# **VIDYASAGAR UNIVERSITY**



# Curriculum for 3 -Year B Sc (HONOURS) in

# Botany

Under Choice Based Credit System (CBCS) w.e.f 2017-2018

# **SEM-VI HONS**

# **CC-13: Plant Metabolism Credits 06**

#### C13T: Plant Metabolism Credits 04

#### **Course Contents:**

#### Unit 1: Concept of metabolism

Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric ,covalent modulation and Isozymes).

#### **Unit 2: Carbon assimilation**

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

#### Unit 3: Carbohydrate metabolism

Synthesis and catabolism of sucrose and starch.

#### **Unit 4: Carbon Oxidation**

Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

#### **Unit 5: ATP-Synthesis**

Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

#### Unit 6: Lipid metabolism

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Synthesis and breakdown of triglycerides,  $\beta$ -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination,  $\alpha$  oxidation.

#### Unit 7: Nitrogen metabolism

Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

#### Unit 8: Mechanisms of signal transduction

Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

#### C13P: Plant Metabolism Credits 02

#### Practical

1. Chemical separation of photosynthetic pigments.

- 2. Experimental demonstration of Hill's reaction.
- 3. To study the effect of light intensity on the rate of photosynthesis.
- 4. Effect of carbon dioxide on the rate of photosynthesis.
- 5. To compare the rate of respiration in different parts of a plant.
- 6. To demonstrate activity of Nitrate reductase in germinating leaves of different plant sources.
- 7. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids
- 1. 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.

# CC-14: Plant Biotechnology Credits 06 C14T: Plant Biotechnology Credits 04 Course Contents:

#### **Unit -1: Plant Tissue Culture**

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

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#### **Unit- 2: Recombinant DNA technology**

Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC

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# **Unit- 3:Gene Cloning**

Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCRmediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR

#### Unit- 4: 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).

#### **Unit - 5: 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); Gentically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

# C14P: Plant Biotechnology Credits 02

Practical

1. (a) Preparation of MS medium.

(b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.

2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.

3. Isolation of protoplasts.

4. Construction of restriction map of circular and linear DNA from the data provided.

5. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene

6. transfer by electroporation, microinjection, microprojectile bombardment.

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

8. Isolation of plasmid DNA.

9. Restriction digestion and gel electrophoresis of plasmid DNA.

#### **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.

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▶ 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.

#### DSE-3: Industrial and Environmental Microbiology Credits 06 DSE-3T: Industrial and Environmental Microbiology Credits 04 Course Contents:

#### Unit 1: Scope of microbes in industry and environment

#### Unit 2: Bioreactors / Fermenters and fermentation processes

Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratory, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.

#### Unit 3: Microbial production of industrial products

Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase or lipase activity, Organic acid (citric acid or glutamic acid), alcohol (Ethanol) and antibiotic (Penicillin)

#### Unit 4: Microbial enzymes of industrial interest and enzyme immobilization

Microorganisms for industrial applications\_and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

## Unit 5: Microbes and quality of environment.

Distribution of microbes in air; Isolation of microorganisms from soil, air and water.

#### Unit 6: Microbial flora of water.

Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.

#### Unit 7: Microbes in agriculture and remediation of contaminated soils.

Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

#### **DSE-3P: Industrial and Environmental Microbiology Credits 02 Practical**

1. Principles and functioning of instruments in microbiology laboratory

2. Hands on sterilization techniques and preparation of culture media.

#### Suggested Readings:

▶ Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.

Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

#### OR

**DSE-3: Bioinformatics Credits 06** 

#### **DSE3T: Bioinformatics Credits 04**

**Course Contents:** 

#### **Unit 1. Introduction to Bioinformatics**

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

#### **Unit 2. Databases in Bioinformatics**

Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

#### **Unit 3. Biological Sequence Databases**

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ. Protein

Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features.

#### **Unit 4. Sequence Alignments**

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

#### Unit 5. Molecular Phylogeny

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

#### **Unit 6. Applications of Bioinformatics**

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement

#### **DSE3P: Bioinformatics Credits 02**

#### Practical

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

#### **Suggested Readings:**

➢ Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

> Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.

Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics.

II Edition. Benjamin Cummings.

# **DSE-4:** Analytical Techniques in Plant Sciences Credits 06

#### DSE4T: Analytical Techniques in Plant Sciences Credits 04 Course Contents:

#### Unit- 1: Imaging and related techniques

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

#### **Unit- 2: Cell fractionation**

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

#### Unit- 3: Radioisotopes

Use in biological research, auto-radiography, pulse chase experiment.

#### **Unit- 4: Spectrophotometry**

Principle and its application in biological research.

#### **Unit- 5: Chromatography**

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

#### Unit- 6: Characterization of proteins and nucleic acids

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

#### **Unit- 7: 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.

#### **DSE4P:** Analytical Techniques in Plant Sciences Credits 02

#### Practical

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.

- 2. Demonstration of ELISA. 3. To separate nitrogenous bases by paper chromatography.
- 4. To separate sugars by thin layer chromatography.
- 5. Isolation of chloroplasts by differential centrifugation.
- 6. To separate chloroplast pigments by column chromatography.
- 7. To estimate protein concentration through Lowry's methods.
- 8. To separate proteins using PAGE.
- 9. To separation DNA (marker) using AGE.
- 10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freezeetching, negative staining, positive staining, fluorescence and FISH).
- 11. Preparation of permanent slides (double staining).

#### **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 Microtechnique 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.

# OR

#### DSE-4: Research Methodology Credits 06

#### **DSE4T: Research Methodology Credits 04**

# **Course Contents:**

#### Unit 1: Basic concepts of research

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

#### **Unit 2: General laboratory practices**

Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases.Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions.Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.

#### Unit 3: Data collection and documentation of observations

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of Tissue specimens and application of scale bars. The art of field photography.

#### **Unit 4: Overview of Biological Problems**

History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics Transcriptional regulatory network.

#### Unit 5: Methods to study plant cell/tissue structure

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.

#### Unit 6: Plant microtechniques

Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials.

#### Unit 7: The art of scientific writing and its presentation

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Powerpoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

# DSE4P: Research Methodology Credits 02

#### Practical

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

# **Suggested Readings:**

Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.

Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

▶ Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.