Shiksha Mandal's
Bajaj College of Science, Wardha

Proposed Syllabus for Four Year Multidisciplinary UG Program with DSC as Major
(Four Year B.Sc. Honors/Research Program)

Program: B.Sc. (Academic Session 2025-26)
Syllabus

DISCIPLINE SPECIFIC CORE (DSC)

DISCIPLINE SPECIFIC ELECTIVE (DSE)

Semester V courses in
Botany

Syllabus under Autonomy

As per National Education Policy (NEP) 2020

B.Sc. Semester V Botany
DSC V: PLANT BIOTECHNOLOGY
[Credits 6]
[60L + 60P]

Course Description: The course introduces various aspects and applications of plant tissue culture and genetic engineering to provide fundamental knowledge to the learners.

Course Objectives:

- To study, maintain, grow plant cells, tissues, or organs under sterile conditions on a nutrientculture medium of known composition.
- To study tools, techniques and application of recombinant DNA technology.
- To study to create copies of a particular gene for downstream applications, principle andapplication of polymerase chain reaction.
- To study introduction of new DNA into an existing organism's cell, by vectors such asplasmids and modified viruses.
- To study the application of biotechnology for crop improvement.
- To study use of computer technology to collect, store, analyze and disseminate biologicaldata and information, such as DNA and amino acid sequences.

Course outcomes:
After completion of the course students will gain the knowledge of –

CO1: The cultivation of plant cells, tissues, or organs on specially formulated nutrient media.
CO2: Tools used in rDNA technology, enzymes and various laboratory techniques to manipulate and isolate DNA segments of interest.
CO3: The process in which a gene of interest is located and copied (cloned) out of all the DNA extracted from an organism.
CO4: Introduction of new DNA into an existing organism's cell, usually by vectors such as plasmids and modified viruses.
CO5: Development of new varieties and individual traits within existing plant varieties include cell and tissue manipulation, marker-assisted selection, transgenic technologies, genomics, and molecular breeding.
CO6: To analyze and interpret biological data, develop computer programs to efficiently access, manage, and use biological information and create mathematical formulas and statistical approaches to evaluate relationships in large datasets.

Unit I: Plant Tissue Culture-I [10 Hrs.]

1.1 Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Methods of Sterilization.
1.2 Totipotency; Basic concept of cellular differentiation (dedifferentiation, undifferentiation, and redifferentiation)
1.3 Organogenesis- Direct and indirect organogenesis, factors affecting organogenesis
1.3 Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids).
1.4 Tissue culture applications: Cryopreservation; Germplasm Conservation).

Unit II: Plant Tissue Culture-II **[10 Hrs.]**

2.1 **Micropropagation**- Steps, factors affecting micropropagation, Acclimatization

2.2 **Somatic embryogenesis-** Direct and indirect somatic embryogenesis, factors affecting somatic embryogenesis, synthetic seeds

2.3 **Cell culture-** isolation of single cell, techniques; factors affecting single cell culture, Induction of callus. Cell suspension culture

2.4 **Protoplast culture**-Isolation and purification of protoplast, culture of protoplast and regeneration of protoplast. Somatic Hybridization and Cybridization.

Unit III: Recombinant DNA technology **[10 Hrs.]**

2.1 Tools and techniques of recombinant DNA technology

2.2 Restriction Endonucleases (History, Types I-IV, biological role and applications).

2.3 Cloning Vectors: Prokaryotic (pBR322, pUC19); Lambda phage, M13, Cosmids,Shuttle vector

2.4 Eukaryotic Vectors (YAC).

Unit IV: Gene Cloning **[10 Hrs.]**

3.1 Recombinant DNA, Bacterial Transformation and selection of recombinant clones.

3.2 Gene Construct; construction of genomic and cDNA libraries

3.3 Screening DNA libraries to obtain gene of interest by genetic selection; colony hybridization.

3.4 Polymerase Chain Reaction (PCR), PCR mediated gene cloning.

Unit V: Methods of gene transfer **[10 Hrs.]**

4.1 Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment.

4.2 *Agrobacterium*-mediated gene transfer.

4.3 T-transposon mediated gene transfer.

4.4 Selection of transgenics– selectable marker and reporter genes b (GUS, GFP).

Unit VI: Applications of Biotechnology **[10 Hrs.]**

5.1 Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean).

5.2 Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations).

5.3 Role of transgenics in bioremediation (Superbug); edible vaccines;

5.4 Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns;Introduction to Protection of Plant Varieties and Farmers Rights Act, 2001.

Practicals: **[60 Hrs.]**

1. Preparation of MS medium.
2. Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, aster and mulberry.
3. Study of anther, embryo culture, micropropagation, somatic embryogenesis & artificial seeds.
4. Isolation of protoplasts.
5. Construction of restriction map of circular and linear DNA from the data provided.
6. Introduction to PCR- demonstration of thermocycler and PCR ingredients.
7. Design of PCR primers by manual method and by primer3 software.
8. Transformation of bacteria and selection of transformant.

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

10. Insect bioassay with bt cotton leaves with larval studies.

11. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr S avr tomato through photographs.

12. Isolation of plant genomic DNA.

13. Isolation of plasmid DNA

14. Quantitative determination of DNA using spectrophotometer and purity of DNA.

15. Restriction digestion and gel electrophoresis of plasmid DNA.

REFERENCE BOOKS:

- 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 Applicationsof recombinant DNA. ASM Press, Washington.
- Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. VikasPublication 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 andApplications. John Wiley & Sons Inc. U.S.A.

B.Sc. Semester – V Botany
DSC V: PLANT BIOTECHNOLOGY
Practical Examination Question Paper

Time: 6 hrs. **Marks: 35**

Q.1.	Experiment 1	10
Q.2.	Experiment 2	10
Q.3.	Spotting	10
Q.4.	Viva-voce	05

B.Sc. Semester V
DSC VI: PLANT ECOLOGY AND PHYTOGEOGRAPHY
[Credits 6]
[60L + 60P]

Course Description: The course includes comprehensive understanding of the fundamental principles of plant ecology, including ecosystem structure, energy flow, nutrient cycling, and plant-environment interactions, the patterns of plant distribution across different geographical regions and understand the historical and environmental factors influencing these patterns.

Course Objectives:

- To study basic concepts, levels, components, inter-relationships between abiotic and bioticfactors of ecology and environment.
- To study interactions between biotic factors, trophical organization and plant adaptations.
- To study definition, scope and characteristics of population and communities.
- To study types and mechanisms of ecological succession, plant succession, plant formationand evolution of ecosystem.
- To study different biogeochemical cycles within ecosystem, stability of ecosystem, majorbiomes and conservation of resources,
- To study the distribution of plants in geographical regions of the world based on latitudinaland longitudinal positions.

Course outcomes:
After completion of the course students will gain the knowledge of –

CO1: Ecosystems and relationships between organisms and environment.
CO2: Interaction of biotic factors, trophical levels and adaptations in plants in different habitats.
CO3: Plant population and community ecology.
CO4: Primary and Secondary succession of plant in an ecosystem, plant formation and ecosystem evolution.
CO5: Functioning and significance of various biogeochemical cycles within the ecosystem.
CO6: Phytogeography, the major plant communities of the world and different vegetational belts of India with characteristic climatic conditions of the area.

Unit I: Ecology and Environment [10 Hrs.]

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

1.2 Climatic Factors: Light and Temperature (effect on vegetation).

1.3 Edaphic factors: Soil- Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.

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

Unit II: Biotic factors [10 Hrs.]

2.1 Interactions between a) plants, animals and human, b) plant community and plants and soil

microorganisms

2.2 Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism.

2.3 Food chains and webs; Ecological pyramids; Biomass.

2.4 Plant adaptations: Morphological, Anatomical & Physiological responses of Hydrophytes, Xerophytes, and Halophytes

Unit III: Population and Community Dynamics [10 Hrs.]

3.1 Population characteristics; population dynamics, carrying capacity, various parameters and measurements.

3.2 Community concept; characteristic features of communities, analysis of communities (analytical and synthetic characters; frequency, density, abundance, Life forms, Raunkier's Biological spectrum)

3.3 Pond and Desert ecosystem Autecology, Ecad, Ecotype

3.4 Community coefficients; Ecotone and edge effects; ecological niche.

Unit IV: Vegetation Development [10 Hrs.]

4.1 Types and mechanisms of ecological succession.

4.2 Plant succession: Hydrosere, Xerosere

4.3 Plant Formation; Association, Consociation and Society.

4.4 Evolution of Ecosystem and oxygenic development.

Unit V: Ecosystem Functional aspects [10 Hrs.]

5.1 Biogeochemical cycles Carbon, Nitrogen, Phosphorus, Sulphur; Mineral cycles (Pathways and processes)

5.2 Ecosystem stability concepts, natural and anthropogenic disturbances.

5.3 Major Biomes of the World

5.4 Conservation of Forest and Water resources

Unit VI: Phytogeography [10 Hrs.]

6.1 Principles of Phytogeography, Distribution (Wides, Endemics, Discontinuous species)

6.2 Theories (Land bridge and continental drift)

6.3 Climatic & Phytogeographic regions of India.

6.4 Local Vegetation (Vidarbha region)

Practicals: [60 Hrs.]

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 of carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. Study of morphological adaptations of hydrophytes and xerophytes (two each).

8. Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Striga*/
Alectra) Epiphytes, Predation (Insectivorous plants).

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

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

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

12. Field visit to familiarize students with ecology of different sites.

REFERENCE BOOKS:

- Ambasht. R.S. (1988). A Textbook of Plant Ecology. Students Friends Co. Varanasi.
- Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4thedition.
- Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi.5th edition.
- Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8thedition.
- Shukla, P. S. and Chandel R. S. (2005). A Textbook of Plant Ecology. S Chand and Co.Ltd.,New Delhi.
- Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation.Anamaya Publications, New Delhi, India.
- Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach.Oxford University Press. U.S.A.

B.Sc. Semester – V Botany
DSC VI: PLANT ECOLOGY AND PHYTOGEOGRAPHY
Practical Examination Question Paper

Time: 6 hrs. **Marks: 35**

Q.1.	Experiment 1	10
Q.2.	Experiment 2	10
Q.3.	Spotting	10
Q.4.	Viva-voce	05

B.Sc. Semester V
DSE I: PLANT MOLECULAR BIOLOGY
[Credits 4]
[60L]

Course Description: The course will cover the structure and function of macro molecules that encode and regulate the flow of genetic information used by living organisms, the structure and content of the genomes found in plant cells, gene structure, expression, and regulation.

Course Objectives:

- To study history, structure, forms and properties of DNA.
- To study genetic material, organization of DNA, RNA, organelle DNA and Nucleosomechromatin structure.
- To study the principles and mechanism of DNA replication.
- To study the principle, mechanism and regulation of transcription in prokaryotes andeukaryotes.
- To study the process and machinery of translation and post-translational modifications ofproteins.
- To study types of DNA damage and DNA repair, mutation, transposable elements andmolecular techniques.

Course outcomes:
After completion of the course students will gain the knowledge of -

CO1: History, structure, forms and properties of DNA.
CO2: Organization of DNA, RNA, mt DNA, cp DNA and Nucleosome chromatin structure.
CO3: Principles and mechanism of DNA replication.
CO4: Principle, mechanism and regulation of transcription in prokaryotes and eukaryotes.
CO5: Process and machinery of translation and post-translational modifications of proteins.
CO6: Types of DNA damage and DNA repair, mutation, transposable elements and molecular techniques.

Unit I: Nucleic acids [10 Hrs.]

1.1 Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey &Chase, Avery, McLeod & McCarty experiment.
1.2 DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure.
1.3 Salient features of double helix. Forms of DNA (A, B, Z),
1.4 Properties of DNA: chemical, physical, spectroscopic and thermal properties of DNA (Buoyant density, effect of acid and alkali, UV- absorption, hyperchromicity and hypochromicity)

Unit II: Genetic Material [10 Hrs.]

2.1 Definition of a gene, organization of genes in viruses, bacteria and eukaryotes, Central Dogma.
2.2 Organization of DNA- Prokaryotes, Viruses, Eukaryotes.
2.3 RNA Structure; Organelle DNA - mitochondria and chloroplast DNA.

2.4 The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Unit III: Replication of DNA [10 Hrs.]

3.1 Chemistry of DNA synthesis (Kornberg's discovery).

3.2 General principles – bidirectional, semiconservative and semi discontinuous replication, RNA priming.

3.3 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.

3.4 Enzymes involved in DNA replication.

Unit IV: Transcription [10 Hrs.]

4.1 Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation.

4.2 Regulation of lactose metabolism and tryptophan synthesis in *E. coli*.

4.3 Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

4.4 Split genes-concept of introns and exons, removal of introns, m-RNA splicing; RNA editing and mRNA transport.

Unit V: Translation [10 Hrs.]

5.1 The genetic code, features of genetic code, degeneracy, wobble hypothesis,

5.2 Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases.

5.3 Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides.

5.4 Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.

Unit VI: DNA Damage and repair [10 Hrs.]

6.1 Types of DNA damage, Types of DNA damaging agents

6.2 multiple repair pathway, Nucleotide excision repair, Base excision repair and Mismatch repair system.

6.3 Mutation: Types, Mutagens, Applications of induced mutations in crop improvement.

6.4 Transposable element in Maize: AC-DS system. Prokaryotic transposons

REFERENCE BOOKS:

- Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to GeneticAnalysis. W. H. Freeman and Co., U.S.A. 10th edition.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. BenjaminCummings. U.S.A. 9th edition.
- Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
- Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc.,
U.S.A. 5th edition.
- 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.

B.Sc. Semester V
DSE II: ECONOMIC BOTANY
[Credits 4]
[60L]

Course Description: The course includes basic plant biology, the relationship between humans and economically important plants and their products, plants used for food, flavour, medicine, fabric, fuel and industrial raw materials.

Course Objectives:

- To study centers of origin of cultivated plants.
- To study origin, evolution, cultivation and uses of cereals, legumes, fodder and fiber crops.
- To study origin, evolution, cultivation of plants used as source of starch, spices, beverages,rubber, etc.
- To study origin, evolution, cultivation of plants used as source of oil, medicinal and aromaticplants.
- To study origin, evolution, cultivation of plants used as timber and non-timber products.
- To study plants used as avenue trees, pollution control, aesthetics, social forestry and agroforestry.

Course outcomes:
After completion of the course students will gain the knowledge of -

CO1: Centers of origin of domesticated plants and evolution of new crops and varieties.
CO2: Origin, evolution, botany, cultivation and uses of cereals, legumes, fodder and fiber crops.
CO3: Origin, evolution, botany, cultivation of plants used as source of starch, spices, beverages, rubber, etc.
CO4: Origin, evolution, botany, cultivation of plants used as source of oil, medicinal and aromatic plants.
CO5: Origin, evolution, botany, cultivation of plants used as timber and non-timber products., benefits and consequences of Green Revolution.
CO6: Plants used as avenue trees, pollution control, aesthetics, social forestry and agroforestry systems.

Unit I: Origin of Cultivated Plants [10 Hrs.]

1.1 Concept of Centers of Origin, their importance with reference to Vavilov's work.
1.2 Examples of major plant introductions.
1.3 Crop domestication and loss of genetic diversity.
1.4 Evolution of new crops/varieties, importance of germplasm diversity.

Unit II: Origin, Evolution, Botany, Cultivation and Uses [10 Hrs.]

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

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

2.3 Forage and Fodder crops: Cowpea, Sorghum, Napier, *Sesbania*

2.4 Fiber crops: Cotton, Jute, Flax.

Unit III: Origin, Evolution, Botany, Cultivation and Uses [10 Hrs.]

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

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

3.3 Beverages: Morphology, processing and uses of Tea and Coffee.

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

Unit IV: Origin, Evolution, Botany, Cultivation and Uses [10 Hrs.]

4.1 General description, classification, extraction, their uses and health implications groundnut, linseed, mustard and coconut (Botanical name, family & uses).

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

4.3 Medicinal plants: Origin, morphology and uses of *Rauwolfia, Withania*, *Azadirachta, Commiphora, Andrographis*.

4.4 Aromatic plants: Origin, morphology and uses of *Cymbopogon, Vetiveria*, Jasmine.

Unit V: Origin, Evolution, Botany, Cultivation and Uses [10 Hrs.]

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

5.2 Important fire wood and timber yielding plants and non-wood forest products (NWFPS) such as Bamboo, Rattam.

5.3 Raw materials for paper making, gums, resins, tannins, dyes, fruits.

5.4 Green revolution; Benefits and adverse consequences, sustainable agriculture, agroecosystem approach.

Unit VI: Recent Trends [10 Hrs.]

6.1 Innovative approaches for meeting world food demands, modern agricultural approach.

6.2 Plants used as Avenue trees for shade, pollution control and aesthetics.

6.3 Social forestry: Plantations for energy, road side, river bank, coastal, marshy, waterlogged, sand dunes and mountainous regions.

6.4 Agroforestry system: Agri-silviculture, horti-silviculture, shifting cultivation, home gardens, alley cropping, intercropping, and, shelterbelts.

REFERENCE BOOKS:

- Arora, R.K. and Nayar, E.R. 1984. Wild Relatives of Crop Plants in India. NBPGR Science Monograph No.7.
- Baker H.G. 1978. Plants and Civilization (3rd ed). C.A. Wadsworth, Belmont.
- Chandel, K.P.S., Shukla, G. and Sharma, N. 1996. Biodiversity in Medicinal and Aromatic Plants in India : Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.
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- Conway, G. and Barbier E., 1994. Plant, Genes and Agriculture. Jones and Bartlett Publishers, Boston.
- Council of Scientific & Industrial Research (1948-1976). The Wealth of India. A Dictionary of Indian Raw Materials and Industrial Products. New Delhi. Raw Materials I-XI, Revised Vol. I-III (1985- 1992) Supplement (2000).
- Council of Scientific & Industrial Research 1986. The Useful Plants of India. Publications and Information Directorate, CSIR, New Delhi.
- Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
- Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

B.Sc. Semester VI
DSC VII: PLANT PHYSIOLOGY AND METABOLISM
[Credits 6]
[60L + 60P]

Course Description: The course will explore the growth and functioning of plants, different physiological processes of translocation, photosynthesis, respiration and nitrogen metabolism, study of all plant internal activity, including the chemical and physical reactions that are a part of life as it exists in plants.

Course Objectives:

- To study the importance of water in plant life and mechanisms for transport of water and solutes in plants, evaluate the role of minerals in plant nutrition and their deficiency symptoms.
- To study the light reactions and carbon assimilation processes responsible for synthesis of food in plants.
- To study the process of respiration, ATP generation and respiratory quotient of molecules.
- To study the role of light on flowering and its physiology in plants.
- To study the physiological factors that regulate growth and development in plants and plant movements.
- To study the physiology of plants and defence mechanism under stress conditions.

Course outcomes:
After completion of the course students will gain the knowledge of -

CO1: Importance of water in plant life, mechanisms for transport of water and solutes in plants, importance of minerals in plant nutrition and their deficiency symptoms.
CO2: Light Reactions and mechanism of carbon assimilation during synthesis of food in plants.
CO3: Mechanism of Respiration and generation of ATP under aerobic and anaerobic conditions, and RQ of different molecules.
CO4: Physiology of flowering in plants and role of light in flowering mechanism.
CO5: Regulation of growth and development in plant by phytohormones and different movements in plants.
CO6: Abiotic and biotic stress in plants, physiology and defence mechanism during stress in plants.

Unit I: Plant Water Relations [10 Hrs.]

1.1 Properties of water; Diffusion, Osmosis, Imbibition and Plasmolysis: Significance
1.2 Water conduction: Root pressure theory, Cohesion-adhesion theory; Transpiration - Stomatal mechanism, Factors and significance. Guttation.
1.3 Uptake, transport and translocation of water, ions, solutes and macromolecules from soil through cell, across membranes.
1.4 Mineral nutrition: Essential and beneficial elements, macro and micronutrients, mineral deficiency symptoms, roles of essential elements; Mineral transport: Passive (Donnan equilibrium), Active (Carrier concept)

Unit II: Photosynthesis [10 Hrs.]

2.1 Introduction, photosynthetic apparatus, photosynthetic pigments, concept of two pigment systems, Role of light, Photophosphorylation.

2.2 Calvin's cycle, C3 -plants, C4 plants, C4 -pathway, CAM pathway, CAM-plants.

2.3 Photorespiration and its significance.

2.4 Translocation of organic solutes; Mechanism of phloem transport, source- sink mechanism.

Unit III: Respiration [10 Hrs.]

3.1 Introduction, mitochondrion as a respiratory center.

3.2 Types of respiration - Aerobic and anaerobic respiration, Mechanism of aerobic respiration.

3.3 Electron Transport mechanism (net ATP generation)

3.4 Respiratory quotient, Pentose Phosphate pathway.

Unit IV: Growth and Development [10 Hrs.]

4.1 Growth: Definition, phases of growth; Circadian rhythms and biological clock.

4.2 Seed dormancy - Definition, Causes and role, methods to break seed dormancy.

4.3 Physiology of flowering - Photoperiodism, concept of florigen, Vernalization and Phytochromes: Pr and Pfr forms, their role

4.4 Ripening of fruits and concept of senescence

Unit V: Plant Growth Regulators and Plant Movements [10 Hrs.]

5.1 Growth Regulators and Elicitors

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

5.3 Plant Movements: Classifications of plant movements.

5.4 Physiological basis of plant movements.

Unit VI: Stress Physiology and Plant Defence System [10 Hrs.]

6.1 Plant Stress: Concept, Types of stress, Plant responses to biotic and abiotic stress.

6.2 Mechanism of biotic and abiotic stress tolerance, HR and SAR.

6.3 Plant defence systems – Overview of plant pathogens and plant diseases.

6.4 Phytoalexins and their host specificity.

Practicals: [60 Hrs.]

Major Experiments

1. To study the permeability of plasma membrane using different concentrations of organic solvents.

2. To study the effect of temperature on permeability of membranes.

3. To determine the osmotic potential of vacuolar sap by plasmolytic method.

4. To determine the water potential of any tuber.

5. To compare the rate of transpiration from two surfaces of leaf- a) bell jar method b) Cobalt chloride method.

6. To determine the path of water (Ascent of sap).

7. To separate chloroplast pigments a) by solvent method and preparation of their absorption spectra, b) paper chromatography.

8. To separate amino acids from plant materials on paper chromatography and their identification by comparison with standards.

9. To measure rate of photosynthesis by Wilmott's bubbler under variable conditions of light, temperature and CO2.

10. To compare rates of respiration of various plant parts.

11. To demonstrate bioassay of auxin, cytokinin, GA, ABA and ethylene using appropriate plant materials.

12. To determine osmotic potential of the cell sap by plasmolytic method.

Minor Experiments

1. To demonstrate the phenomenon of imbibition.
2. To demonstrate the root pressure.
3. To demonstrate that the amount of water absorbed, and the amount of water transpired is approximately equal.
4. To demonstrate that light is necessary for photosynthesis (Ganong's light screen).
5. To demonstrate that the light, chlorophyll and CO2 are necessary for photosynthesis(using Moll's half-leaf experiment).
6. To demonstrate fermentation by Kuhne's tube.
7. To demonstrate aerobic respiration.
8. To demonstrate the evolution of CO_2 in respiration.
9. To demonstrate that the part of energy is released in the form of heat during respiration.
10. To demonstrate the measurement of growth of germination pea seeds.
11. To demonstrate the phenomenon of gravitropism (geotropism), phototropism and hydrotropism.
12. To determine proline content of any stress plant.

REFERENCE BOOKS:

- Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. NarosaPublishing House, New Delhi.
- Dey, P.M. and Harborne, J. B. (1997). Plant Biochemistry. Harcourt Asia Pte Ltd/Academic Press I Printed in India 2000.
- Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley andSons. U.S.A. 4th edition.
- Jain V.K. (2017). Fundamental of Plant Physiology. 19th Ed. S. Chand Publication NewDelhi.
- Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

B.Sc. Semester – VI Botany
DSC VII: PLANT PHYSIOLOGY AND METABOLISM
Practical Examination Question Paper

Time: 6 hrs. **Marks: 35**

Q.1.	**Major Experiment**	**12**
Q.2.	**Minor Experiment**	**08**
Q.3.	**Spotting**	**10**
Q.4.	**Viva-voce**	**05**

B.Sc. Semester VI
DSC VIII: PLANT BIOCHEMISTRY
[Credits 6]
[60L + 60P]

Course Description: The course consists of the fundamental principles and concepts of plant biochemistry, including the structure and function of biological macromolecules such as proteins, carbohydrates, lipids, and nucleic acids, explore the various metabolic pathways and processes and kinetics of enzymatic reactions and their regulation in plants.

Course Objectives:

- To study the properties, classification, synthesis and breakdown pathways of carbohydratesin plants.
- To study the structure and classification of amino acids, levels of protein structure, regulationof protein synthesis, post-translational modification and protein denaturation.
- To study the structure, classification, mechanism and kinetics of enzymes.
- To study the structure, classification and functions of important lipids.
- To study bioenergetics and Nitrogen assimilation in plants.
- To study and classify different metabolites in plants and analytical techniques.

Course outcomes:
After completion of the course students will gain the knowledge of –

CO1: Properties, classification, biosynthesis, breakdown pathways and function of carbohydrates in plants.
CO2: Structure, classification of amino acids, different levels of protein structure, regulation of protein synthesis in eukaryotes, post-translational modification and protein denaturation.
CO3: Structure, classification, mechanism of action of enzymes, enzyme kinetics and factors affecting enzyme activity.
CO4: Structure, classification and functions of important lipids, triacyl glycerols, and phosphoglycerides.
CO5: Laws of Thermodynamics, coupled and redox reactions, structure and role of ATP, and metabolism of Nitrogen in plants.
CO6: Primary and Secondary metabolites in plants, and working principle and applications of different analytical techniques used in metabolite analysis.

Unit I: Carbohydrates [10 Hrs.]

1.1 Carbohydrates: Definition, properties and role.
1.2 Classification: Aldoses and ketoses; monosaccharides, disaccharides and polysaccharides.
1.3 Synthesis of Starch and Sucrose.
1.4 Catabolism (degradation) of starch and sucrose.

Unit II: Amino Acids and Proteins [10 Hrs.]

2.1 Structure of amino acids; classification of amino acids.
2.2 Levels of protein structure-primary, secondary, tertiary and quaternary; Ramchandran Plot.
2.3 Physical and chemical properties of amino acids.
2.3 Protein denaturation and biological roles of proteins.

Unit III: Enzymes **[10 Hrs.]**

3.1 Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group.

3.2 Classification of enzymes; Features of active site, substrate specificity.

3.3 Mechanism of action (activation energy, lock and key hypothesis, induced - fit theroy).

3.4 Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

Unit IV: Lipids **[10 Hrs.]**

4.1 Definition and major classes of storage and structural lipids.

4.2 Fatty acids structure and functions.

4.3 Essential fatty acids; Triacyl glycerols structure, functions and properties.

4.4 Phosphoglycerides: structure, functions and properties.

Unit V: Bioenergetics and Nitrogen Assimilation **[10 Hrs.]**

5.1 Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions.

5.2 Coupled reactions, redox reactions.

5.3 ATP: structure, its role as an energy currency molecule.

5.4 Nitrogen Metabolism: Overview of nitrogen fixation, ammonia uptake and reduction, nitrite reduction.

Unit VI: Secondary Metabolites and Analytical Techniques **[10 Hrs.]**

6.1 Metabolism Biochemistry: Primary and secondary metabolites in plants as important natural products.

6.2 Types of alkaloids, phenols, flavonoids, glycosides, and their functions; distribution and localization. Biosynthesis of plant secondary metabolites

6.3 Phytochemical Techniques: Quantitative and Qualitative analysis methods.

6.4 TLC, HPLC, HPTLC principle and techniques.

Practicals: **[60 Hrs.]**

1. Brachet J. & Mirshy, A.E., ed., The Cell Biochemistry, Physiology,To demonstrate test forglucose in grapes, & sucrose in canesugar / beet root.
2. To demonstrate test for protein.
3. To demonstrate the activity of enzyme papain (on egg albumin)
4. To demonstrate the lipid test in oily seeds.
5. To demonstrate the test for starch / cellulose.
6. To demonstrate the activity of enzyme amylase from germinating Wheat grains.
7. Qualitative analysis of secondary metabolites.
8. Detection of secondary metabolites by TLC.
9. Separation of Amino acids by chromatographic techniques.
10. Spectrophotometer estimation of secondary metabolites.

REFERENCE BOOKS:

- Alice Kurian and M. Asha, 2007. Medicinal plants. New India Publishing House, NewDelhi.
- Brachet J. & Mirshy, A.E., ed., The Cell Biochemistry, Physiology,Morphology, Vol.II.

Academic Press Inc. London LTD. 1961.

- Buchanan, B.B.; Gruissem, W.; Jones, R.L.; Biochemistry & Molecular Biology of Plants,American Society of Plant Physiologists, Rockville, Maryland, 2000.
- David. L. Nelson, Michael. M. Cox. Lehninger Principles of Biochemistry. W.H. Freeman; 6th edition
- Davies, D.D., ed., The Biochemistry of Plants, Vol.II, Academic Press, London, 1987.
- Duke, J.A. CRC Handbook of Phytochemical Constituents of GRAS Herbs, Foods &other Economic Plants. CRC Press, Boca Raton, FL, 1992.
- Epstein, E., Mineral Nutrition of Plants: Principles & Perspectives. John Wiley & Sons,New York, 1972.
- Raaman N., 2006 Phytochemical techniques. New India Publishing House, New Delhi.
- S. Sadasivam A. Manickam, Biochemical Methods, New age publishers, 2009.
- Sathya Narayanan U, 1999, "Biochemistry". (2nd Edition), Kolkata, Allied publishers.
- Van Damme J.M., Willey J. Penmans, Arpad Pustazi and Susan Bardocz Hand Book ofPlant Lectins: Properties and Biomedical Applications. Jain Boooks and Pub. Distributers.
- Wilson Walker, Wilson and Walker's Principles and Techniques of Biochemistry andMolecular Biology, Cambridge University Press. 2018.

B.Sc. Semester – VI Botany
DSC VIII: PLANT BIOCHEMISTRY
Practical Examination Question Paper

Time: 6 hrs. **Marks: 35**

Q.1.	Experiment 1	10
Q.2.	Experiment 2	10
Q.3.	Spotting	10
Q.4.	Viva-voce	05

B.Sc. Semester VI
DSE III: PLANT BREEDING AND BIOSTATISTICS
[Credits 4]
[60L]

Course Description: The course includes comprehensive knowledge and hands-on experience in various aspects of plant breeding, genetics, molecular biology, biotechnology, statistical methods in breeding, and crop improvement techniques.

Course Objectives:

- To study the science driven creative process of developing new plant varieties.
- To study crop-improvement methods for developing new crop varieties and hybrids withwider adaptability and higher yield.
- To study methods of selection and hybridization of plant varieties.
- To study quantitative inheritance, inbreeding depression and heterosis.
- To study recent trends and techniques for crop improvement and breeding.
- To study the application of statistical techniques to scientific research.

Course outcomes:
After completion of the course students will gain the knowledge of –

CO1: Scope of Plant breeding, important achievements and challenges in plant breeding.
CO2: Different methods and techniques used for crop improvement.
CO3: Selection of plant variety, back cross, scope and techniques of hybridization.
CO4: Concept, mechanism and application of quantitative inheritance, inbreeding depression and heterosis.
CO5: Recent trends and approaches used for crop improvement and plant breeding.
CO6: Statistical methods such as variables, data collection procedures, dispersion, correlation and regression analysis.

Unit I: Plant Breeding [10 Hrs.]

1.1 Introduction and objectives of Plant Breeding.
1.2 Breeding systems: modes of reproduction in crop plants.
1.3 Important achievements of plant breeding.
1.4 Undesirable consequences of plant breeding.

Unit II: Methods of crop improvement [10 Hrs.]

2.1 Introduction: Centers of origin and domestication of crop plants, plant genetic resources.
2.2 Selection methods: For self-pollinated, cross pollinated and vegetatively propagated plants.
2.3 Hybridization: For self- and Cross-pollinated plants.
2.4 Hybridization for vegetatively propagated plants – Procedure, advantages and limitations.

Unit III: Selection, back cross method of selection, hybridization [10 Hrs.]

3.1 Selection: History of selection, pure line selection, mass selection, pedigree selection, bulk method of selection, merits and demerits.

3.2 Backcross method of selection: Introduction, requirements, applications of back cross methods, genetic consequences of repeated back crossing, procedure of back cross method.
3.3 Hybridization: History, techniques, objectives, types of hybridization –interspecific, intergeneric, distant hybridization.
3.4 Procedure of hybridization, choice of parents.

Unit IV: Quantitative Inheritance, Inbreeding depression and Heterosis [10 Hrs.]

4.1 Concept, mechanism, examples of inheritance of Kernel colour in wheat.
4.2 Monogenic vs polygenic Inheritance.
4.3 History, genetic basis of inbreeding depression and heterosis.
4.4 Applications of inbreeding depression and heterosis.

Unit V: Crop improvement and breeding [10 Hrs.]

5.1 Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.
5.2 Role of mutations (Polyploidy) in crop Improvement.
5.3 Distant Hybridization
5.4 Nanotechnology and its applications in crop improvement programmes.

Unit VI: Biostatistics [10 Hrs.]

6.1 Definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.
6.2 Types and methods of data collection procedures. Classification - tabulation and presentation of data - sampling methods.
6.3 Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.
6.4 Types and methods of correlation, regression, simple regression equation, similarities and dissimilarities of correlation and regression. Hypothesis - simple hypothesis - student 't' test - chi square test.

***Numerical Problems**

1) Calculation of mean, standard deviation and standard error
2) Calculation of range, coefficient of variation
3) Calculation of correlation coefficient values and finding out the probability
4) Calculation of ‘t’ value and finding out the probability value for the calculated t value.

REFERENCE BOOKS:

- An Introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J.

ChristianMedical College, Vellore

- Biostatistics, Danniel, W.W., 1987.New York, John Wiley Sons.
- Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press.
- Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.
- Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.
- The Principles of scientific research, Freedman, P. New York, Pergamon Press.

B.Sc. Semester VI
DSE IV: AESTHETIC BOTANY AND PHARMACOGNOSY
[Credits 4]
[60L]

Course Description: The course includes the study of plants with an appreciation for their beauty and design, their visual appeal, patterns, and the way they contribute to art, design, and culture and the study of medicinal drugs derived from plant sources.

Course Objectives:

- To study different phytogeographical regions of India, endemic species and plants used foraesthetics for outdoor and indoor purpose.
- To study design, types and components of gardening.
- To study designing, planning, and managing outdoor spaces to enhance their aesthetic andfunctional qualities.
- To study the foundation of traditional medicines, active compounds in plants that are used totreat various diseases.
- To study the crucial process of ensuring the safety, efficacy, and consistency of medicinalproducts derived from natural sources.
- To study cultivation, collection, processing and storage of natural drugs

Course outcomes:

After completion of the course students will gain the knowledge of -

CO1: Phytogeographical regions of India, endemic species and plants used for aesthetic value.
CO2: Planting and nurturing flowers, vegetables, and herbs to maintaining lawns, shrubs, and trees.
CO3: Selection the right plants based on the climate, soil, and desired aesthetics for landscaping.
CO4: Physical, chemical, biochemical, and biological properties of these natural substances, aiming to discover and develop new drugs.
CO5: Identifying and quantifying the active compounds responsible for the drug's therapeutic effects and standardization of natural drugs.
CO6: Cultivation, collection, processing, and storage of natural drugs, to ensure that the final product is of high quality, and safe for use.

Unit I: General aspects of Aesthetic plants [10 Hrs.]

1.1 Phytogeographical regions of India: Climate, Vegetation and Floristic regions.
1.2 Endemism; Concept of hotspots, hot spots of the world.
1.3 Forest types of India.
1.4 Aesthetic plants: Outdoor and Indoor plants

Unit II: Gardening [10 Hrs.]

2.1 Garden Design: Scope and objectives of gardening; Style of gardens (Formal, Informal)
2.2 Types of gardens (English, Mughal and Japanese).
2.3 Components of garden; Planning of outdoor gardens- Small, Residential, Larger Home Garden, Roof and Terrace Garden, Industrial garden, Housing complex; Indoor gardening.
2.4 Garden Features and Ornamentation: Water, Garden pool, Stream, Waterfall, Fountain,

Rocks, Roads, Walks, Pavements and Steps, Walls fences and Gates, Hedges, Arches.

Unit III: Landscaping [10 Hrs.]

3.1 Landscape Design: Definition, objectives and scope, Landscape elements of construction and designing of Residential, Commercial, Educational Institute and religious places.

3.2 Palms and Cycas: Characteristics, propagation, culture, pest and disease, importance and uses, genera and species of palms and Cycads.

3.3 Bamboo and Conifers: Genera, species and varieties; Lawns & Grasses: Planting methods, maintenance, pest management

3.4 Ornamental succulents, Cacti; Polyhouse technology; Scope and objectives of floriculture.

Unit IV: Introduction to Pharmacognosy [10 Hrs.]

4.1 Definition, history, scope and development of Pharmacognosy

4.2 Sources of Drugs – Plants, Animals, Marine and Tissue culture

4.3 Organized drugs, unorganized drugs (dried latex, dried juices, dried extracts, gums and mucilages, oleoresins and oleo- gum -resins).

4.4 Classification of crude drugs: Alphabetical, morphological, taxonomical, chemical, pharmacological
classification of drugs

Unit V: Quality control of Drugs of Natural Origin [10 Hrs.]

5.1 Adulteration of drugs of natural origin.

5.2 Evaluation by organoleptic, microscopic, physical, chemical and biological methods and properties.

5.3 Quantitative microscopy of crude drugs including lycopodium spore method, leaf constants (stomata, trichomes, xylem, phloem, ergastic substances), camera lucida.

5.4 Diagrams of microscopic objects to scale with camera lucida.

Unit VI: Cultivation, Collection, Processing and storage of natural drugs [10 Hrs.]

6.1 Cultivation and Collection of drugs of natural origin.

6.2 Factors influencing cultivation of medicinal plants.

6.3 Plant hormones and their applications.

6.4 Polyploidy, mutation and hybridization with reference to medicinal plants.

REFERENCE BOOKS:

- Anatomy of Crude Drugs by M.A. Iyengar.
- Essentials of Pharmacognosy, Dr. S. H. Ansari, IInd edition, Birla publications, New Delhi,2007
- Hartmann HT, Kester DE, Davies FT and Geneve RL. 2002. Plant Propagation – Principlesand Practices. Prentice Hall India Ltd.
- Herbal drug industry by R.D. Choudhary (1996), Ist Edition, Eastern Publisher, New Delhi.
- Mohammad Ali. Pharmacognosy and Phytochemistry, CBS Publishers & Distribution, NewDelhi.
- Practical Pharmacognosy: C.K. Kokate, Purohit, Gokhlae.
- Randhawa G.S., and Mukhopadhyay A. 2004. Floriculture in India. Allied Publishers Pvt.Limited.
- Royal Horticultural Society's Encyclopedia of Gardening.
- Swarup Vishnu. 2003. Garden Flowers. National Book Trust

- Textbook of Pharmacognosy by C.K. Kokate, Purohit, Gokhlae (2007), 37th Edition, NiraliPrakashan, New Delhi.
- Textbook of Pharmacognosy by T.E. Wallis
- Tyler, V.E., Brady, L.R. and Robbers, J.E., Pharmacognosy, 9th Edn., Lea and Febiger,Philadelphia, 1988.
- W. C. Evans, Trease and Evans Pharmacognosy, 16th edition, W.B. Sounders & Co., London, 2009.