ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

REVISED UG SYLLABUS UNDER CBCS

(Implemented from Academic Year 2020-21)

PROGRAMME: FOUR YEAR B.Sc. (Hons)

Domain Subject: BOTANY

Fourth Year – VII and VIII Semesters (5 Courses in each semester)

(Syllabus with Learning Outcomes, References, & Co-curricular Activities)

Semester – VII: 3 Courses of Higher Order (P.G. level) + 2 Skill Oriented Courses

Semester	Components of study	Course No. & Title of the Course	Hours/ week	No. credits	Internals	External	Total Marks
VII	Higher Order Courses (HOC)	8(A) Plant Pathology (OR) 8(B) Plant Systematics	4	4	75	25	100
		PP/PS Practical	2	1	-	50	50
		9(A) Plant Biochemistry (OR) 9(B) Plant Developmental Biology	4	4	75	25	100
		PB/PDB Practical	2	1	-	50	50
		10(A) Plant Molecular Biology (OR) 10(B)Plant Resources and Utilization	4	4	75	25	100
		PMB/PRU Practical	2	1	-	50	50
	Skill Oriented Courses (SOC)	11(A) Gardening and Landscaping (OR) 11(B) Herbal Technology	4	4	75	25	100
		GL/HT Practical	2	1	-	50	50
		12(A) Floriculture (OR) 12(B) Organic Farming	4	4	75	25	100

		FC/OF Practical	2	1	-	50	50
VIII	Higher Order Courses (HOC)	13(A) Plant Biotechnology (OR) 13(B) Crop Physiology	4	4	75	25	100
		PB/CP Practical	2	1	-	50	50
		14(A) Plant Genetic Engineering (OR) 14(B) Genetics of Crop Improvement	4	4	75	25	100
		PGE/GCI Practical	2	1	-	50	50
		15(A) Bioinformatics and Computational Biology (OR) 15(B)Phyto-medicines and Ethnobotany	4	4	75	25	100
		BCB/PE Practical	2	1	-	50	50
	Skill Oriented Courses (SOC)	16(A) Biofertilizers and Biopesticides (OR) 16(B) Natural Resource Management	4	4	75	25	100
		BB/NRM Practical	2	1	-	50	50
		17(A) Soil fertility and Conservation (OR) 17(B) Industrial and Environmental Biotechnology	4	4	75	25	100
		SC/IEB Practical	2	1	-	50	50

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VII
Domain Subject: BOTANY

Semester – VII

Higher Order Course 8 (A): Plant Pathology

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Identify the plant pathogens based on the disease symptoms.
2. Classify the plant diseases based on the causal agents.
3. Explain the life cycle of plant pathogenic organisms.
4. Interpret the factors responsible for disease development and defence mechanisms of host.
5. Predict the role of environment in disease development.
6. Estimate the severity of plant diseases.
7. Choose appropriate methods of disease management.

II. Syllabus of theory:

UNIT-I: Significance and causes of plant diseases (12h)

1. Scope and objectives of plant pathology; socio-economic significance of plant diseases with special reference to India and abroad.
2. Causes and classification of plant diseases.
3. Important plant pathogenic organisms (fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa), phanerogamic parasites (*Cuscuta, Loranthus, Orobanche, Striga*) and nematodes with examples of diseases caused by them.

UNIT-II: Disease symptomatology (10h)

1. Growth, reproduction, survival and dispersal of important plant pathogens
2. Role of environment and host nutrition on disease development.
3. Host parasite interaction, recognition concept and infection, symptomatology.

UNIT-III: Disease development and defense strategies (12h)

1. Disease development - role of enzymes, toxins, and growth regulators.
2. Defense strategies- oxidative burst; phenolics, phytoalexins, PR proteins, elicitors.
3. Genetics of resistance; Rí genes; mechanism of genetic variation in pathogens.
4. Molecular basis for resistance; genetic engineering for disease resistance.

UNIT-IV: Epidemiology (12h)

1. Compound and simple interest diseases, slow and rapid epiphytotics.
2. Essential conditions for an epidemic, decline of the epidemic.
3. Disease measurement and severity.
4. Disease progress curve and analysis of epidemics.

UNIT-V: Disease management (14h)

1. Principles of plant disease management-cultural, physical, biological, chemical, organic amendments and botanicals
2. Methods of plant disease control, integrated control measures of plant diseases. fungicides, bactericides, and chemotherapy,
3. Nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.

III. Practical syllabus:

1. Equipment and tools used in plant pathology laboratory.
2. Study of symptoms of plant diseases caused by viruses, bacteria, fungi, and algae.
3. Study of symptoms of plant diseases caused by protozoans and nematodes.
4. Preparation of culture media for fungi and bacteria.
5. Methods to prove Koch's postulates with biotroph and necrotroph pathogens.
6. Isolation techniques and preservation of disease samples.
7. Pure culture techniques of common plant pathogens.
8. Safety measures to prevent the spread of pathogens.

IV. Suggested student activities:

- Identify the diseases of plants in their native place using "Plantix app".
- Classroom seminars on identified diseases and their causal agents.
- Identify the similarities of the symptoms among the diseased plants.
- Collect some infected plant organs in your locality and make herbarium or museum mounts.
- Data collection on common preventives and control measures of plant diseases adopted by the farmers in the local area.
- Identity the prevalent crop diseases in their locality and submit a survey report.
- Collection of scientific literature on plant diseases.

V. Textbooks:

- Mehrotra, R S and Ashok Aggarwal, (2017) Plant Pathology, Mc Graw Hill India.
- Mundkar.B.B., (1967) Fungi and Plant Disease, Macmillan and Co. Limited
- Rangaswamy. G & Mahadevan A, (1988), Diseases of Crop Plants in India, Prentice Hall India Learning Private Limited.

VI. Reference Books:

- Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.
- Fry WE. 1982. Principles of Plant Disease Management. Academic Press, New York. Hewitt HG. 1998.
- Heitefuss R & Williams PH. 1976. Physiological Plant Pathology. Springer Verlag, Berlin, New York.
- Marsh RW. 1972. Systemic Fungicides. Longman, New York. Nene YL & Thapliyal PN. 1993. Fungicides in Plant Disease Control. Oxford & IBH, New Delhi.
- Mehrotra RS & Aggarwal A. 2003. Plant Pathology. 2nd Ed. Oxford & IBH, New Delhi.

- Palti J. 1981. Cultural Practices and Infectious Crop Diseases. Springer- Verlag, New York.
- Singh DP & Singh A. 2007. Disease and Insect Resistance in Plants. Oxford & IBH, New Delhi.
- Singh RS. 2002. Introduction to Principles of Plant Pathology. Oxford & IBH, New Delhi.
- Upadhyay RK & Mukherjee KG. 1997. Toxins in Plant Disease Development and Evolving Biotechnology. Oxford & IBH, New Delhi.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VII
Domain Subject: BOTANY

Semester – VII

Higher Order Course 9 (A): Plant Biochemistry

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. List out and classify the metabolites in plants.
2. Explain the general properties and synthesis of biomolecules in plants.
3. Elaborate the functions and applications of plant secondary metabolites.
4. Explain the chemical nature and functions of nucleic acids.
5. Discuss the structure and kinetics of enzymes.
6. Formulate methods to study the lineages of plants using isozymes.

II. Syllabus of theory:

UNIT-I: Metabolites in plants (10 hr)

1. Basic principles of biochemistry, overview of plant biochemistry.
2. Primary and secondary metabolites in plants.
3. Biosynthesis and catabolism of carbohydrates, Classification, D and L designation, open chain and cyclic structures, epimers and monomers, maturation.

UNIT-II: Amino acids, proteins and Lipids (14h)

1. Amino acids - classification, biosynthesis, structure, and stereochemistry,
2. Chemical reactions of amino acids (due to carbonyl and amino groups), pK value, peptide bond-nature and conformation.
3. Proteins - General properties, denaturation and renaturation,
4. Structural organization of proteins primary, secondary, tertiary and quaternary structures.
5. A brief account of lipids in plants.

UNIT-III: Secondary metabolites in plants (12h)

1. Introduction to secondary metabolites in plants: Definition, classification, and their roles in plant growth, development, and interactions with the environment.
2. Biosynthetic pathways involved in the production of secondary metabolites (alkaloids, flavonoids, terpenoids).
3. Functions and applications of secondary metabolites in plants: Plant defense mechanisms, pigmentation, aroma, flavor, medicinal properties, and ecological significance of secondary metabolites.

UNIT-IV: Nucleic acids (12h)

1. Building blocks of nucleic acids, Purines and pyrimidines, nucleosides, nucleotides.
2. Types of DNA (A, B and Z), double stranded linear DNA, Circular DNA and Extra chromosomal DNA.

3. Kinetics of nucleic acids.
4. Different types of RNA and their biological functions

UNIT-V: Basic concepts of enzymology (12h)

1. Enzyme structure: specific three-dimensional shape; enzyme kinetics - Michaelis-Menten kinetic model.
2. Enzyme regulation mechanisms - feedback inhibition, allosteric regulation, and covalent modification.
3. Enzyme inhibition: reversible and irreversible.
4. Isozymes and their applications in taxonomy and identification of plant species; Isozyme markers in genetic diversity studies.

III. Practical syllabus:

1. Qualitative and quantitative (anthrone method) estimation of carbohydrates.
2. Reactions of mono, di, tri and polysaccharides.
3. Estimation of protein by Lowry or biuret method.
4. Reactions of amino sugars, glycosaminoglycons, glycolproteins.
5. Reactions of some common lipids(triacyl glycerides, sterols and carotenoids) in plants.
6. Qualitative and quantitative estimation of alkaloids, flavonoids, terpenoids.
7. Demonstration of electrophoresis.
8. Demonstration of Western blotting
9. Demonstration of ELISA
10. Enzyme kinetics and inhibition assays to measure enzyme activity(amylase/polyphenol oxidase) in plant extracts using spectrophotometry.

IV. Suggested student activities:

- Estimation of carbohydrate content in different food grains.
- Estimation of protein content in different food grains.
- Identification and estimation of secondary metabolites(gums, resins, catechols) in local plant species.
- Separation and identification of isozymes in different species of a genus or different genera of a family.
- Collection of literature of secondary metabolites of plants, their role and applications.
- Preparation of models of enzyme structure and kinetics.
- Study of some enzyme assays.

V. Textbooks:

- Hans-Walter Heldt and Birgit Piechulla, 2011. Plant Biochemistry, Academic Press, Cambridge
- Chris P. J. Hawes and Marilyn J. Hawes, 2013. Plant Biochemistry: An Introduction, Garland Science, New York
- G. Jones and D. T. Cooke, 2000. Introduction to Plant Biochemistry, Wiley, New Jersey

- Peter M. Dey and John B. Harborne, 1997, Plant Biochemistry and Molecular Biology, John Wiley & Sons, New Jersey

VI. Reference books:

- Bob B. Buchanan, Wilhelm Gruissem, and Russell L. Jones, 2015 Biochemistry and Molecular Biology of Plants, Wiley-Blackwell, New Jersey
- D.D. Davies, 2004 Plant Biochemistry, Springer, New York
- David D. Davies, 1981 The Biochemistry of Plants: A Comprehensive Treatise Academic Press, Cambridge
- David T. Dennis and David J. Turpin, 1995 Plant Biochemistry and Molecular Biology, Longman, London
- Hans-Walter Heldt and Fiona Heldt, 2005 Plant Biochemistry, Academic Press, Cambridge
- J.B. Harborne, 1988 Introduction to Plant Biochemistry Academic Press, Cambridge
- Principles of Biochemistry – Lehninger, Macmillar U.K. 2021

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VII
Domain Subject: BOTANY

Semester – VII
Higher Order Course 10 (A): Plant Molecular Biology

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Explain in detail the autocatalytic process of DNA.
2. Compile the causes for DNA damage and predict appropriate repair mechanism.
3. Elaborate the requirements and the process of RNA synthesis.
4. Discuss about the synthesis of protein from mRNA.
5. Compare the regulation of gene and expression in Prokaryotes and Eukaryotes.

II. Syllabus of theory:

UNIT I: Biosynthesis of genetic material (12h)

1. Central dogma of molecular biology.
2. DNA replication and repair - replication fork, continuous and discontinuous DNA synthesis.
3. Enzymes and proteins in replication - Single Strand DNA Binding proteins (SSB), helicases, topoisomerases, DNA ligases; priming by RNA polymerase and primase.
4. DNA polymerases, mechanism of replication in Prokaryotes and Eukaryotes.

UNIT-II: Damage and repair mechanisms of DNA (12h)

1. Types of damage - oxidative damage, single-strand breaks, double-strand breaks, base damage, cross-linking, DNA adducts, replication errors.
2. Regenerate response - Base Excision Repair (BER), Nucleotide Excision Repair (NER), Mismatch Repair (MMR), Homologous Recombination (HR), Non-Homologous End Joining (NHEJ).

UNIT-III: Transcription (14h)

1. RNA polymerases - structure of *E.coli* RNA polymerase, and nature of Eukaryotic RNA polymerases.
2. Promoters, enhancer sequences; initiation, elongation and termination of RNA synthesis; monocistronic and polycistronic RNAs.
3. Post-transcriptional modifications of eukaryotic hnRNA – capping, methylation and polyadenylation.
4. RNA splicing and splicing mechanisms- splicing of nuclear pre-tRNA, group I and group II introns, and pre-mRNA splicing. Excision of multiple introns. Role of catalytic RNA.

UNIT-IV: Translation (10h)

1. General features of genetic code, codon degeneracy and universality.
2. Mitochondrial genetic code, tRNA role in protein synthesis; Aminoacyl-tRNA synthetases, wobble hypothesis.

3. Mechanism of initiation, elongation and termination of protein synthesis.
4. Post-translational modifications; Protein sorting and targeting.

UNIT-V: Regulation of gene expression (12h)

1. House-keeping genes, constitutive genes, and regulatory genes.
2. Regulatory proteins- DNA-binding motif of regulatory proteins.
3. Regulation of gene expression in prokaryotic operons; negative and positive regulation.
4. Fine structure of lac operon. Repressor and the catabolite activator proteins in gene regulation of lac operon.

III. Practical syllabus:

1. Determination of log phase during culturing of *E. coli*
2. Estimation of DNA by diphenylamine method.
3. Determination of purity and quantity of DNA by UV absorption method.
4. Determination of melting temperature (Tm) of DNA
5. Estimation of RNA by orcinol method.
6. PAGE electrophoresis of proteins.
7. Demonstration of Southern and Western blotting.
8. Restriction digestion of DNA.
9. Separation of RE-digested fragments by gel electrophoresis.

IV. Suggested student activities:

1. Learning different techniques of molecular biology through

Virtual Labs - AMRITA VISHWA VIDYAPEETHAM (vlab.co.in)
https://www.labxchange.org/
Kusile Labs | Technology Foundation
https://learn.saylor.org/course/

V. Textbooks

- Alan Jones and Jim Plunkett.2011"Plant Molecular Biology" by Publisher: Cambridge University Press.
- Chris Hawes and Benjamin White 2018 "Plant Cell Biology. Garland Science,
- David Clark and Robert Goldberg 2019"Plant Molecular Biology" Oxford University Press,.
- Stanton Gelvin and Rob Schilperoort, (1994) "Plant Molecular Biology Manual" Springer.
- Sue Carson, Heather Miller, and D. Scott Witherow.(2019)Molecular Biology Techniques: An Intensive Laboratory Course" Academic Press,

VI. Reference Books:

- Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter, (2014) Molecular Biology of the Cell, Garland Science.
- Keith Wilson and John Walker, (2018) Principles and Techniques of Biochemistry and Molecular Biology by, published by Cambridge University Press.
- Michael M. Cox and Jennifer Doudna, (2019) Molecular Biology: Principles and Practice W.H. Freeman and Company

- Robert Weaver , (2017) Molecular Biology, McGraw-Hill Education
- Sandy B. Primrose and Richard Twyman, (2010), Principles of Gene Manipulation and Genomics by, Wiley-Blackwell.
- Plant Molecular Biology, Agatha Wilson 2016 Syrawood Publishing House

Semester – VII

Skill Oriented Course 11(A): Gardening and Landscaping

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Identify the different types of plants suitable to develop various types of gardens.
2. Handle and maintain the tools and implements required for garden operations.
3. Design, develop and manage a garden in a sustainable manner.
4. Acquaint with the modern trends and advanced gardening techniques.
5. Categorize and infer various animate and inanimate elements for landscaping.
6. Design, develop and manage a good landscape.

II. Syllabus of theory:

Unit-1: Introduction to gardening (12h)

1. Gardening: Definition and its benefits, home garden and its importance.
2. Basic gardening principles - soil preparation, watering, and fertilization.
3. Choosing the right plants for your garden and understanding their needs.
4. Different types of gardening – roof, terrace, vertical gardening; tools and equipment needed for gardening.

Unit-2: Planning and creating a garden (12h)

1. Planning and designing your garden space; shade loving plants for home garden, suitable annuals, perennials and flowering trees
2. Introduction to potted plants, terrarium; Introduction, definition, methodology on bonsai planting.
3. Understanding the life cycle of plants; pruning, trimming, and shaping plants for optimal growth.
4. Health, pest and disease management strategies; composting and soil amendment techniques.

Unit-3: Advanced gardening techniques (12h)

1. Introduction to commercial gardening; Brief account of propagation methods for plants (Cuttings, grafting, and seeding).
2. Advanced pruning techniques for trees and shrubs; techniques for creating garden structures (trellises and raised beds).
3. Garden design principles and aesthetics.
4. Introduction to sustainable gardening practices (permaculture and organic gardening).

Unit-4: Introduction to landscaping (10h)

1. Definition of landscaping; historical and cultural significance of Landscaping.
2. Elements of landscaping design: Color, texture, form, line, and scale.
3. Principles of landscaping design: Balance, proportion, rhythm, unity and contrast.

4. Site analysis and assessment; soil types, texture, and structure.
5. Plant selection and maintenance; water management and conservation.

Unit-5: Implementation of landscaping projects (14h)

1. Project management and planning; site preparation and excavation.
2. Hard scaping: Materials, design, and installation of walkways, patios, and walls; landscape lighting -design and installation.
3. Soft scaping: Planting, irrigation methods and maintenance.
4. Budgeting and cost estimation; safety practices and regulations in landscaping. sustainable landscaping practice.

III. Practical syllabus:

1. Identification of different types of garden plants.
2. Identification of garden tools and implements.
3. Designing of water garden and rock Garden
4. Designing of tray landscape
5. Designing of terrarium
6. Identification of physical elements in landscape
7. Establish and maintenance of lawn and grass suitable for lawn.
8. Making of topiaries.
9. Making of hedges and plant suitable for hedges.

IV. Suggested student activities:

1. Operation and maintenance of garden equipment.
2. Preparation of media for potted plants and potting
3. Estimate of given garden design - BOQ preparation.
4. Practice on bonsai plant training.
5. Operation and maintenance of landscaping equipment.
6. Landscape designing of a residential area or a public garden.
7. Maintenance of commercial gardens
8. Maintenance of different types of lawn grass
9. Reading and making CAD drawings for landscaping.
10. On hand practice of landscaping

V. Textbooks:

- Barbara Damrosch (2008) The Garden Primer, Workman Publishing, New York, NY.
- Lewis Hill (2003) The Flower Gardener's Bible - Storey Publishing, North Adams, MA.
- Rosemary Alexander (2018) The Essential Garden Design Workbook, Timber Press, Portland, Oregon, USA
- Cheryl Merser and Susan Blackmore (2016) The Garden Design Book, Mitchell Beazley, London, UK
- Jack E. Ingels and William R. Nelson (2017) Landscaping Principles and Practices Cengage Learning, Boston, Massachusetts, USA

VI. Reference books:

- Catriona Tudor Erler (2015) The Complete Book of Landscape Design, Construction and Planting, Quarry Books, Beverly, Massachusetts, USA
- Christopher Lloyd (2019) The Well-Tempered Garden, Frances Lincoln Publishers Ltd, London, UK)
- John L. Motloch (2017) The Sustainable Landscape, CRC Press, Boca Raton, Florida, USA
- Ken Druse (2019) The Natural Garden, Clarkson Potter Publishers, New York, USA)
- Olivier Filippi (2016) Planting Design for Dry Gardens, Thames & Hudson, London, UK)

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VII
Domain Subject: BOTANY

Semester – VII

Skill Oriented Course -12(A): Floriculture

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Summarize the significance of flowers in human life.
2. Explain the breeding techniques of some flowering plants.
3. Acquire skills related to production techniques in floriculture.
4. Demonstrate skills of protected cultivation in floriculture.
5. Acquire skills in relation to post-harvest operations in floriculture.

II. Syllabus of theory:

UNIT-1: Basic aspects of floriculture (10h)

1. Floriculture: Definition, history, scope and importance.
2. Floriculture industry, area and production, industrial importance of ornamental plants and flowers in India and Andhra Pradesh.
3. Sexual and asexual propagation methods for floriculture crops.
4. Factors affecting seed germination and cutting/rooting success; techniques for seed sowing, cuttings, layering, division, and grafting; nursery management practices for young plants.

UNIT-2: Breeding techniques for flowering plants (10h)

1. Objectives and techniques in ornamental plant breeding.
2. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of following flower crops.
   (a) *Chrysanthemum* (b) Rose (c) *Crossandra* (d) Tuberose (e) Jasmine (f) *Gladiolus*

UNIT-3: Production technology-1 (14h)

1. Production techniques of following flowering plants for domestic and export market:

(a) Rose (b) *Chrysanthemum* (c) Marigold (d) Tuberose (e) *Crossandra* (f) Jasmine

UNIT-4: Production technology-2 (14h)

1. Production techniques of following flowering plants for domestic and export market:

(a) *Anthurium* (b) *Gerbera* (c) *Gladiolus* (d) *Dahlia* (e) *Heliconia* (f) Orchids

UNIT-5: Recent trends in floriculture (12h)

1. Growing of flowering plants under protected environments such as glass house, plastic house, net house, etc.
2. Importance of flower arrangement; Ikebana - techniques, types, suitable flowers and cut foliage.
3. post-harvest technology of cut and loose flowers with respect of commercial flower crops.
4. Dehydration techniques for drying of flowers, scope importance and status.

III. Practical syllabus:

1. Identification of commercially important floricultural crops.
2. Propagation techniques in Marigold/Rose/*Chrysanthemum*/Tuberose.
3. Propagation techniques in *Gladiolus*/Carnation/*Petunia*
4. Sowing of seeds and raising of seedlings of a flowering plant.
5. Training and pruning of Rose/Jasmine.
6. Drying and preservation of flowers.
7. Use of chemicals and other compounds for prolonging the vase life of cut flowers.
8. Flower arrangement practices.
9. Making bouquets, garland, veni and gajra.

IV. Suggested student activities:

1. Cultivation of any two flowering plants and recording the data from sowing to harvesting.
2. Studying various factors affecting flower development and quality.
3. Practicing the techniques to enhance the shelf-life of flowers.
4. Making floral designs to use in landscaping.
5. Practicing techniques in handling various types of flowers.
6. Visits to Floriculture fields and Horticulture University/college.

V. Textbooks:

- T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy.2003. Commercial flowers. Partha Sankar Basu, Nayaudyog,206, Bidhan Sarani, Kolkata
- S.K. Bhattacharjee and L.C. De. 2003. Advanced Commercial Floriculture. Aavishkar Publishers, Distributors, Jaipur, India.
- V.L. Sheela, 2008. Flower for trade. New India Publishing Agency, New Delhi
- Dewasish Choudhary and Amal Mehta. 2010. Flower crops cultivation and management. Oxford Book Company, Jaipur, India.

VI. Reference books:

- Dr. Charles P. Griner (2012) Floriculture: Designing and Merchandising, Delmar Cengage Learning, Clifton Park, NY.
- Edward F. Gilman and Terri W. Starman (2013) Floriculture Principles and Species, Pearson, Upper Saddle River, NJ.
- Paul V. Nelson (2010) Greenhouse Operation and Management, Prentice Hall, Upper Saddle River, NJ.
- Hudson T. Hartmann and Dale E. Kester (2002) Plant Propagation: Principles and Practices, Prentice Hall, Upper Saddle River, NJ.
- Shane Smith (2000) Greenhouse Gardener's Companion: Growing Food and Flowers in Your Greenhouse or Sunspace, Fulcrum Publishing, Golden, CO.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VII
Domain Subject: BOTANY

Semester – VII
Higher Order Course 8 (B): Plant Systematics

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Explain the principles and methods used in plant taxonomy and systematics.
2. Compile evolutionary trends among different plant groups.
3. Discuss different types of evidence used to deduce lineages in plant systematics.
4. Compare and contrast the characteristics of different groups in angiosperms.
5. Appraise the molecular techniques used in plant systematics.
6. Create phylogenetic trees to infer evolutionary relationships among different plant groups.
7. Elaborate the speciation processes with substantial evidences.

II. Syllabus of theory:

UNIT-1: Plant systematics – an overview (10h)

1. Principles of plant systematics; Taxonomy, Phylogeny, systematics; Evolution.
2. Classification, Scientific names, nomenclature, Linnaean hierarchy.
3. Phylogenetic Systematics: overview and goals, taxon selection, character analysis.
4. Cladogram construction, cladogram analysis

UNIT-2: Evolution and diversity of plants (12h)

1. Evolution and diversity of Bryophytes and land plants.
2. Evolution and diversity of vascular plants
3. Evolution and diversity of woody and seed plants.
4. Evolution of flowering plants.
5. Angiosperm Phylogenetic Group (APG-IV) classification.

UNIT-3: Evidence for systematics (14h)

1. Vegetative characteristics (shoot, leaves, stems, roots, modified structures).
2. Inflorescence types; floral characteristics (calyx, corolla, androecium, gynoecium, extra-floral structures).
3. Angiosperm life cycles; seed, embryo and fruit characteristics.
4. Palynological, chromosomal and phytochemical data in plant systematics.
5. Plant species concepts; molecular methods in plant systematics.

UNIT-4: Characteristics of angiosperm plant groups-1 (12h)

1. Characteristics of ANITA grade families.
2. Characteristics of Magnoliid families
3. Characteristics of Monocot families

UNIT-5: Characteristics of angiosperm plant groups-2 (12h)

1.Characteristics of basal Eudicot families
2. Characteristics of Rosid families
3. Characteristics of Asterid families

III. Practical syllabus:

1.Description of specimens from locally available representative families.
2. Description of a genus based on 3-4 different species.
3. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients.
4. Identification of plant specimens using floras and identification keys.
5. Preparation of identification keys for at least 10 specimens based on morphological features.
6. Study of herbarium specimens of different families covered in theory course.

IV. Suggested student activities:

1. Field trips within and around the college campus studying the local Flora
2. Compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated, as are abundant.
3. Collection of literature on palynological and chemical methods in taxonomy.
4. Collection of literature on use of molecular markers to determine genetic relatedness. between species.
5. Construction of dendrograms using appropriate software.

V. Text books:

- Jones S B and Luchinger A E (1986). Plant Systematics 2nd edn, McGraw Hill Book CO.
- Judd et al. (2007) Plant Systematics – A phylogenetic approach. Sinauer Pub.
- Singh G (2004). Plant Systematics, 2nd Edn, Oxford and IBH, New Delhi.

VI. Reference books:

- Stace C. A. (1980) Plant Taxonomy and Biosystematics.
- Simpson, M.G. (2010) Plant Systematics. Elsevier, Amsterdam.
- Stuessy, T.F. (2009) Plant Taxonomy: The systematic Evaluation of Comparative Data. Columbia University Press, New York.
- Crawford, D.J. (2003) Plant Molecular Systematics. Cambridge University Press, Cambridge, UK
- Davis P H and Heywood V H. (1963) Principles of Angiosperm Taxonomy, Oliver and Boyd.
- Jain S. K. and Rao R. R. (1976) Handbook of Field and Herbarium Methods, Today and Tomorrow Publishers, New Delhi.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VII
Domain Subject: BOTANY

Semester – VII
Higher Order Course 9 (B): Plant Developmental Biology

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Explain the fundamental principles of plant growth and development.
2. Discuss the molecular and genetic mechanisms that regulate plant development.
3. Perform experimental techniques related to plant developmental biology.
4. Analyze and interpret primary literature in the field of plant developmental biology.
5. Understanding the importance of plant development in applied branches of botany.

II. Syllabus of theory:

Unit 1: Plant growth and differentiation (10h)

1. Molecular and cellular basis of plant growth and differentiation.
2. Control of cell division, expansion, and differentiation.
3. Role of hormones, signaling pathways, and transcription factors in regulating growth and differentiation.

Unit 2: Development of root and shoot (12h)

1. Root development, hormonal control of root architecture, environmental factors influencing root architecture, lateral root development.
2. Axillary shoot development, bud initiation,
3. Hormones involved in axillary bud formation: auxin, cytokinin and novel hormones (guvermectin, jasmonates, brassinosteroids). Abscisic Acid and branching.

Unit 3: Organogenesis and pattern formation (12h)

1. Formation of organs - leaves, roots, and shoots.
2. Molecular genetics of root, shoot and leaf development.
3. Apical meristem and lateral meristem development.
4. Establishment of plant polarity and spatial patterning.

Unit 4: Flower development and leaf senescence (14h)

1. Structure and function of floral organs; transition from vegetative to reproductive phase – induction, morphological and histochemical changes in shoot apex, floral meristems.
2. Genetic and molecular mechanisms of flower development - ABC and ABCE models.
3. Light mediated regulation; Photoreceptors- phytochromes, cryptochromes, phototropins.
4. Signal transduction leading to photomorphogenesis and photoperiodic responses.
5. Symptoms of senescence. regulation of leaf senescence molecular genetic regulation of leaf senescence.

Unit 5: Fruit and seed development (12h)

1. Fruit development and fruit set; Fruit maturation and ripening, mechanism of fruit ripening.
2. Seed development, embryo development.
3. Seed dormancy, seed germination, role of hormones in germination.

III. Practical syllabus:

1. Isolation of vegetative and reproductive apical meristems.
2. Tracing the course of stomatal development and observations of stomatal types (anomocytic, anisocytic, parasitic, diacytic).
3. Origin and development of epidermal structures (trichomes, glands and lenticels).
4. Histochemical comparison between vegetative SA and reproductively induced SA.
5. Stages in root development and gravitropism.
6. Study of flowering and reproductive development using microscopy.
7. Study of stages of leaf senescence and abscission
8. Study of stages of fruit development and maturation.
9. Observing stages of embryo development, dissection, and isolation of developing embryo.

IV. Suggested student activities:

1. Observation of plant growth stages.
2. Collection of literature on genetic basis of plant development.
3. Observations on plant vegetative and reproductive tissues and organs under a microscope.
4. Performing experiments to investigate the effects of plant growth regulators on plant growth and development.
5. Conducting experiments to understand the role of light in development and morphogenesis in plants.
6. Observations on different movements in plants and their organs.
7. Learning genetic analysis techniques to identify the genes responsible for specific developmental processes.

V. Text books:

- Anupama Singh ed. (2017) Plant Developmental Biology: From Morphogenesis to Molecular Regulation and Beyond", Springer.
- Cris Kuhlemeier (2019) Plant Developmental Biology: From Genes to Networks, Academic Press.
- J. Derek Bewley (2013) Plant Developmental Biology: The Cell Embryo and the Seed, Springer,
- Jitendra Kumar (2022) Plant Developmental Biology: Biotechnological Perspectives, Springer.
- Robert Sablowski (2016) Plant Developmental Biology: Genetics, Epigenetics and Environmental Regulation", Wiley-Blackwell.
- Sujay Rakshit (2016) Plant Developmental Biology: Biotechnological Perspectives, Springer, 2016.

VI. Reference books:

- Douglas E. Soltis ed. (2018) Plant Developmental Biology: From Gene to Function University of California Press,
- Edwin R. Hutchison (2015) Plant Developmental Biology", CRC Press.

- Eng-Chong Pua l Michael R. Davey Ed. (2010) Plant Developmental Biology - Biotechnological Perspectives Vol 1 & Vol II Springer-Verlag Berlin Heidelberg.
- Girdhar K. Pandey (2010) Plant Developmental Biology: Biotechnological Perspectives Springer.
- Santosh Kumar Upadhyay (2015) Plant Developmental Biology and Biotechnology CRC Press**.**

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VII
Domain Subject: BOTANY

Semester – VII
Higher Order Course 10 (B): Plant Resources and Utilization

I. Learning outcomes: Students at the successful completion of the course will be able to:
1. Explain the significance of plants in human civilization.
2. Acquire a comprehensive knowledge of different plant products used in human nutrition.
3. Discuss the uses of medicinal and aromatic plants.
4. Appraise the importance of timber and non-timber products for value added products.
5. Determine the value of plants as biofuels and bioplastics.

II. Syllabus of theory:

UNIT-1: Food plants (12h)
1. Centers of diversity of plants, origin of crop plants.
2. Domestication and introduction of crop plants; concepts of sustainable development.
3. Cultivation, production, and uses of cereals (rice and wheat), major (jowar and bajra) and minor millets (finger millet, fox tail millet), pulse crops (red gram and black gram) and sugarcane.

UNIT-2: Plant products (12h)
1. A general account of oil seed crops and vegetable oils.
2. A general account of fruit and vegetable yielding plants.
3. Plant sources and economic importance of rubber, latex, gums, resins, dyes, alkaloids and tannins.
4. A general account of major fiber crops in India; textile production from plant fibers.

UNIT-3: Commercial plant products (12h)
1. A general account and economic potential of spices and condiments.
2. Plant sources and economic importance of flavoring products, beverages, fumitories and masticatories and narcotics.
3. Utilization of some important ornamentals, flowering plants and orchids.

UNIT-4: Medicinal and aromatic plant products (12h)
1. Traditional and modern uses of some medicinal plants of India.
2. Active compounds in medicinal plants and their pharmacological effects.
3. Essential oils and their uses; aromatic plants in perfumery and cosmetics.
4. Phytochemicals and their potential health benefits.

UNIT-5: Timber products and energy crops (12h)
1. Important timber yielding plants of India; wood as a construction and manufacturing material.
2. Other uses of wood products, such as paper and fuel.
3. Energy crops, biofuels and bioplastics.
4. Bamboos, *Eucalyptus*, *Casuarina* - generation of paper industry raw material.

III. Practical syllabus:

1. Study of morphology and micro-chemical test for stored material of any 3 food crops.
2. Study of morphology and microscopic study anatomy of some plant fibers (cotton, jute, hemp, ramie, sisal).
3. Study of morphology, medicinal and aromatic plants and their useful parts.
4. Study of some oil yielding crops and properties of their oils.
5. Study of some gum, resin, tannin, dye yielding plants.
6. Study of firewood, biofuel and timber yielding plants.

IV. Suggested student activities:

1. Visits to markets selling plant products, collecting data and preparation of a report.
2. Visit to forest places and collecting data on utilization of plants by ethnic people.
3. Collection of literature on wild plants and their utilization.
4. Visits to industries making different plant products.
5. Collection of literature on utilization of plants in folklore and traditional medicines.

V. Textbooks:

- S. K. Jain and R. A. Jain, (2015) Handbook of Plant Resources, Springer, New York.
- H. Panda and A. K. Padhi, (2017) Medicinal Plants and Their Utilization, Springer, Singapore.
- G.E. Wickens (1998) Economic Botany: Principles and Practices, Chapman & Hall, London.
- S.L. Kochhar (1990) The Economic Botany of the Tropics, Macmillan, London.

VI. Reference books:

- K. V. Peter, (2004) Handbook of Herbs and Spices, CRC Press, Boca Raton.
- J. E. Simon, J. A. Duke, and E. A. L. Bobilya, (1990) Handbook of Edible Weeds, CRC Press, Boca Raton.
- J. Smartt and N. Haq, (2016) Handbook of Industrial Crops, Springer, New York.
- P. N. Ravindran, (2017) The Encyclopedia of Herbs and Spices, CABI, Wallingford.
- Beryl B. Simpson (2010) Economic Botany: Plants in Our World, Academic Press, London.
- Michael J. Balick and Paul Alan Cox (1996) Plants, People, and Culture: The Science of Ethnobotany, Scientific American Library, New York.
- Ben-Erik van Wyk (2016) Food Plants of the World: An Illustrated Guide, Timber Press, Portland.
- Jo Homan (2012) Plants That Changed History, Chartwell Books, New York.
- Gary J. Martin (2004) Ethnobotany: A Methods Manual, Earthscan Publications, London.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VII
Domain Subject: BOTANY

Semester – VII

Skill Oriented Course 11(B): Herbal Technology

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Explain the principles associated with Indian systems of medicine.
2. Identify important medicinal plants of India and elaborate their therapeutic values.
3. Justify the utilization of herbal preparations for common ailments.
4. Formulate appropriate extraction and formulation method for a specific herb.
5. Acquire skills in screening of herbal drugs against diseases.
6. Discuss about the standardization of herbal drugs and WHO guidelines.

II. Syllabus of theory:

UNIT-1: Herbal medicinal systems in India (12h)

1. Herb, herbal medicine: Definition, Importance of herbal therapies; herbal verses conventional drugs. Safety in herbal drugs, toxicity in herbals and their interactions.
2. Historical and cultural use of medicinal plants in India.
3. Basic concepts of Indian systems of medicine - Ayurveda, Unani, Homoepathy, Siddha, and Naturopathy.
4. Classification of herbs and their taxonomy; herbs used as nutraceuticals and healing agents, herbal cosmetics, herbal pesticides.

UNIT-2: Herbal medicines and excipients (12h)

1. Herbal medicines for viral infections - Colds and Flu, Urinary tract infections, Diarrhoea etc.
2. Herbal medicines for skin conditions - burns, cuts and scrapes, rashes, stings and bites etc.
3. Herbal Excipients – Significance of substances of natural origin as excipients – colorants, sweeteners, binders, diluents, viscosity builders, disintegrants, flavours and perfumes.
4. Analytical profiles of *Acorus calamus, Centella asiatica, Glycyrrhiza glabra, Gymnema sylvestre, Catharanthus roseus* and *Withania somnifera*.

UNIT-3: Herbal extraction and formulation methods (12h)

1. Infusion, decoction, tinctures; digestion, maceration, percolation.
2. Successive solvent extraction, super critical fluid extraction, steam distillation, head space techniques, sepbox.
3. Preparation and storage of herbal extracts; Quality control and standardization of extracts.
4. Formulating herbal preparations; calculating dosages based on age, weight, and health status, adjusting dosages based on individual responses.

UNIT-4: Screening methods for herbal drugs (12h)

1. Pharmacological actions of herbal constituents, herb-drug interactions.
2. Anti-fertility agents, anti-diabetic drugs, anti-anginal drugs.

3. Cardiac glycosides, analgesic activity, antipyretic activity.
4. Legal and ethical considerations on dispensing herbal medicines.

UNIT-5: Standardization of herbal drugs (12h)

1. Importance of standardization, problems involved in the standardization of herbs.
2. Standardization of single drugs and compound formulations; WHO guidelines for quality standardized herbal formulations, estimation of parameter limits used for standardization.
3. Conservation strategies of medicinal plants, conservation types.
4. Government policies for protecting the traditional knowledge.

III. Practical syllabus:

1. Taxonomic identification of some medicinal plants.
2. Preliminary phytochemical screening of crude drugs.
3. Determination of moisture content of crude drugs.
4. Determination of extractive values of crude drugs.
5. Preparation of herbal cosmetics.
6. Preparation and standardization of herbal formulation.
7. Evaluation of excipients of natural origin.
8. Determination of the alcohol content of Asava and Arishta.

IV. Suggested student activities:

1. Case studies and practical applications of herbal medicine.
2. Patient education and counselling on the use of herbal medicines.
3. Collection of literature on therapeutic uses and contraindications of common herbal medicines.
4. Identification of medicinal plants and sustainable harvesting practices.
5. Collection of data on traditional knowledge associated with herbal preparations.
6. Developing treatment plans and integrating herbal medicine into clinical practice.
7. Monograph analysis of herbal drugs from recent Pharmacopoeias.

V. Text books:

- Agarwal, S.S. and Paridhavi, M., (2007) Herbal Drug Technology Universities Press (India) Private Limited.
- Roop K. Khar, S. G. Jadhav, and V. N. Yadav (2011) Herbal Drug Technology, CBS Publishers & Distributors, New Delhi, India.
- Wallis, T.E., (1985) Textbook of Pharmacognosy, CBS Publishers and Distributors.

VI. Reference books:

- Evans, W.C., (2001) Trease and Evans Pharmacognosy Elsevier Health Sciences.
- Lanza, R.P. and Atala, A., (2006) Methods of Tissue Engineering Elsevier Publications.
- "Herbal Drugs: Ethnomedicine to Modern Medicine" by K. K. Janardhanan (2010), Studium Press LLC, Houston, TX, USA.
- Giacinto Bagetta and Marco Cosentino (2018) Herbal Medicines: Development and Validation of Plant-derived Medicines for Human Health, CRC Press, Boca Raton, FL, USA.
- Iris F. F. Benzie and Sissi Wachtel-Galor (2011) Herbal Medicine: Biomolecular and Clinical Aspects, CRC Press, Boca Raton, FL, USA.
- Daan J. A. Crommelin, Robert D. Sindelar, and Bernd Meibohm (2020), Pharmaceutical Biotechnology: Fundamentals and Applications CRC Press, Boca Raton, FL, USA.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VII
Domain Subject: BOTANY

Semester – VII

Skill Oriented Course 12 (B): Organic Farming

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Compare and contrast the advantages and disadvantages of conventional and organic farming.
2. Acquire skills on different composting methods.
3. Acquaint with cultural and crop protection practices related to organic forming.
4. Acquire knowledge on various management practices in organic farming.
5. Discuss about the certification and marketing of organic foods.
6. Explain the initiatives of government in promoting organic farming

II. Syllabus of theory:

UNIT-1: Basic concepts of organic farming (10h)

1. Organic farming: Definition, ecological social and economic benefits.
2. Organic farming and its components; concepts and principles.
3. Biodynamic and natural farming approaches; permaculture and LEISA farming approaches.
4. Sustainable Agriculture, key indicators of sustainable agriculture.
5. Living soil and healthy plant concepts.

UNIT-2: Organic inputs for soil (12h)

1. Vermicompost production technology.
2. Organic manures: Farmyard Manure (FYM), Enrichment of FYM.
3. Compost, methods of composting (Bangalore, Indore, Coimbatore, NADEP methods).
4. Green manuring, classification of green manures.
5. Classification of organic residues, recycling of organic residues.

UNIT-3: Organic crop management (12h)

1. Introduction to Organic Crop Management – land preparation, planting technic, nutrient management.
2. Factors considered for nutrient management; recommended nutrient quantity –blanket, major problems; balance sheet method.
3. Nutrient composition of some organic resources, right timing of nutrient application.
4. Right method of nutrient application, nutrient use efficiency.

UNIT-4: Cultural and crop protection practices (14h)

1. Pre-sowing irrigation; crop rotation, intercropping and mixed cropping.
2. Use of tolerant and resistant varieties; manipulation in sowing dates, irrigation/flooding, destruction of volunteer plants.

3. Pest and disease management – preventive, physical and mechanical methods.
4. Organic crop management – rice, red gram, groundnut, and tomato.
5. Government interventions to promote organic farming: NPOF, NPMSHF, NHM, RKVY, KVK and APEDA.

UNIT-5: Certification and Marketing of Organics (12h)

1. Organic certification process – definition, need, aim and scope, requirements to maintain certification.
2. Organic certification process – labeling of products, NPOP, organic quality control, standards, accreditation, inspection, and certification.
3. Operational structure of organic certification.
4. Marketing of organic products.

III. Practical syllabus:

1. Preparation of Jeevamrutham (liquid and solid) and Beejamrutham.
2. Preparation of Neemastram and Brahmastram.
3. Preparation of Agniastram and Dashaparni Kashayam.
4. Study of intercropping method.
5. Study of water management in Organic Farming.
6. Study of livestock component in Organic Farming.
7. Hands on training on vermicompost preparation.
8. Study of different organic and green manures.

IV. Suggested student activities:

1. Making a study report on soil chemistry in a conventional and organic crop field.
2. A case study on organic farming of an agricultural crop from beginning to ending.
3. A case study on organic farming of a horticulture crop from beginning to ending.
4. A study on economics of a crop in conventional and organic farming methods.
5. A case study on getting certification for an organic farm product.

V. Textbooks:

- Vandana Shiva, Poonam Pande and Jitendra Singh, (2004). Principles of Organic Farming - Renewing the Earth’s Harvest, Navdanya, New Delhi.
- Sujit Chakrabarty, Sumati Narayan, Farooq Ahmad Khan, (2019). Arts and Science of Organic Farming, Purna Organics
- Thapa, U., and P. Tripathi, (2016). Organic Farming in India, Agrotech Publictions, Udaipur
- Peter, V. Fossel, (2007). Organic Farming (Everything You Need to Know), Voyageur Press, USA

VI. Reference books:

- Richard Wiswall (2009), The Organic Farmer's Business Handbook Chelsea Green Publishing, White River Junction, VT, USA.
- William Lockeretz (2007), Organic Farming: An International History CABI Publishing, Wallingford, UK.

- Ann Larkin Hansen (2010), The Organic Farmer's Manual: A Comprehensive Guide to Starting and Running a Certified Organic Farm Storey Publishing, North Adams, MA, USA.
- Masanobu Fukuoka (1978), The One-Straw Revolution: An Introduction to Natural Farming Rodale Press, Emmaus, PA, USA.
- Gary Zimmer (2000), The Biological Farmer: A Complete Guide to the Sustainable & Profitable Biological System of Farming Acres U.S.A., Austin, TX, USA
- Albert Howard (1947), The Soil and Health: A Study of Organic Agriculture University Press of Kentucky, Lexington, KY, USA.
- Terri Paajanen (2014), The Complete Guide to Organic Livestock Farming Atlantic Publishing Group, Inc., Ocala, FL, USA.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VIII
Domain Subject: BOTANY

Semester – VIII

Higher Order Course 13(A): Plant Biotechnology

I. Learning outcomes: Students after the successful completion of the course will be able to:
1. Explain the scientific techniques and tools used in plant tissue culture laboratories.
2. Detailed knowledge about applications of plant tissue culture in agriculture and horticulture sectors.
3. Acquire skills related to various aspects of plant tissue culture.
4. Evaluate the role of transgenic plants in solving certain plant related beneficiary issues.
5.Justify the role of plant biotechnology in bioenergy and phytoremediation.
6. Judge the biosafety and bioethics issues related to plant biotechnology.

II. Syllabus of theory:

UNIT-1: Basic techniques in plant tissue culture (14h)

1. Sterilization techniques; formulation of media for plant tissue culture; role of plant growth regulators in plant differentiation and morphogenesis.
2. Concept of totipotency, initiation and maintenance of callus cultures; induction of morphogenesis in vitro.
3. Somatic embryogenesis and organogenesis; factors affecting somatic embryogenesis and organogenesis.
4. Molecular overview of somatic embryogenesis; synthetic seeds and their applications.
5. Applications of plant biotechnology in agriculture and horticulture.

UNIT-2: Organ and haploid culture techniques (10h)

1. Importance and applications of meristem culture, zygotic embryo culture, endosperm culture.
2. Micropropagation and its uses, commercial exploitation of micropropagation.
3. Production of haploids using anther, pollen and unfertilized ovule cultures, their characterization and applications.

UNIT-3: Cell and protoplast cultures (14h)

1.Cell suspensions – continuous and batch cultures; mass cultivation of plant cells using bioreactors.
2. Production of secondary metabolites from cell cultures, strategies used for enhanced production of secondary metabolites. Biotransformation using plant cell cultures.
3. Isolation, purification, and culture of protoplasts; methods used for protoplast fusion.
4. Somatic hybridization/cybridization –selection systems for somatic hybrids/cybrids, their characterization and applications.

UNIT-4: Transgenic plants (12h)

1. Transgenic plants – definition, biosafety and ethical issues associated with transgenic plants.
2. Herbicide resistance (glyphosate), insect resistance (alpha amylase inhibitor).

3. Virus resistance (coat protein mediated, nucleocapsid gene), disease resistance (antifungal proteins, PR proteins).
4. Quality improvement (Golden rice), Shelf-life enhancement (Flavr savr tomato).

UNIT-5: Advances in plant biotechnology (10h)

1. Plant synthetic biology and its applications; plant-based vaccines and therapeutics.
2. Biofortification and genetically modified foods.
3. Biodegradable plastics, polyhydroxybutyrate.
4. Applications of plant biotechnology in bioenergy production and environmental remediation.

III. Practical syllabus:

1. Equipment used in plant tissue culture.
2. Sterilization techniques in plant tissue culture laboratory.
3. Preparation of culture media
4. Callus induction and subculturing.
5. Organogenesis using PGRs'
6. Demonstration of cell and protoplast culture.
7. Demonstration of organ cultures.
8. Demonstration of anther and pollen cultures.

IV. Suggested student activities:

1. Visits to tissue culture laboratories in universities/research institutes/private sector.
2. Learning various practices in plant biotechnology using virtual labs in websites.
3. Preparation of reports on different transgenic plants available at present.
4. Case studies of modern applications of plant biotechnology.

V. Text Books:

- Ignacimuthu , S., (2003) Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
- Kalyan Kumar De., (1997) Plant Tissue Culture – New Central Book Agency (P) Ltd., Calcutta.
- Mascarenhas A.F., (1991) Hand book of Plant Tissue Culture. Indian Council of Agricultural Research. New Delhi.
- Narayanaswamy, S (1994) Plant Cell and Tissue Culture, Tata –Mc Graw Hill Publishing Co., Ltd., New Delhi.

VI. Reference Books:

- C. Neal Stewart Jr. (2018) Plant Biotechnology and Genetics: Principles, Techniques, and Applications John Wiley & Sons, Inc. in Hoboken, New Jersey, USA.
- Adrian Slater, Nigel W. Scott, and Mark R. Fowler (2008) Plant Biotechnology: The Genetic Manipulation of Plants Oxford University Press in Oxford, UK.
- S. Mohan Jain and Pramod K. Gupta (2010) Plant Biotechnology: Methods and Applications CRC Press, Taylor & Francis Group in Boca Raton, Florida, USA.
- Ram Lakhan Singh (2017) Plant Biotechnology: Recent Advances and Future Prospects Springer International Publishing AG in Cham, Switzerland.
- Altman and P.M. Hasegawa (2013) Plant Biotechnology and Agriculture: Prospects for the 21st Century Elsevier Inc. in Amsterdam, Netherlands.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VIII
Domain Subject: BOTANY

Semester – VIII

Higher Order Course 14(A): Plant Genetic Engineering

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Explain the tools and techniques used in plant genetic engineering.
2. Acquire skills on isolation DNA and making chimeric DNA.
3. Elaborate about cloning vectors and gene cloning methods.
4. Explain about construction of DNA libraries.
5. Justify the role of genetic engineering to make products for human welfare.
6. Judge the biosafety and bioethics related to plant genetic engineering.

II. Syllabus of theory:

UNIT I: Tools in genetic engineering (12h)

1. Genetic engineering - Introduction and outlines of genetic engineering.
2. DNA splicing and joining - enzymatic cleavage of DNA; restriction and modification enzymes-classification, nomenclature, and importance of restriction endonucleases.
3. Restriction mapping, DNA ligases, polynucleotide kinase, alkaline phosphatases, S1 nuclease, terminal transferase, Bal 31 nuclease.

UNIT II: Gene cloning (10h)

1. Cloning vectors-characteristics of a vector.
2. Natural plasmids used as vectors- advantages and disadvantages.
3. Artificial plasmids and their importance as cloning vectors.
4. Vectors used for cloning in *E.coli*. (Plasmids, bacteriophage derivatives, Cosmides, BACs), yeast (YACs, shuttle vectors), higher plants (Ti plasmid derivatives, caulimovirus)

UNIT III: DNA libraries (12h)

1. Genomic DNA library and cDNA library synthesis.
2. Joining of DNA fragments to vector molecules, cohesive termini ligation and blunt end ligation – linkers, adaptors and homopolymer tails.
3. Screening of recombinants for a positive clone- genetic, biochemical and hybridization methods. Microarrays.

UNIT IV: Techniques in rDNA technology (14h)

1. Introduction of Recombinant DNA molecules into appropriate hosts; competent cells preparation, electroporation, microinjection, and particle bombardment method, and selection of transformants.
2. *Agrobacterium* mediated transformation of plant cells.
3. Identification of transformed cells and micropropagation of transformed cell into callus, and regeneration of transgenic plants.
4. Expression of cloned genes-construction of expression vectors.

UNIT V: Applications of genetic engineering (12h)

1. DNA Finger Printing - RAPD, RFLP and AFLP analysis.
2. Application of RFLP in pedigree analysis, biodiversity, genetic counseling, and germ plasm maintenance.
3. Plantibodies and plant vaccines; applications of plant genetic engineering in agriculture, medicine, and industry.
4. Environmental and safety concerns of plant genetic engineering; ethical considerations in plant genetic engineering.

III. Practical syllabus:

1.Isolation of DNA from plant cells.
2.Thermal melting of DNA and preparation of single stranded DNA template
3.Isolation of plasmid DNA.
4. In vitro DNA ligation, transformation of *E.coli*.
5. Agarose gel electrophoresis and restriction mapping of DNA.
6. Demonstration of DNA sequencing.
7. Demonstration of PCR.
8. Demonstration of reporter gene assay (Gus/CAT/b-GAL).
9. Demonstration of RFLP and RAPD techniques.

IV. Suggested student activities:

1. Studying tools and techniques in plant genetic engineering using virtual labs on websites.
2. Collection of literature on current applications of plant genetic engineering.
3. Case studies on genetic modification of plant traits using genetic engineering methods
4. Collecting literature on molecular markers for plant genetic engineering.
5. Report on ethical considerations and regulations governing plant genetic engineering.
6. Case studies of controversies surrounding plant genetic engineering - public perceptions and attitudes.

V. Textbooks:

- B.K. Sarma and P.S. Rao (2005) Plant Genetic Engineering: Principles and Applications. IK International Publishing House. New Delhi, India.
- Adrian Slater, Nigel W. Scott, and Mark R. Fowler (2013) Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press Oxford, UK.
- Altman (2005) Methods in Molecular Biology: Plant Genetic Engineering Humana Press, Totowa, NJ. L.
- Peña and F. A. Rodríguez (2013) Transgenic Plants: Methods and Protocols, Humana Press, New York
- S.B. Primrose (1994). Molecular Biotechnology, Blackwell Scientific Pub. Oxford.

VI. Reference Books:

- John Hammond and Brian G. Atkinson (2019) Plant Genetic Engineering, Springer,Cham, Switzerland
- Trevor A. Thorpe (2005) Plant Genetic Engineering, Blackwell Publishing, Oxford, UK
- C. Neal Stewart Jr. (2016) Plant Biotechnology and Genetics: Principles, Techniques, and Applications Wiley-Blackwell, Hoboken, NJ.
- T. Gerats and J. H. A. Schell (2000) Genetic Engineering of Plants: An Agricultural Perspective Springer, Dordrecht.

- S.K. Sopory and R.B. Fenton (2015) Plant Genetic Engineering Springer, Dordrecht.
- J. Sambrook, E. Frisch and T. Maniatis (2000) Molecular Cloning: Laboratory manual, Cold Spring Harbor Laboratory Press New York.
- M.K.Sateesh,Bioethics and Biosafety 2008 I K International Publishing House.
- Goel and Parashar, IPR, Biosafety and Bioethics 1e Paperback-2013,Pearson

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VIII
Domain Subject: BOTANY

Semester – VIII

Higher Order Course 15(A): Bioinformatics and Computational Biology

I. Learning outcomes: Students at the successful completion of the course will be able to:

1.Learn about the most used bioinformatics databases, tools, and software packages.
2. Make use of web-based bioinformatic resources to study genomics, proteomics etc.,
3. Analyze and interpret biological data using computational tools and algorithms.
4. Design and execute bioinformatics experiments to answer research questions and hypotheses in biology.
5. Design and carry out computational experiments to test biological hypotheses.
6. Explain about drug discovery and development using computer aided programs.

II. Syllabus of theory:

UNIT-1: Basics of bioinformatics (14h)

1. Bioinformatics: Definition, objectives, and branches; application of Bioinformatics; Role of internet and www in bioinformatics.
2. Basic biomolecular concepts: Protein and amino acid, DNA & RNA, sequence, structure and function; forms of biological information.
3. Types of nucleotide sequence: Genomic DNA, Complementary DNA (cDNA), Recombinant DNA (rDNA), Expressed Sequence Tags (ESTs), Genomic Survey Sequences (GSSs).

UNIT-2: Bioinformatics resources and sequence data bases (12h)

1. Databases and bioinformatics tools - NCBI, EBI, ExPASy, RCSB, DDBJ.
2. Organization of databases: data contents, purpose, and utility.
3. Nucleic acid sequence databases: GenBank, EMBL, DDBJ
4. Protein sequence databases: Uniprot-KB: Swiss-Prot, TrEMBL, UniParc
5. Data bases: *Arabidopsis thaliana* (TAIR), Rice.

UNIT-3: Sequence analysis and alignment (12h)

1. Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues.
2. Scoring matrices: basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, matrix derivation methods and principles.
3. Measurement of sequence similarity; Similarity and homology; Basic concepts of sequence alignment; use of pairwise alignments for analysis of Nucleic acid and protein sequences and interpretation of results.

UNIT-4: Algorithms in computing (12h)

1. Biological and computer algorithm; Fibonacci problem, dynamic programming, time and space complexity of algorithms, Laplace's rule.
2. Search algorithms: Random walk, Hill climbing, simulated annealing.
3. Combinatorial pattern matching: Hash Tables, repeat Finding, exact pattern matching.

4. Genetic algorithm: Basic concepts, reproduction, cross over, mutation, fitness value, optimization using GAs; Applications of GA in bioinformatics.

UNIT-5: Drug Discovery and development (10h)

1. Drug nomenclature, Routes of drug administration and dosage forms; bioavailability of drugs - Lipinski's rule.
2. Drug targets, drug-target interaction, and dose-response relationships.
3. Overview of molecular docking and drug docking. Computer aided drug design (CADD).

III. Practical syllabus:

1. Sequence Databases: EMBOSS, NCBI Toolkit, Expasy tools.
2. Search tools against Databases: BLAST and FASTA.
3. Pair wise alignment: Dot Plot; global and local alignment method.
4. GOR method for primary and secondary structure prediction.
5. Protein motif and domain analysis: MEME/MAST; ProSite
6. Tools in sequence assembly and annotation.

IV. Suggested student activities:

1. Learning about different bioinformatics tools and their applications.
2. Case studies on using bioinformatics tools to analyze real-world data.
3. Working on real-world datasets and develop new algorithms or tools to analyze them.
4. Collection of literature related to genomics and proteomics.
5. Case studies on development of new drugs using computational biology.
6. Identifying genetic variations, analyzing protein structures, studying the expression of genes using bioinformatics.

V. Text Books:

- David W. Mount (2001) Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, New York.
- Arthur M. Lesk (2013) Introduction to Bioinformatics Oxford University Press, Oxford.
- Andreas D. Baxevanis and B. F. Francis Ouellette (2004) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins Wiley-Interscience, New York.
- Neil C. Jones and Pavel A. Pevzner (2004) An Introduction to Bioinformatics Algorithms MIT Press, Cambridge.
- Aluru, S. (Ed.). (2006). Handbook of computational molecular biology. CRC Press: Boca Raton, FL, USA.
- Salzberg, S.L. (2019). Bioinformatics: Introduction and methods. CRC Press: Boca Raton, FL, USA.

VI. Reference Books:

- Pavel Pevzner and Ron Shamir (2011) Bioinformatics for Biologists Cambridge University Press, Cambridge.
- Teresa Attwood and David Parry-Smith (2001) Principles of Bioinformatics Wiley-Blackwell, Oxford.
- Paul M. Selzer, Richard J. Marhöfer, and Oliver Koch (2018) Applied Bioinformatics: An Introduction Springer, Berlin.
- Thomas Lengauer (2017) Bioinformatics: From Genomes to Therapies Springer, Berlin.
- Steven H. D. Haddock and Casey W. Dunn (2010) Practical Computing for Biologists Sinauer Associates, Sunderland.

- Vince Buffalo (2015) Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools O'Reilly Media, Sebastopol.
- Setubal, J.C., & Meidanis, J. (Eds.). (2007). Introduction to computational molecular biology. PWS Publishing Company: Boston, MA, USA.
- Lesk, A.M., & Chothia, C. (Eds.). (2012). Computational biology: A practical introduction to bioinformatics and computational genomics. Wiley-Blackwell: Hoboken, NJ, USA.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VIII
Domain Subject: BOTANY

Semester – VIII
Skill Oriented Course 16(A): Biofertilizers and Biopesticides

I. Learning outcomes: Students on successful completion of the course will be able to:

1. Understand the advantages and disadvantages of biofertilizers and biopesticides.
2. Identify different microbes used as biofertilizers and biopesticides.
3. Acquire skills on isolation and culture of microbial agents used as biofertilizers and biopesticides.
4. Understand the process of production and application of biofertilizers and biopesticides.
5. Evaluate the economic and environmental impacts of using biofertilizers and biopesticides.
6. Gain knowledge about the regulations on the production and use of biofertilizers and biopesticides.

II. Syllabus of theory:

Unit 1: Introduction to biofertilizers (12h)

1.Biofertilizers: Definition, scope, status, and importance; Advantages and limitations of biofertilizers compared to chemical fertilizers.

2.Types of biofertilizers (e.g. nitrogen-fixing, phosphate-solubilizing, plant growth-promoting).

3. Structure and characteristic features of bacterial (*Azospirillum, Azotobacter, Rhizobium*), actinomycetes (*Frankia*), cyanobacterial (*Anabaena, Nostoc, Hapalosiphon*) and fungal (AM and ectomycorrhiza) biofertilizers.

UNIT-2: Production and application of biofertilizers (14h)

1. Production of biofertilizers: Strain selection, sterilization, growth, equipment, fermentation (solid state and liquid), mass production of carrier based and liquid bio fertilizers.
2. Factors affecting the production of biofertilizers (i.e., temperature, pH, aeration, carbon source); quality control of biofertilizers
3. Application methods and dosage of biofertilizers.
4. Effect of biofertilizers on soil fertility, plant growth, and yield.

UNIT-3: Commercialization and future prospects of biofertilizers (10h)

1.Biofertilizers -storage, shelf life, quality control and marketing; regulatory framework and certification for biofertilizers.

2.Application technology for seeds, seedlings, tubers, sets etc.; factors influencing the efficacy of bio fertilizers.

3.Economic feasibility and cost-benefit analysis of using biofertilizers.

4.Future prospects and potential of biofertilizers in sustainable agriculture and environmental protection.

UNIT-4: Biopesticides and applications (14h)

1. Biopesticides: Definition and classification; advantages and limitations of biopesticides compared to chemical pesticides. Modes of action and mechanisms of biopesticides.

2. Characteristics and applications of microbial pesticides – bacteria, fungi and viruses.
3. Characteristics and applications of botanical pesticides (plant extracts and essential oils) and biochemical (pheromones and repellents).
4. Biocontrol agents (*Trichoderma* spp., *Pseudomonas* spp. and *Bacillus* spp) and their efficacy on seed borne and soil borne plant pathogens.

UNIT-5: Production and marketing of biopesticides (10h)

1. Production and formulation of biopesticides and biocontrol agents.
2. Commercialization and market trends of biopesticides; regulatory framework for biopesticides.
3. Integrated pest management (IPM) and biopesticides; future prospects and challenges for biopesticides.

III. Practical syllabus:

1. Nutritional media and their preparations.
2. Enumeration of microbial population in soil- bacteria, BGA, fungi, actinomycetes.
3. Methods of isolation and purification of microbial cultures.
4. Isolation of Rhizobium from legume root nodule.
5. Isolation of BGA from rhizosphere.
6. Isolation of Mycorrhiza.
7. Culture of *Trichoderma* spp., *Pseudomonas* spp. and *Bacillus* spp.
8. Quality control tests for biofertilizers, Biopesticides and bioagents.

IV. Suggested student activities:

1. Collection of data on utilization of biofertilizers and biopesticides by farmers and conducting awareness campaign at farmers' fields.
2. Collection of literature on various biofertilizers, biopesticides and biocontrol agents.
3. Visits to production units of biofertilizers, biopesticides and biocontrol agents.
4. Case studies on efficacy of biofertilizers, biopesticides and biocontrol agents.
5. Report on mass production technologies of biofertilizers, biopesticides and biocontrol Agents.
6. Case study on ill effects of chemical fertilizers and pesticides.

V. Textbooks:

- Subba Rao, N.S. (1993) Biofertilizers in Agriculture and Forestry, Oxford and IBH. Publ. Co., New Delhi.
- Das, A. C., & Mukherjee, A. K. (2019). Biofertilizers for sustainable agriculture: a review of principles, processes, and practices. Springer.
- Sadasivam, S., & Manickam, A. (2018). Biofertilizers technology. Springer.
- S. S. Gnanamanickam, (2011) Biopesticides: Pest Management and Regulation, CAB International, Wallingford, UK.
- B.S. Bisht, J.S. Panwar, and V.P. Bhatt, (2016) Handbook of Microbial Biofertilizers, CRC Press, Boca Raton, FL.

VI. Reference Books:

- Gupta, S., & Prasad, R. (2018). Microbial inoculants in sustainable agricultural productivity. Springer.
- Akhtar, M. S., & Siddiqui, Z. A. (2018). Role of rhizobacteria in soil: interactions and mechanisms. Springer.

- N. Amaresan, N. Kumar, and A.K. Gupta, (2011) Handbook of Biofertilizers and Microbial Pesticides, Springer Science & Business Media, New York, NY.
- Opender Koul and G.S. Dhaliwal, (2009) Biopesticides: State of the Art and Future Opportunities, Springer Science & Business Media, New York, NY.
- Franklin R. Hall and Julius J. Menn, (1999) Biopesticides: Use and Delivery, Humana Press, Totowa, NJ.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VIII
Domain Subject: BOTANY

Semester – VIII

Skill Oriented Course 16(A): Soil fertility and Conservation

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Acquire both theoretical and practical knowledge on various aspects of soil fertility and conservation.
2. Explain the causes for erosion of soil and loss of fertility.
3. Determine the characteristics of different soils and acquire managerial skills.
4. Evaluate the soil fertility and recommend required quantities of fertilizers.
5. Acquire skills on various practices related to soil conservation.
6. Design and predict appropriate measures to control soil fertility and suggest conservation methods to a given area.

II. Syllabus of theory:

UNIT-1: Introduction to soil fertility and productivity (10h)

1. Definition of soil fertility and productivity; history of soil fertility.
2. Factors affecting soil fertility and productivity.
3. Luxury consumption of nutrients and nutrient interactions in plants and soils
4. Transformations and availability of Nitrogen, Phosphorus Potassium, Ca, Mg, S and micronutrients in soil.

UNIT-2: Characteristics of soils (12h)

1. Acid soil and calcareous soil-Definition, their formation and characteristics. Management of acid & calcareous soils.
2. Salt affected soils- Definition, their formation and classification- saline, alkaline, saline-alkali soils, their characteristics, and management.
3. Soil testing– importance and objectives and critical levels of different nutrients in soil.
4. Role of microorganisms in organic matter decomposition – humus formation. Importance of C:N ratio and pH in plant nutrition.

UNIT-3: Methods of soil fertility evaluation (14h)

1. Visual deficiency symptoms; Plant analysis- total analysis, rapid tissue test, enzyme test, DRIS method and critical levels of nutrients in plants.
2. Biological methods- field experimentation tests, use of indicator plants, microbiological tests and laboratory and green house tests.
3. N P K fertilizers- definition of fertilizer, their classification, types of fertilizers and composition of nutrients in fertilizers.
4. Methods of fertilizer application- solid and liquid forms of fertilizer application and their advantages and disadvantages.

UNIT-4: Soil erosion and sedimentation (12h)

1. Causes of soil erosion – water, wind and human activities; problems associated with soil

erosion.
2. Soil erosion by water, erosion process, mechanics of soil erosion by water; forms of soil erosion by water.
3. Wind erosion, soil loss estimation, wind erosion prediction equation.
4. Soil loss tolerance, movement of sediment from watershed.

UNIT-5: Soil conservation practices (12h)

1. Importance of soil and soil conservation, concept of soil conservation.
2. Soil conservation practices on cultivated land: Vegetative method, cropping system, Tillage.
3. Mechanical Methods: Gully erosion control practices, stream bank erosion control practices; Soil loss estimation.
4. Soil conservation practices on developing areas; wind erosion control practices; Soil conservation activities of DSC.

III. Practical syllabus:

1. Analysis of soil for organic matter.
2. Determination of available N, P, K in soil samples.
3. Determination of available micronutrients in soil samples.
4. Estimation of gypsum requirement of saline and alkali soils.
5. Estimation of Lime requirement of acid soils.
6. Analysis of plant samples for essential elements.
7. Measurement of soil-water content and infiltration rate of soil.

IV. Suggested student activities:

1. Collection of literature on factors associated with soil fertility.
2. Studying the different types of soil in India and Andhra Pradesh.
3. Case studies on loss of soil fertility in India and abroad.
4. Collection of literature on soil conservation practices in India and Andhra Pradesh.
5. Case studies on soil conservation movements (Save soil)
6. Collection of literature related to healthy soil-healthy plants.
7. Reports on organic farming practices for conservation of soil health.

V. Textbooks:

- Brady, N.C. and Weil, R.R. (2016) The Nature and Properties of Soils, 15th Edition. Pearson, New Jersey, USA.
- Hopkins, B. (2018) Soil Fertility, Second Edition. Wiley-Blackwell, Oxford, UK.
- Stevenson, F.J. and Cole, M.A. (1999) Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulfur, Micronutrients. Wiley-Blackwell, Oxford, UK.

VI. Reference Books:

- Lal, R. (2015) Principles of Soil Conservation and Management, 5th Edition. Springer, New York, USA.
- Tisdale, S.L., Nelson, W.L. and Beaton, J.D. (2015) Soil Fertility and Fertilizers, 8th Edition. Prentice Hall, New Jersey, USA.
- Reicosky, D.C. and Flora, C.B. (2018) Conservation Tillage and Soil Carbon Sequestration: A Reader. Soil and Water Conservation Society, Iowa, USA.
- Wild, A. (2004) Soils, Land and Food: Managing the Land During the Twenty-First Century. Cambridge University Press, Cambridge, UK.

- Lal, R. (2020) Soil Health and Intensification of Agroecosystems. CRC Press, Boca Raton, Florida, USA.
- Hargrove, W.L. (2019) Soil Fertility Management for Sustainable Agriculture, 2nd Edition. CRC Press, Boca Raton, Florida, USA.
- Roshan Babu Ojha(2016) An Introduction to Soils, Soil Fertility and Soil conservation, Heritage Publisher, Kathmandu.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VIII
Domain Subject: BOTANY

Semester – VIII

Higher Order Course 13(B): Crop Physiology

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Illustrate the importance of water to plant life and explain water absorption mechanism.
2. Relate the physiological disorders in plants to mineral deficiencies.
3. Interpret the crucial metabolic processes that occur in plants and relate them to growth.
4. Compile the physiological effects of different plant growth regulators.
5. Determine the physiological changes in plants subjected to various environmental stresses.
6. Compare and contrast the physiology of plants under natural and stress conditions.

II. Syllabus of theory:

UNIT-1: Plant water relations (12h)

1. Introduction – review on plant anatomy - Importance of crop physiology in agriculture,
2. Role and significance of water - diffusion, imbibition, osmosis, and its significance, plasmolysis,
3. Field capacity, water holding capacity of soil and permanent wilting point,
4. Absorption of water - mode of water absorption – active and passive absorption and factors affecting absorption.
5. Translocation of solutes - phloem and xylem transport.
6. Transpiration - types - Steward's theory of mechanism - significance, factors affecting transpiration and guttation; anti-transpirants.

UNIT-II: Nutrio-physiology (10h)

1. Mineral nutrition - introduction - criteria of essentiality of elements - macro, secondary and micronutrients
2. Sand and soil less culture- hydroponics; mechanism of uptake – physiological role of nutrients,
3. Foliar diagnosis - nutritional and physiological disorders - foliar nutrition and fertigation.

UNIT-III: Photosynthesis and respiration (14h)

1. Photosynthesis - requirements of photosynthesis - light, CO_2, pigments and water. mechanism of photosynthesis - light reaction - cyclic and non-cyclic photo-phosphorylation - Red drop - Emerson enhancement effect.
2. Photosynthetic pathways - C3, C4 and CAM, Differences between C3, C4 and CAM pathways; factors affecting photosynthesis.
3. Photorespiration- photorespiration process and significance of photorespiration.
4. Respiration - Glycolysis, TCA and Pentose Phosphate Pathway, Oxidative phosphorylation; differences between oxidative phosphorylation and photophosphorylation.
5. Respiratory quotient and energy budgeting in respiration.

UNIT-IV: Growth physiology (14h)

1. Growth - growth curve, phases of growth and factors influencing growth.
2. Growth analysis - LAI, LAD, SLW, SLA, LAR, NAR, RGR and CGR in relation to crop productivity; source sink relationship.
3. Photoperiodism-role of phytochrome in flowering and regulation of flowering. transmission of stimulus - theories of flowering - vernalization, protein and fat synthesis
4. Plant growth regulators - growth hormones - definition and classification - physiological role of auxins and GA.
5. Physiological role of cytokinin, ethylene and ABA.
6. Synthetic growth regulators and their uses in crop productivity; practical application of plant growth regulators in crop productivity

UNIT-V: Stress physiology (10h)

1. Environmental stresses - water stress - physiological changes - adaptation to drought and amelioration
2. Temperature stress - physiological changes - low and high temperature - chilling injury – tolerance – alleviation.
3. Low light and UV radiation stresses - physiological changes and alleviation
4. Salt stress - physiological changes and alleviation.

III. Practical syllabus:

1. Extraction and Estimation of Chlorophyll pigments.
2. Determination of plasmolysis of cell
3. Demonstration of symptoms of mineral deficiency.
4. Effect of temperature stress on membrane stability.
5. Effect of water stress on Relative water content of leaves
6. Effect of Salt and Water stress on the Proline accumulation.
7. Seed viability test using Tetrazolium chloride and Seedling vigor.
8. Bioassay of Gibberellins on seed germination and seedling growth.
9. De-repression of Dwarf Characters of plants by Gibberellins.
10. Separation of Isozymes of Peroxidase by native PAGE.
11. Extraction and separation of soluble plant proteins by SDS PAGE.

IV. Suggested student activities:

1. Design and conduct experiments to understand the effects of PGRs on plant growth and development.
2. Collection of literature on various kinds of environmental stresses on plants.
3. Making a report on mineral deficiency symptoms by visiting the crop fields.
4. Understanding the stress physiology of plants using computer simulation models.
5. Case studies on crop productivity under various environmental stresses.
6. Studying the hydroponics, aquaponics and aeroponics as modern methods in cropping.

V. Textbooks:

- Jain, J.K. 2007. Fundamentals of plant physiology, S.Chand & Company Ltd., New Delhi.

- Pandey, S. N. and B. K.Sinha, 2006. Plant Physiology. Vikas Publishing House Private Limited, New Delhi.
- Purohit, S.S, 2005. Plant physiology, Student edition, Jodhpur.
- Ray Noggle, G. and Fritz, G. J., 1991. Introductory Plant Physiology. Prentice Hall of India Pvt. Ltd., New Delhi.
- Taiz. L. and Zeiger. E., 2006. Plant Physiology. Publishers: Sinauer Associates, Inc., Massachusetts, USA

VI. Reference Books:

- Salisbury, F. B. and Ross, C. W. (1992). Plant Physiology. Wadsworth Publishing Co., Belmont, CA, USA.
- Singh, V. and Singh, R. P. (2012). Crop Physiology. Kalyani Publishers, New Delhi, India.
- Sadras, V. O. and Calderini, D. F. (2015). Crop Physiology: Applications for Genetic Improvement and Agronomy. Academic Press, San Diego, CA, USA.
- Duncan, W. G. (1971). Crop Physiology. Iowa State University Press, Ames, IA, USA.
- Higinbotham, N. (1975). The physiology of plants under stress. Wiley, New York, NY.
- Hopkins, W. G., & Huner, N. P. A. (2008). Introduction to plant physiology. John Wiley & Sons, New York, NY.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VIII
Domain Subject: BOTANY

Semester – VIII
Higher Order Course 14(B): Genetics of Crop Improvement

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Acquire knowledge on principles of plant genetics guiding breeding of crop plants.
2. Perform skills related to breeding of self and cross-pollinated crops.
3. Propose a specific breeding technique for a given plant species.
4. Interpret heritability and heterosis in hybrid plants.
5. Design and conduct field trials, and analyze data to evaluate the performance of different varieties.
6. Explore the molecular breeding methods to address specific problem in plant breeding.

II. Syllabus of theory:

UNIT-1: Genetic basis of crop improvement (12h)

1. Plant breeding: history, scope, and importance; objectives: yield, quality, resistance, and adaptation.
2. Concepts in plant breeding: genetic variation, heritability, and selection.
3. Patterns of evolution in crop plants - centers of origin - biodiversity and its significance.
4. Plant introduction and role of plant genetic resources in plant breeding.
5. General and specific combining ability; types of gene actions and implications in plant breeding.

UNIT-2: Breeding methods for various crops (14h)

1. Pure line theory and its genetic basis; role of genotype and environment in continuous variation.
2. Pure line and mass selection methods for improvement of self-pollinated crops.
3. Genetic basis of self-incompatibility and male sterility and their use in hybrid seed production.
4. Recurrent selection and hybridization methods used for cross-pollinated crops; synthetics and composites.
5. Clonal selection and apomictic methods for improvement of vegetatively propagated crops.

UNIT-3: Mutation and polyploidy breeding (10h)

1. Traits controlled by multiple genes; breeding for quantitative traits - response to selection and genetic gain.
2. Mutation breeding, distant hybridization, polyploidy breeding.
3. Quality seed - classes, production practices and maintenance of pure seed, purity standards.

UNIT-4: Breeding for resistance and quality (12h)

1. Breeding for disease resistance: host resistance, vertical resistance, and horizontal resistance.
2. Breeding for insect resistance: antibiosis, antixenosis, and tolerance.
3. Breeding for abiotic stress resistance: drought, salinity, and temperature.
4. Breeding for quality traits: nutritional quality, functional quality, and processing quality.

UNIT-5: Molecular plant breeding (12h)

1.DNA markers and their applications in plant breeding: RFLP, SSR, and SNP
2.Marker Assisted Selection (MAS) and its applications.
3.Genomics and biotechnology tools for plant breeding: genetic engineering, gene editing, and genomic selection.

III. Practical syllabus:

1. Floral biology of a self and a cross pollinated species.
2. Practicing self-pollination technique.
3. Practicing various techniques in hybridization – emasculation, cross-pollination and bagging.
4. Pollen viability test using Brewbaker's medium and acetocarmine staining.
5. Studying pollen germination on stigma.
6. Collection and preservation of germplasm of some crop plants.
7. Solving problems on multiple factor inheritance.

IV. Suggested student activities:

1.Collection of literature on various plant breeding techniques.
2. Case studies on introduction, selection and hybridization methods used for crop improvement in India.
3. Visit to Agriculture and Horticulture research stations to learn plant breeding techniques.
4. Making a report on genetic markers for desirable traits in plants.
5. Collecting literature on breeding methods used in improvement of quality and resistance in crop plants.

V. Textbooks:

- Chopra,V. L. (2000) Plant Breeding. Theory and Practicals (2nd edition),Oxford & IBH Publ. Co. Pvt.. Ltd., New Delhi.
- Poehlman, J.M. & Borthakur, D. (1959) Breeding Asian Field Crops with Special Reference to Crops of India. Oxford & IBH Publishing Co. New Delhi, Bombay, Calcutta.
- Sharma, J R. (1994) Principles and Practice of Plant Breeding, Tata-McGraw Hill Publ. Co. Ltd, New Delhi.
- Simmond, N.W.(1976) Evolution of Crop Plants. N.W Simmond (Ed.) Edinburgh School of Agriculture & Longman Group Ltd.
- Gupta, P.K. (2008) Plant Breeding, Rastogi Publications, Meerut
- Singh, B.D. & N.S.Shekhawat (2017) Molecular Plant Breeding, Scientific Publishers, Jodhpur

VI. Reference Books:

- Allard, R.W.1960. Principles of Plant Breeding. John Wiley & Sons. Inc. New York.
- Backcock., E.B. 2001 Genetics and Plant breeding. Agrobios (India), Jodhpur
- Briggs,F.N & Knowles, P.F 1967. Introduction to Plant Breeding. Reinhold Publ. Co., New York/ Amsterdam/ London.
- Acquaah, G. (2012). Principles of Plant Genetics and Breeding. Wiley-Blackwell: Hoboken, NJ, USA.
- Brown, A. H. D., Clegg, M. T., Kahler, A. L., & Weir, B. S. (1990). Plant Population Genetics, Breeding, and Genetic Resources. Sinauer Associates: Sunderland, MA, USA.
- Frey, K. J. (2012). Breeding Field Crops. Iowa State University Press: Ames, IA, USA.

- Simmonds, N. W. (1995). Principles of Crop Improvement. Longman Scientific & Technical: Harlow, UK.
- Stoskopf, N. C. (1993). Plant Breeding: Theory and Practice. Westview Press: Boulder, CO, USA.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VIII
Domain Subject: BOTANY

Semester – VIII

Higher Order Course 15 (B): Phyto-medicines and Ethnobotany

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Understand the importance of phytomedicines in human health.
2. Explain about certain healing herbs and their applications.
3. Appraise the value of some plant products as phytomedicines for common ailments of humans.
4. Analyze the ethnic communities in India and their ethnobotanical knowledge.
5. List out plants used as phytomedicines and ethnomedicines.
6. Interpret the cultural practices of ethnic communities and their role in conservation of plants.

II. Syllabus of theory:

UNIT-1: Basic concepts of phytomedicines (10h)

1. Phytomedicines: Definition, history, and cultural significance of phytomedicines.
2. Classification of phytomedicines; advantages and limitations of using phytomedicines.
3. Traditional and modern uses of phytomedicines; pharmacological principles and mechanisms of action of phytomedicines.
4. Sources of phytomedicine, their safety and toxicity; extraction methods for phytomedicines.

UNIT-2: Phytomedicines - therapeutic applications (14h)

Botanical description, chemical constituents, pharmacological properties, therapeutic applications, dose, administration, and safety considerations of following phytomedicines:

(1) Turmeric (*Curcuma longa*) (2) Garlic (*Allium sativum*) (3) Ginger (*Zingiber officinale*) (4) Ginkgo (*Ginkgo biloba*) (5) Ginseng (*Panax ginseng*) (6) Aloe vera (*Aloe barbadensis*) (7) Peppermint (*Mentha piperita*) (8) Licorice (*Glycyrrhiza glabra*)

UNIT-3: Plant products for health (12h)

1. Medicinal plants and products as per Indian Herbal Pharmacopoeia (IHP).
2. A general account of plants used in Ayurveda, Unani, Siddha, and Homoeopathic systems of medicine for various disorders.
3. Chemical nature, uses in pharmacy, medicinal and health benefits of following plant products:
   (a) Carotenoids: α and β – Carotene, Lycopene and Lutein
   (b) Limonoids: d- Limonene and α – Terpineol (c) Saponins: Glycyrrhizin and Shatavarins
   (d) Flavonoids: Rutin, Hesperidin, Naringin and Quercetin (e) Phenolic acids:- Ellagic acid
4. Psychoactive plants classification; stimulants, plants for mental health, hallucinogens, depressants and anti-depressants.

UNIT-4: Ethnobotany in India (12h)

1. Ethnobotany: Definition, history, significance, scope and objectives; ethnobotany as an

interdisciplinary science; branches of ethnobotany.
2. Centers of ethno-botanical studies in India; major and minor ethnic communities of India, ethnic communities of Andhra Pradesh - anthropology, customs and beliefs.
3. Plants used by ethnic groups as food, intoxicants and beverages, fodder, fiber, resins, oils, fragrances and other uses.
4. Ethno- and folklore medicines in India and Andhra Pradesh; Role of ethnomedicines and their scope in modern times.

UNIT-5: Ethnomedicinal plants (12h)

1. Medico-ethnobotanical sources in India; Significance of the following plants in ethno-botanical practices:
   (a) *Azadirachta indica* (b) *Ocimum sanctum* (c) *Vitex negundo* (d) *Gloriosa superba*
   (e) *Tribulus terrestris* (f) *Pongamia pinnata* (g) *Cassia auriculata* (h) *Indigofera tinctoria*
2. Role of ethnobotany in modern medicine with reference to *Rauvolfia serpentina, Trichopus zeylanicus, Artemisia vulgaris* and *Withania somnifera*.
3. Role of ethnic groups in conservation of plant genetic resources; ethnobotany as a tool to protect the interests of ethnic groups.
4. Biopiracy, Intellectual Property Rights (IPR) and Traditional Knowledge (TK).

III. Practical syllabus:

1. Studying ethnic food crops of their locality.
2. Studying ethnomedicines for humans and animals.
3. Studying ethnobotanical databases and Traditional knowledge Digital Library (TKDL).
4. Studying various plant products used as medicines.
5. Macroscopic and microscopic evaluation of phytomedicines and ethnomedicines.
6. Collection of herbaria of some medicinal plants used by ethnic people of their locality.
7. Report on traditional knowledge of ethnic groups in their locality.

IV. Suggested student activities:

1. Collection of literature on medicinal plants used by humans and associated traditional knowledge.
2. Interacting with ethnic people in their area and learning about their traditional knowledge.
3. Making a report on various plants used by ethnic communities of their area.
4. Report on role of sacred groves and ethnic people in conservation of plants.
5. Listing out important ethnic communities in India and studying their cultural practices and beliefs.
6. Collection of literature on biopiracy of TK and role of IPR in protecting TK.

V. Text Books:

- Jain,S.K. (1995) Manual of Ethnobotany, Scientific Publishers, Jodhpur.
- Jain,S.K. (1981) Glimpses of Indian. Ethnobotany, Oxford and IBH, New Delhi
- Jain,S.K.(1989) Methods and approaches in ethnobotany. Society of ethnobotanists,
- Lucknow, India.
- James A. Duke (2002) Handbook of Medicinal Herbs, CRC Press, Boca Raton, FL.

- Charles W. Fetrow and Juan R. Avila (2000) The Complete Guide to Herbal Medicines, Pocket Books, New York, NY.

VI. Reference Books:

- Iris F. F. Benzie and Sissi Wachtel-Galor (2011) Herbal Medicine: Biomolecular and Clinical Aspects, CRC Press, Boca Raton, FL.
- Ashish Kumar Singh (2014) Phytochemicals: Biosynthesis, Function and Application, Springer Science & Business Media, New York, NY.
- Simon Mills and Kerry Bone (2005) The Essential Guide to Herbal Safety, Elsevier Churchill Livingstone, St. Louis, MO.
- Schultes, R.E. and R.F. Raffauf (1990). The Healing Forest: Medicinal and Toxic Plants of the Northwest Amazonia. Dioscorides Press, Portland, Oregon.
- Balick, M.J., E. Elisabetsky, and S.A. Laird (eds.) (1996). Medicinal Resources of the Tropical Forest: Biodiversity and Its Importance to Human Health. Columbia University Press, New York.
- Duke, J.A. (1992). Handbook of Edible Weeds. CRC Press, Boca Raton, Florida.
- Martin, G.J. (1995). Ethnobotany: A Methods Manual. Chapman and Hall, London.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VIII
Domain Subject: BOTANY

Semester – VIII

Skill Oriented Course 16(B): Natural Resource Management

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Acquire skills on methodologies to study the availability and exploitation of natural resources.
2. Identify and analyse the key components of natural resource management.
3. Explain strategies for sustainable utilization of natural resources
4. Predict the impacts of over-exploitation of natural resources and suggest measures for sustainable utilization.
5. Elaborate the changes in global climate due to anthropogenic activities.
6. Explain the alternative sources for energy management.

II. Syllabus of theory:

UNIT-1: Basic concepts of natural resource management (10h)

1. Natural resources and their types; importance of natural resource management.
2. Historical development of natural resource management; major challenges facing natural resource management.
3. Stakeholders in natural resource management; natural resource policy and governance.
4. Land use planning and its components; use and exploitation of mineral resources, environmental effects of extracting and using mineral resources.

UNIT-2: Natural resources and sustainability (10h)

1. Ecosystem services and their importance; biodiversity and its importance.
2. Water resources and their importance; fossil fuels utilization and environmental impacts.
3. Resource conflicts: resource extraction, access and control system; principles sustainable development.
3. Adaptive management; community-based natural resource management; market-based natural resource management.

UNIT-3: Techniques and tools for natural resource management (12h)

1. Ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies.
2. Remote sensing and GIS; field-based techniques for resource assessment and monitoring.
3. Socio-economic and environmental impact assessment; ecological modeling.
4. Poverty and implications in resource management in developing countries; conflict resolution and negotiation techniques.

UNIT-4: Global ecology - threats to ecosystems (14h)

1. Greenhouse effect and climate change, ozone depletion, ecosystems responses to long-term climate patterns.
2. Ecosystem management and conservation; soil erosion and conservation strategies; water management and conservation strategies.
3. Sustainable forest management, Agenda-21 and UNEP programmes towards sustainable development.
4. Biodiversity conservation strategies, national biodiversity strategy and action plan; wildlife management and conservation.

UNIT-5: Alternative energy resources (14h)

1. Renewable electricity and key elements; wind energy, solar power, photovoltaic technology, hydrogen fuel, tidal power.
2. Wood energy/ fuel wood use, Biochemical conversion, sources of energy generation, industrial waste, agro residues, anaerobic digestion and biogas production, thermo-chemical conversions, gasification and types of gasifiers, briquetting, ethanol, bio-gas.
3. Bio-diesel: raw materials, production methods, trans-esterification and applications; bio-diesel potential in India, ecological impacts of bio-fuel cultivation.

III. Practical syllabus:

1. Determination of Water quality parameters.
2. Analysis of various types of soils for their texture and structure.
3. Determination of air quality parameters.
4. Assessment of resources and monitoring using GIS (Geographical Information System) and remote sensing.
5. Case studies – urban planning, forestry application, environment/disaster Management.
6. Evaluating species richness, species evenness, biomass in grasslands, biomass in forests – qualitative vs. quantitative methods.
7. Canopy measurements of structure and cover, tree and leaf biomass,
8. Determination of density, frequency and abundance of local vegetation by transect and quadrat sampling methods.

IV. Suggested student activities:

1. Studying the global initiatives on natural resource management through UNEP, IUCN, WWF websites.
2. Case studies on conflicts about natural resources between countries and between states in India.
3. Using simulations for real-world scenarios of natural resources and test different management strategies.
4. Collecting literature on impacts of climate change on natural resources.
5. Case studies and examples of successful adaptation and mitigation strategies for natural resource management.

V. Text Books:

- David J. Pimentel (2002) Natural Resource Management: The Ecological and Economic Foundations, Academic Press, San Diego.
- James R. Goss (1999) Introduction to Natural Resource, Planning, John Wiley & Sons, New York.
- Roger Perman, (2011) Natural Resource and Environmental Economics, Pearson Education, Harlow, England.
- John Hendee and Chad Dawson (2008) Principles of Natural Resource Management, Taylor & Francis, New York

VI. Reference Books:

- Daniel D. Chiras (2016) Natural Resource Conservation: Management for a Sustainable Future, Pearson Education, Harlow, England.
- Daniel D. Chiras, (2014) Sustainable Natural Resource Management: For Scientists and Engineers, Wiley, New York.
- V. Kneese and J. L. Sweeney, (1985), Handbook of Natural Resource and Energy Economics North Holland, Amsterdam.
- Barry C. Field and Martha K. Field, (2012) Natural Resource Economics: An Introduction, Waveland Press, Long Grove, Illinois.

A.P. State Council of Higher Education
Semester-wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), Semester – VIII
Domain Subject: BOTANY

Semester – VIII

Skill Oriented Course 17(B): Industrial and Environmental Biotechnology

I. Learning outcomes: Students at the successful completion of the course will be able to:

1. Design and develop bioprocesses for the production of products to address the human needs.
2. Acquire skills on laboratory techniques and equipment used in industrial biotechnology.
3. Explain fermentation, bio catalysis, and downstream processing in industrial biotechnology.
4. Analyze and interpret data from bioprocess experiments, and to design experiments to test hypotheses related to bioprocess optimization.
5. Acquire skills on waste management using plants and microbes.
6. Discuss about the plants and microbes useful for industrial and environmental biotechnology.

II. Syllabus of theory:

UNIT-1: Basics of industrial microbiology (12h)

1. Microbial organisms in nature and their importance; microbes in service of nature and mankind.
2. Sampling, culture and cultivation of microorganisms; batch culture and continuous culture of microbes for commercial use.
3. Bioprocessing and bioreactors; fermentation kinetics and scale-up.
4. Cell disruption and recovery techniques; purification and formulation of fermentation products; product analysis and quality control.

UNIT-2: Industrial biotechnology products-1 (12h)

1. Enzymes of industrial importance, their production and purification.
2. Microbial fermentation for antibiotic production; bioactive molecule production and applications.
3. Production technology of Penicillin and Streptomycin; vaccines production and metal leaching.
4. Wine making, vinegar and citric acid production.

UNIT-3: Industrial biotechnology products-2 (10h)

1. Tax and non-tax alcohol production, brewing industry.
2. High fructose corn syrup, cheese making, and single cell production.
3. Gaseous fuels: biohydrogen, biomethane and microbial fuel cell.
4. Liquid fuels: bioethanol, biodiesel and biobutanol.

UNIT-4: Environmental biotechnology -1 (14h)

1. Microbial Reactors, aerobic and anaerobic wastewater treatment processes; concept of D.O., B.O.D., and C.O.D.
2. Genetically modified microbes - their uses in environmental management recycling and up-gradation technologies; production of useful products, energy for waste.

3. Biogas technology, plant design, construction, operation, biogas form organic wastes, water weeds, landfills, microbiology of anaerobic fermentation.

UNIT-5: Environmental biotechnology -2 (12h)

1. Biotransformation, bioconversion, bioremediation, phytoremediation technology, fermentation technology.
2. Biotechnological approaches for solid waste management.
3. Phytotechnology-aquatic Phyto systems, nutrient film techniques, algal treatment systems.
4. Environmental problems and environmental monitoring through microorganisms.

III. Practical syllabus:

1. Preparation of media for bacteria and yeast cultures
2. Production of wine using common yeast
3. Production of citric acid by *A. niger*
4. Immobilization of an enzyme by gel-entrapment
5. Production of hydrogen or biogas using cow/cattle dung
6. Isolation of microbes from soil or industrial effluents
7. Estimation of BOD in water samples
8. Production of alcohol by fermentation and estimation of alcohol by colorimetry
9. Production of biofertilizers (*Azolla*)
10. Growth curves of bacteria, Measurement of growth in liquid cultures
11. Quality testing of milk by MBRT

IV. Suggested student activities:

1. Collection of literature on various microbes employed in industrial and environmental biotechnology.
2. Case studies on bioremediation processes.
3. Visit to biotechnology industries making different products.
4. Visit to biogas plants and waste water treatment plants.

V. Text Books:

- Christoph Wittmann and James C. Liao (2018) Industrial Biotechnology: Sustainable Production and Bioresource Utilization, Wiley-VCH, Weinheim, Germany.
- Hans-Joachim Rehm and Gerald Reed, (2014) Industrial Biotechnology: Microorganisms, Wiley-VCH, Weinheim, Germany.
- Christoph Wittmann and James C. Liao (2013) Industrial Biotechnology: Products and Processes, Wiley-VCH, Weinheim, Germany.
- Ronald L. Crawford and Don L. Crawford (2013) Bioremediation: Principles and Applications, Cambridge University Press, Cambridge.

VI. Reference Books:

- Steinbüchel and R. Marchessault (2007) Handbook of Industrial Biotechnology Wiley-VCH, Weinheim, Germany.
- Larry Walker and Mark Rapport (2001) Industrial Biotechnology: Principles and Applications, CRC Press, Boca Raton, Florida, USA.

- Michael C. Flickinger and Stephen W. Drew (1999), Industrial Biotechnology: An Introduction, Wiley, New York, USA.
- Bruce E. Rittmann and Perry L. McCarty (2012) Environmental Biotechnology: Principles and Applications, McGraw-Hill Education, New York.
- Sung-Hwan Kim and In S. Kim (2010) Biotechnology for the Environment: Wastewater Treatment and Modeling, Waste Gas Handling, Springer, Berlin.