (up to family), morphology, anatomy and reproduction of Cycas, Pinus, Ginkgo and Gnetum, (Developmental details not to be included).
8 lectures

UNIT – V

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

PRACTICAL

(20 classes, each class of 2hour)

FM – 30 marks

1. **Riccia** – Morphology of thallus.
2. **Marchantia**- Morphology of thallus, whole mount of rhizoids & Scales, vertical sectionof thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).
3. **Anthoceros-** Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
4. **Pellia, Porella**- Permanent slides.
5. **Sphagnum**- Morphology of plant, whole mount of leaf (permanent slide only).
6. **Funaria**- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus,spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.
7. **Psilotum**- Study of specimen, transverse section of synangium (permanent slide).
8. **Selaginella**- Morphology, whole mount of leaf with ligule, transverse section of stem,whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).

9. **Equisetum**- Morphology, transverse section of internode, longitudinal section ofstrobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
10. **Pteris**- Morphology, transverse section of rachis, vertical section of sporophyll, 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).
11. **Cycas**- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
12. **Pinus**- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stem, longitudinal section of transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section & radial longitudinal sections stem (permanent slide).
13. **Gnetum**- Morphology (stem, male & female cones), transverse section of stem, verticalsection of ovule (permanent slide)
14. 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. 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. Vander-Poorteri 2009 Introduction to Bryophytes, COP.

GENERIC ELECTIVE COURSES

SEMESTER – III

GE – I

Biodiversity (Microbes, Algae, Fungi and Archegoniate)

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

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 life- cycles of the following: Nostoc, Oedogonium, Vaucheria, Fucus, Polysiphonia, Economic importance of algae. **10 lectures**

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

UNIT – III

Introduction to Archegoniate: Unifying features of archegoniates, Transition to land habit, Alternation of generations. **2 lectures**

Bryophytes: General characteristics, Classification (upto family), Range of thallus organization, morphology, reproduction of Marchantia and Funaria (Developmental details not to be included), Economic importance of bryophytes with special mention of Sphagnum. **6 lectures**

UNIT – IV

Pteridophytes: General characteristics, classification, Early land plants (Rhynia), Morphology and reproduction of Selaginella, Equisetum and Pteris, (Developmental details not to be included), Heterospory and seed habit, stellar evolution, Economic importance of Pteridophytes. **5 lectures**

UNIT – V

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

PRACTICAL

(20 classes, each class of 2hour)

FM – 30 Marks

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Oedogonium, Vaucheria, Fucus* and Polysiphonia through temporary preparations and permanent slides (* Fucus - Specimen and permanent slides)

5. **Rhizopus and Penicillium:** Asexual stage from temporary mounts and sexual structuresthrough permanent slides.
6. **Alternaria:** Specimens/photographs and tease mounts.
7. **Puccinia:** Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; 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 throughgemma 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.

SEMESTER – IV
(GE – II)
PLANT PHYSIOLOGY AND METABOLISM

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I

Plant-water relations: Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. **4 Lectures**

Mineral nutrition: Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps. **4 Lectures**

Translocation in phloem: Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading. **4 lectures**

UNIT – II

Photosynthesis: Photosynthetic Pigments (Chlorophyll a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C_3, C_4 and CAM pathways of carbon fixation; Photorespiration. **8 lectures**

UNIT – III

Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway. **4 lectures**

UNIT – IV

Enzymes: Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition. **3 lectures**

Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation. **3 lectures**

UNIT – V

Plant growth regulators: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene. **5 lectures**

Plant response to light and temperature: Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization. **5 lectures**

PRACTICAL

(20 classes, each class of 2hour)

FM – 30 marks

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Separation of amino acids by paper chromatography.

Demonstration experiments (any four)

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

Suggested Readings:

- Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th Edition.
- Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.

- Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

SEMESTER – III
CORE COURSE – V
ANATOMY OF ANGIOSPERMS

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I

Introduction and scope of Plant Anatomy: Applications in systematics, forensics and pharmacognosy. **2 lectures**

Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); 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, 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); Quiescent centre; 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; Sap wood and heart wood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. **5 lectures**

Periderm: Development and composition of periderm 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); Anatomical adaptations of xerophytes and hydrophytes. **5 lectures**

UNIT – V

Secretory System: Hydathodes, cavities, lithocysts and laticifers & Anomalous secondary growth in dicot stems. **3 lectures**

Practical

(20 classes, each class of 2hour)

FM – 30 marks

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

SEMESTER – III
CORE COURSE – VI
ECONOMIC BOTANY

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

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, evolution of new crops/ varieties, importance of germplasm diversty. **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 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*, *Papave*r 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 *groundnut*, *coconut*, and *Brassica* (Botanical name, family & uses) **4 lectures**

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

4 lectures

UNIT – V

Natural Rubber: Para-rubber: tapping, processing and uses. **2 lectures**

Timber plants: General account with special reference to teak and pine. **2 lectures**

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

PRACTICAL

(20 classes, each class of 2hour)

FM – 30 marks

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, 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. **Wood:** Tectona, Pinus: Specimen, section of young stem.
10. **Fibre-yielding plants:** Cotton (specimen, whole mount of fibre and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fibre).

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

SEMESTER – III
CORE COURSE – VII
GENETICS

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I

Mendelian genetics and its extension Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Polygenic inheritance. **16 Lectures**

UNIT – II

Extra chromosomal Inheritance: Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium*. **6 Lectures**

UNIT – III

Linkage, crossing over and chromosome mapping: Linkage and crossing over- Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence. **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: CLB method. **6 Lectures**

UNIT – V

Fine structure of gene: Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism. **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

(20 classes, each class of 2hour)

FM – 30 marks

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis.
3. Chromosome mapping using test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits with floral chart.
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. Photographs/Permanent Slides showing Translocation Ring, Inversion Bridge.

Suggested Readings:

- Gardner, E. J., Simmons, M. J., Snustad, D. P. (1991). Principles of Genetics, John Wiley & sons, India. 8th Edition.
- Snustad, D. P. and Simmons, M. J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th Edition.
- Klug, W. S., Cummings, M. R., Spencer, C. A. (2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th Edition.
- 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 COURSE – VIII
MOLECULAR BIOLOGY

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I

Nucleic acids: Carriers of genetic information: Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment. **4 Lectures**

UNIT – II

The Structures of DNA and RNA / Genetic Material: Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. Organelle DNA - mitochondria and chloroplast DNA. The Nucleosome -Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. **8 Lectures**

The replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication. **6 Lectures**

UNIT – III

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

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, RNA editing and mRNA transport. **5 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; Fidelity of translation; 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. **5 Lectures**

Practical

(20 classes, each class of 2hours)

FM – 30 marks

1. Preparation of LB medium and raising *E.Coli*.
2. Isolation of genomic DNA from *E.Coli*.
3. DNA isolation and RNA estimation by orcinol method.
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.

Suggested Readings:

- 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.
- Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th Edition.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th Edition.
- Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd Edition.
- 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 COURSE – IX
PLANT ECOLOGY AND PHYTOGEOGRAPHY

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

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, 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 and Humidity: Variations; adaptations of plants to their variation. **4 Lectures**

UNIT – III
Biotic interactions: **2 Lectures**
Population ecology: Characteristics and Dynamics. Ecological Speciation **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
Ecosystems: Structure; Processes; Trophic organisation; Food chains and Food webs; 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; Continental drift; 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
(20 classes, each class of 2hours)

FM – 30 marks

1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
3. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
4. 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 (Orobanche) 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 Raunkiaer's frequency distribution law.
9. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
10. Field visit to familiarise students with ecology of different sites.

Suggested Readings:

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

SEMESTER – IV
CORE COURSE – X
PLANT SYSTEMATICS

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I

Plant identification, Classification, Nomenclature; Biosystematics. **2 Lectures**

Identification: Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; 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. **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. **6 Lectures**

Systems of classification: Major contributions of Theophrastus, Linnaeus, de Candolle, Hutchinson, Takhtajan; 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, cladograms (definitions and differences). **4 Lectures**

UNIT – V

Phylogeny of Angiosperms: Terms and concepts (homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin & evolution of angiosperms; methods of illustrating evolutionary relationship (phylogenetic tree, cladogram). **7 Lectures**

PRACTICAL

(20 classes, each class of 2hours)

FM – 30 marks

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

Ranunculaceae - *Ranunculus, Delphinium*
Brassicaceae - *Brassica, Alyssum / Iberis*
Myrtaceae - *Eucalyptus, Callistemon*
Umbelliferae - *Coriandrum /Anethum / Foeniculum*
Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax*

Solanaceae - *Solanum nigrum/Withania*
Lamiaceae - *Salvia/Ocimum*
Euphorbiaceae - *Euphorbia hirta/E.milii, Jatropha*
Liliaceae - *Asphodelus/Lilium/Allium*
Poaceae - *Triticum/Hordeum/Avena*

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

Suggested Readings:

- Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd Edition.
- Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
- 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.
- Maheshwari, J. K. (1963). Flora of Delhi. CSIR, New Delhi.
- Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.

SEMESTER – V
CORE COURSE – XI
REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I
Introduction: 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. **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, Palynology and scope (a brief account); Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia. **5 Lectures**

UNIT – III
Ovule: Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis; Organization and ultra structure of mature embryo sac. **5 Lectures**
Endosperm: Types, development, structure and functions. **3 Lectures**
Embryo: General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo- endosperm relationship; Nutrition of embryo; Unusual features; Embryo development. **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); Methods to overcome self- incompatibility: mixed pollination, Intraovarian and in vitro pollination; 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. **4 Lectures**

PRACTICAL
(20 classes, each class of 2hours)

FM – 30 marks

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), ultra structure of pollen wall (micrograph); Pollen viability.

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, ultra structure of mature egg apparatus.
5. Intra-ovarian pollination; Test tube pollination through photographs.
6. **Embryogenesis:** Study of development of dicot embryo through permanent slides.

Suggested Readings:

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

SEMESTER – V
CORE COURSE – XII
PLANT PHYSIOLOGY

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I
Plant water relationship: Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation, Ascent of sap– cohesion-tension theory, Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement. **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, criteria for essentiality, mineral deficiency symptoms, physiological 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 K^+ ion influx, 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. **10 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

(20 classes, each class of 2hours)

FM – 30 marks

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 seeds.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).

Suggested Readings:

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

SEMESTER – VI

CORE COURSE – XIII

PLANT METABOLISM

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I

Concept of metabolism: Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes). Signal transduction (Phospholipids, cGMP&NO) **5 Lectures**

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, PS I, PS II, Q cycle, CO_2 reduction, photorespiration, C_4 pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.

10 Lectures

UNIT – III

Carbon Oxidation: Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, TCA - cycle, mitochondrial electron transport, oxidative phosphorylation, factors affecting respiration. **6 Lectures**

ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, role of uncouplers. **4 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, α 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 Amino acids synthesis. **5 Lectures**

PRACTICAL

(20 classes, each class of 2hours)

FM – 30 marks

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 germinationg 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

- Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th Edition.
- Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th Edition.
- Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

SEMESTER – VI
CORE COURSE – XIV
PLANT BIOTECHNOLOGY

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I
Plant Tissue Culture: Historical perspective; Aseptic tissue culture techniques, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones). Cryopreservation; Germplasm conservation. **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. **7 Lectures**

UNIT – III
Recombinant DNA technology – I: Restriction Endonucleases (History, Types I, II & III, biological role and application); Restriction Mapping; Cloning Vectors: Prokaryotic (pUC 18, pBR322, Lambda phage, M13, phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC), Selection of recombinant clones by bacterial transformation, PCR-mediated gene cloning).
10 Lectures

UNIT – IV
Recombinant DNA technology - II: Construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; Probes-oligonucleotide, heterologous, 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 (RoundUp 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 (brief idea).
10 Lectures

PRACTICAL
(20 Classes, each class of 2hours)

FM – 30 marks

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. Construction of restriction map of circular and linear DNA from the data provided.
4. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.

5. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.

Suggested Readings:

- Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th Edition.
- Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th Edition.
- Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
- Chawla, H.S. (2010). Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Singh, B. D. (2010) Biotechnology: Expanding Horizon. Kalyani Publishers. New Delhi.

DISCIPLINE SPECIFIC ELECTIVE COURSES

SEMESTER – V

(DSE – I)

ANALYTICAL TECHNIQUES IN PLANT SCIENCES

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

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, freeze fracture. **10 Lectures**

UNIT – II

Cell fractionation: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$ gradient, analytical centrifugation, ultracentrifugation, marker enzymes. **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. **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: 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

(20 Classes, each class of 2hours)

FM – 30 marks

1. Demonstration of ELISA.
2. To separate nitrogenous bases by paper chromatography.
3. To separate sugars by thin layer chromatography.
4. Isolation of chloroplasts by differential centrifugation.
5. To separate chloroplast pigments by column chromatography.
6. To estimate protein concentration through Lowry's methods.
7. To separate proteins using PAGE.
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.

Suggested Readings:

- Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd Edition.
- Ruzin, S.E. (1999). Plant Micro technique and Microscopy, Oxford University Press, New York. U.S.A.
- 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.
- Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th Edition.

SEMESTER – V
(DSE – II)
BIOSTATSTICS

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I
Biostatistics: Definition - statistical methods - basic principles, Variables - measurements, functions, limitations and uses of statistics. **8 Lectures**

UNIT – II
Collection of data primary and secondary - types and methods of data collection procedures - merits and demerits, Classification - tabulation and presentation of data – sampling methods. **8 Lectures**

UNIT – III
Measures of central tendency - Mean, Median, Mode, geometric mean - merits & demerits, Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations. **10 Lectures**

UNIT – IV
Correlation - types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression. **8 Lectures**

UNIT – V
Statistical inference - hypothesis - simple hypothesis - student 't' test - chi square test.
6 Lectures

PRACTICAL

(20 Classes, each class of 2hours)

FM – 30 marks

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.

Suggested Readings:

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

SEMESTER – VI
(DSE – III)
STRESS BIOLOGY

F.M. – 70 marks **Time – 3hrs**
Lectures: 60 (40 Theory + 20 Practical) **End Sem. – 50 marks**
Credits – 06 **Internal – 20 marks**

Theory

UNIT – I
Defining plant stress: Acclimation and adaptation. Water stress; Salinity stress; High Light stress, Temperature stress. **2 Lectures**

UNIT – II
Hypersensitive reaction; Pathogenesis– related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates. **12 Lectures**

UNIT – III
Stress sensing mechanisms in plants: Role of nitric oxide. Calcium modulation, Phospholipid signalling **12 Lectures**

UNIT – IV
Developmental and physiological mechanisms that protect plants against environmental stress: Adaptation in plants; Changes in root: shoot ratio; Aerenchyna development; Osmotic adjustment; Compatible solute production. **10 Lectures**

UNIT – V
Reactive oxygen species – Production of Oxygen free radicals, Free radical induced lipid peroxidation, Enzymatic scavenging mechanism, Non-enzymatic scavenging mechanism.
4 Lectures

PRACTICAL
(20 Classes, each class of 2hours)

FM – 30 marks

1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.
2. Superoxide activity in seedlings in the absence and presence of salt stress.
3. Assay of Ascorbate
4. Assay of peroxidase.
5. Assay of superoxide dismutase activity.
6. Quantitative estimation and analysis of catalase.

Suggested Readings:

- Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th Edition.
- Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th Edition.

SEMESTER – VI
(DSE – IV)

A Project work is to be undertaken by the student in consultation with the teachers of the department. The student has to prepare the project under the supervision of a teacher of the department. Further, he/she has to submit one Seminar Paper in the department.

	Project Work/ Seminar	**- 100 Marks**
A)	Dissertation/ Viva-voce	- 70 Marks
B)	Seminar	- 30 Marks

The project work is to be evaluated by both the Internal & External Examiners and an External Examiner is to be invited to conduct the Project Evaluation and Viva-Voce.