ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

Model Syllabus for 4-Year UG Honours in B.Sc. (Botany) as Major in consonance with Curriculum framework w.e.f. AY 2025-26

COURSE STRUCTURE (for Semester I to VI)

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	Diversity of Microbes	3	3
			Diversity of Microbes -Practical	2	1
		2	Diversity of Thallophytes	3	3
			Diversity of Thallophytes -Practical	2	1
	II	3	Diversity of Archegoniates	3	3
			Diversity of Archegoniates -Practical	2	1
		4	Anatomy and Embryology of Angiosperms	3	3
			Anatomy and Embryology of Angiosperms - Practical	2	1
II	III	5	Morphology and Taxonomy of Angiosperms	3	3
			Morphology and Taxonomy of Angiosperms - Practical	2	1
		6	Plant resources and Utilization	3	3
			Plant resources and Utilization -Practical	2	1
		7	Plant Ecology, Biodiversity and Phytogeography	3	3
			Plant Ecology, Biodiversity and Phytogeography -Practical	2	1
	IV	8	Cell and Molecular biology	3	3
			Cell and Molecular biology -Practical	2	1
		9	Genetics and Plant breeding	3	3
			Genetics and Plant breeding -Practical	2	1
		10	Plant Physiology and Metabolism	3	3
			Plant Physiology and Metabolism -Practical	2	1
III	V	11	Plant Biotechnology	3	3
			Plant Biotechnology -Practical	2	1

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
		12 A	Ethnobotany and Phytomedicines	3	3
			Ethnobotany and Phytomedicines -Practical	2	1
		OR			
		12 B	Bioinstrumentation Techniques	3	3
			Bioinstrumentation Techniques -Practical	2	1
		OR			
		12 C	Concepts of Horticulture	3	3
			Concepts of Horticulture-Practical	2	1
		13 A	Traditional Systems of Medicine	3	3
			Traditional Systems of Medicine -Practical	2	1
		OR			
		13 B	Plant Genetic Engineering	3	3
			Plant Genetic Engineering-Practical	2	1
		OR			
		13 C	Gardening and Landscaping	3	3
			Gardening and Landscaping-Practical	2	1
	VI	14 A	Herbal Technology	3	3
			Herbal Technology-Practical	2	1
		OR			
		14 B	Bioinformatics and Computational Biology	3	3
			Bioinformatics and Computational Biology-Practical	2	1
		OR			
		14 C	Plant Propagation Techniques	3	3
			Plant Propagation Techniques-Practical	2	1
		15 A	Pharmacognosy and Phytochemistry	3	3
			Pharmacognosy and Phytochemistry-Practical	2	1
		OR			
		15 B	Omics in Plant Sciences	3	3
			Omics in Plant Sciences-Practical	2	1
		OR			
		15 C	Ornamental Horticulture and Commercial Floriculture	3	3
			Ornamental Horticulture and Commercial	2	1

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
			Floriculture-Practical		

Note: In the III Year (during the V and VI Semesters), students are required to select a pair of electives from one of the **Three** specified domains. **For example: if set 'A' is chosen, courses 12 to 15 to be chosen as 12 A, 13 A, 14 A and 15 A.** To ensure in-depth understanding and skill development in the chosen domain, students must continue with the same domain electives in both the V and VI Semesters.

SEMESTER-I

COURSE 1: DIVERSITY OF MICROBES

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has to:

1. Gain awareness on hypotheses about the origin of life on Earth, and structure and multiplication of viruses.
2. Identify and describe the unique characteristics and significance of special types of bacteria.
3. Describe the structure, classification, and reproductive methods of eubacteria.
4. Tell the types of soil microorganisms and explain their interactions with each other, plants, and soil components.
5. Identify and differentiate between beneficial and harmful activities microbes in different fields.

II. Course Outcomes: On completion of this course students will be able to:

1. Illustrate the origin of life on Earth and diversity, multiplication and economic value of viruses.
2. Deliberate the general characteristics, and economic importance of special groups of bacteria.
3. Explain the structure, nutrition, reproduction and significance of eubacteria.
4. Evaluate the interactions of soil microbes among themselves and with plants.
5. Compile the value and applications of microbes in various fields.

III. Syllabus of Theory:

Unit-1: Origin of life and Viruses **10 Hrs.**

1. Origin of life, concept of primary Abiogenesis; Miller and Urey experiment.; discovery of microorganisms, Pasteur experiments, germ theory of diseases; three domain – six kingdom classification of Carl Woese.
2. Shape and symmetry of viruses; structure of TMV and Gemini virus.
3. Lytic and lysogenic cycles of T-even phages; a brief account of prions, viroids and virusoids.
4. Transmission of plant viruses and their control; significance of viruses in production of vaccines and bio-pesticides.

Unit-2: Special groups of Bacteria **7 Hrs.**

1. General characteristics, and economic importance of following special groups of bacteria:

a) Archaebacteria b) Actinomycetes c) Phytoplasma d) Cyanobacteria

2. Culture and cultivation of *Spirulina*

Unit-3: Eubacteria **8 Hrs.**

1. Occurrence, distribution and cell structure of eubacteria; classification of Eubacteria based on nutrition
2. Reproduction- asexual (binary fission and endospores) and bacterial recombination (conjugation, transformation, and transduction).
3. Economic importance of Eu-bacteria with reference to their role in Agriculture and industry (fermentation and medicine).

Unit-4: Soil microbes – interactions **10Hrs.**

1. Distribution of microorganisms in soil; factors influencing the soil microflora; role of microorganisms in soil fertility.
2. Microbial interactions: symbiosis, neutralism, commensalism, competition, antagonism, synergism, parasitism and predation.
3. Microorganisms of rhizosphere, phyllosphere and spermosphere; microbial interactions and their effect on plant growth.

Unit-5: Beneficial and harmful microbes **10 Hrs.**

1. A brief account of symptoms of viral diseases in plants; Tungro disease in paddy.
2. A summary of symptoms of bacterial diseases in plants; Citrus canker.
3. Microorganisms as food; probiotics and prebiotics; products from microorganisms, Metabolites, enzymes, and antibiotics.
4. Bacterial and Cyanobacterial biofertilizers – their applications; Bacterial biopesticides and their applications.

IV. Text Books:

1. Bhattacharjee, R.N., (2017) Introduction to Microbiology and Microbial Diversity, Kalyani Publishers, New Delhi.
2. Dubey, R.C. & D. K. Maheswari (2013) A Text Book of Microbiology, S.Chand & Company Ltd., New Delhi
3. Toshniwal, R.L. (2007) Agricultural Microbiology, Agrobios (India), Jodhpur

V. Reference Books:

1. Pelczar Jr., M.J., E.C.N. Chan & N. R. Krieg (2001) Microbiology, Tata McGraw-Hill Co, New Delhi
2. Presscott, L. Harley, J. and Klein, D. (2005) Microbiology, Tata McGraw –Hill Co. New Delhi.
3. Gyaneshwar, A.D., G.J. Parekh, and V.S. Reddy (2004) Agricultural Microbiology: Plant-Soil Interactions, Research Signpost, Kerala, India
4. Zaki A. Shuler and Zainul Abid (2014) Agricultural Microbiology: Principles and Applications, CRC Press, Boca Raton, Florida, USA

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Collecting scientific literature on historical developments in microbiology.

Evaluation method: Evaluating the report based on a rubric.

Unit-2: Activity: Group discussion on various groups of special bacteria.

Evaluation method: Assessment of active participation, soft skills, communication skills, collaborative skills, time management etc., of a group or a student based on a rubric.

Unit-3: Activity: Presentation or poster summarizing the classification of Eu-bacteria based on nutrition.

Evaluation method: Assessment based on accuracy and understanding.

Unit-4: Activity: Microscopic observation of bacterial samples from soil/ phylloplane in their native place/ college campus.

Evaluation method: Evaluating the report on characteristics and classification of eubacteria.

Unit-5: Activity: Visit to Agriculture/Horticulture universities to learn about biofertilizers and biopesticides.

Evaluation method: Evaluating the report submitted by the student based a rubric.

SEMESTER-I

COURSE 1: DIVERSITY OF MICROBES

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Take all necessary precautions in the microbiology laboratory.
2. Handle the instruments and prepare media for laboratory work.
3. Identify various microbes through microscopic observations.

II. Laboratory/Field exercises:

1. Study the principle and applications of important instruments (autoclave, hot air oven, incubator, Inoculation loop, Inoculation needle, membrane filter, laminar air flow system, colony counter. biological safety cabinets, BOD incubator, pH meter) used in the microbiology laboratory.
2. Study of Viruses (TMV and Gemini) using electron micrographs/ models.
3. Microscopic study of Cyanobacteria using temporary/permanent slides.
4. Study of Archaebacteria, Actinomycetes and Phytoplasma using permanent slides/ electron micrographs/diagrams.
5. Microscopic study of Eubacteria using temporary/permanent slides.
6. Gram staining technique of Bacteria.
7. Demonstration of culture and cultivation of *Spirulina*
8. Tungro in Paddy and Citrus canker

SEMESTER-I

COURSE 2: DIVERSITY OF THALLOPHYTES

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has to:
1. Brief the general characters, classification and value of algae.
2. Discuss the morphology, reproduction and life cycles of some algae.
3. Tell the general characters, classification and value of fungi.
4. Discuss the morphology, reproduction and life cycles of some fungi.
5. Summarize the morphology, anatomy, reproduction and economic value of lichens.

II. Course Outcomes: On completion of this course students will be able to:
1. Compile the general characteristics of algae and their significance in nature.
2. Compare and contrast the characteristics of different groups of algae.
3. Summarize the important features of fungi and their economic value.
4. Distinguish different groups of fungi based on their characteristics.
5. Elaborate the features and significance of lichens.

III. Syllabus of Theory:

Unit-1: Introduction to Algae **8Hrs.**

1. General characteristics of algae: occurrence and distribution, cell structure, pigments, flagella and reserve food material.
2. F.E.Fritsch (1935) classification of algae; thallus organization in algae.
3. Life cycles in algae; ecological and economic importance of algae.

Unit-2: Biology of selected Algae **10Hrs.**

1. Occurrence, structure, reproduction and life cycle of:
   (a) Chlorophyceae: *Spirogyra* (b) Phaeophyceae: *Ectocarpus* and (c) Rhodophyceae: *Polysiphonia*

2. Culture and cultivation of *Chlorella*

Unit-3: Introduction to Fungi **8Hrs.**

1. General characteristics of fungi; Ainsworth (1973) classification.
2. Thallus organization and nutrition in fungi.
3. Reproduction in fungi (asexual and sexual); heterothallism and para-sexuality.
4. Ecological and economic importance of fungi.

Unit-4: Biology of selected Fungi **10Hrs.**

1. Occurrence, structure, reproduction and life cycle of:
   (a) Zygomycotina: *Rhizopus* (b) Ascomycotina: *Penicillium* (c) Basidiomycotina: *Puccinia*

Unit-5: Lichens **7 Hrs.**

1. Lichens: definition, phycobionts and mycobionts in lichens; morphology and internal structure of lichens; classification based on growth form, habitat and fungal partner.
2. Reproduction – vegetative, asexual and sexual methods.
3. Ecological and economic importance of lichens.

IV. Text Books:

1. Pandey, B.P. (2013) College Botany, Volume-I, S. Chand Publishing, New Delhi
2. Hait,G., K.Bhattacharya & A.K.Ghosh (2011) A Text Book of Botany, Volume-I, New Central Book Agency Pvt. Ltd., Kolkata

V. Reference Books:

1. Fritsch, F.E. (1945) The Structure & Reproduction of Algae (Vol. I & Vol. II) Cambridge University Press Cambridge, U.K.
2. Bold, H.C.& M. J. Wynne (1984) Introduction to the Algae, Prentice-Hall Inc., New Jersey
3. Robert Edward Lee (2008) Phycology. Cambridge University Press, New York
4. Van Den Hoek, C., D.G.Mann & H.M.Jahns (1996) Algae: An Introduction to Phycology. Cambridge University Press, New York.
5. Alexopoulos, C.J., C.W.Mims & M.Blackwell (2007) Introductory Mycology, Wiley& Sons, Inc., New York
6. Mehrotra, R.S.& K. R. Aneja (1990) An Introduction to Mycology. New Age International Publishers, New Delhi.
7. Kevin Kavanagh (2005) Fungi; Biology and Applications John Wiley& Sons, Ltd., West Sussex, England.
8. John Webster & R. W. S. Weber (2007) Introduction to Fungi, Cambridge University Press, New York.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Algae specimen collection from any water bodies in their locality, recording the characteristics, identification and classifying them according to Fritsch system.
Evaluation method: Evaluating the presentation or report summarizing findings.

Unit-2: Activity: Microscopic observations and recording distinguishing characters of any six algal forms excluding the genera in the syllabus.
Evaluation method: Conducting a Quiz or an exam/ evaluating the chart or drawings or summarized data on similarities and differences.

Unit-3: Activity: Collection of economically valuable fungal products.
Evaluation method: Evaluating the collections made and awarding grade.

Unit-4: Activity: Group discussion/quiz/JAM on characteristics of various groups of algae.
Evaluation method: Assessment of the performance of individual/group of students based on a rubric.

Unit-5: Activity: Microscopic observations and summarizing the salient features of the fungal genera and lichen forms in the syllabus.
Evaluation method: Conducting a Quiz or an exam/ evaluating the chart or drawings or concise data on similarities and differences.

SEMESTER-I

COURSE 2: DIVERSITY OF THALLOPHYTES

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:
1. Identify some algal and fungal species based on the structure of thalli and reproductive organs.
2. Decipher the lichens based on morphological, anatomical and reproductive features.
3. Realize the value of algal, fugal and lichen products available in markets.

II. Laboratory/field exercises:
Study/ microscopic observation of vegetative, sectional/anatomical and reproductive structures of the following using temporary or permanent slides/ specimens/ mounts:
1. **Algae:** *Spirogyra, Ectocarpus, Vaucheria* and *Polysiphonia*; a centric and a pennate diatom.
2. Demonstration of culture and cultivation of *Chlorella*
3. Identification of some algal products available in local market.
4. **Fungi:** *Rhizopus, Penicillium* and *Puccinia*
5. Identification of some fungal products available in the local market.
6. **Lichens:** Crustose, foliose and fruiticose
7. Identification of some lichen products available in the local market.

SEMESTER-II

COURSE 3: DIVERSITY OF ARCHEGONIATES

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has to:

1. Explain the general characters, classification and significance of Bryophytes.
2. Discuss the morphological, anatomical and reproductive characters of Pteridophytes.
3. Acquire knowledge of evolutionary trends in Pteridophytes and their value.
4. Brief the morphological, anatomical and reproductive characters of Gymnosperms.
5. Summarize the evolutionary trends in Gymnosperms.

II. Course Outcomes: On completion of this course students will be able to:

1. Compare and contrast the morphological, anatomical and reproductive features of some Bryophytes.
2. Illustrate the morphological, anatomical and reproductive characteristics of some Pteridophytes.
3. Infer the evolution of vasculature, heterospory, and seed habit in Pteridophytes.
4. Compare and contrast the morphological, anatomical and reproductive features of some Gymnosperms.
5. evaluate the evolutionary trends in Gymnosperms.

III. Syllabus of Theory:

Unit-1: Biology of Bryophytes **9 Hrs.**

1. General characteristics of Bryophytes; Rothmaler (1951) classification.
2. Occurrence, morphology, anatomy, reproduction (developmental details are not needed) and life cycle of (a) Hepaticopsida: *Marchantia* (b) Anthoceratopsida: *Anthoceros* (c) Bryopsida: *Funaria*
3. General account on the evolution of sporophytes in Bryophyta.

Unit-2: Biology of Pteridophytes **10 Hrs.**

1. General characteristics of Pteridophyta; Smith (1955) classification.
2. Occurrence, morphology, anatomy, reproduction (developmental details are not needed) and life history of: (a) Lycopsida: *Lycopodium* (b) Sphenopsida: Equisetum and (c) Filicopsida: *Marsilea*

Unit-3: Evolutionary trends in Pteridophytes **8 Hrs.**

1. Geological time scale; a brief account of *Rhynia*
2. Stelar evolution in Pteridophytes; heterospory and seed habit.
3. Ecological and economic importance of Pteridophytes.

Unit-4: Biology of Gymnosperms **10 Hrs.**

1. General characteristics of Gymnosperms; Sporne (1965) classification.
2. Occurrence, morphology, anatomy, reproduction (developmental details are not needed) and life history of:(a) Cycadopsida: *Cycas* (b) Ginkgoopsida: *Ginkgo* and (b) Gnetopsida: *Gnetum*

Unit-5: Evolutionary trends in Gymnosperms **8 Hrs.**

1. A brief account on fossilization processes and types of fossils.
2. A over view of *Cycadeoidea* and *Pentoxylon*
3. A summary of evolutionary trends in Gymnosperms.
4. Ecological and economic importance of Gymnosperms.

IV. Text Books:

1. Acharya, B.C., (2019) Archchegoniates, Kalyani Publishers, New Delhi
2. Bhattacharya, K., G. Hait&Ghosh, A. K., (2011) A Text Book of Botany, VolumeII, New Central Book Agency Pvt. Ltd., Kolkata
3. Hait,G., K.Bhattacharya & A.K.Ghosh (2011) A Text Book of Botany, Volume-I,New Central Book Agency Pvt. Ltd., Kolkata
4. Pandey, B.P. (2013) College Botany, Volumes-I&II, S. Chand Publishing, New Delhi

V. Reference Books:

1. Shaw, A.J.& B.Goffinet (2000) Bryophyte Biology. Cambridge University Press, New York.
2. Smith, G.M. (1971) Cryptogamic BotanyVol. II., Tata McGraw Hill, New Delhi
3. Sharma,O.P.(2012) Pteridophyta. Tata McGraw-Hill, New Delhi
4. Sporne, K.R. (1971) The Morphology of Gymnosperms. Hutchinsons Co. Ltd., London
5. Coulter, J.M. & C.J.Chamberlain(1910) Morphology of Gymnosperms, The University of Chicago Press, Chicago, Illinois
6. Bhatnagar, S.P. & Alok Moitra (1996) Gymnosperms. New Age International, New Delhi

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Collection and identification of Bryophytes from their locality.
Evaluation method: Assessing the collections made by the student and assigning a grade.

Unit-2: Activity: Making temporary slides/models/drawings of Pteridophytes in the syllabus. **Evaluation method:** Assessment of the temporary slides/model/drawing.

Unit-3: Activity: Group discussion/Quiz/JAM on evolutionary trends in Pteridophytes.
Evaluation method: Assessing the abilities of a group/ an individual based on the performance.

Unit-4: Activity: Study of wood elements in locally available Gymnosperms and making temporary slides.
Evaluation method; Validation of prepared slides submitted by the learner.

Unit-5: Activity: Assignment/seminar on evolutionary trends in Gymnosperms-making comparative account.
Evaluation method: Evaluating the quality of assignment written with apt examples/quality of presentation using a rubric.

SEMESTER-II

COURSE 3: DIVERSITY OF ARCHEGONIATES

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, the student shall be able to:

1. distinguish the Pteridophytes and Gymnosperms based on their morphological, anatomical and reproductive structures.
2. make systematic classification of plant species using vegetative and floral characters.
3. identify angiosperm plant species and make herbarium specimens.

II Laboratory/field exercises:

1. Study/ microscopic observation of vegetative, sectional/anatomical, and reproductive structures of the following using temporary or permanent slides/specimen/ mounts:

A. Bryophyta: *Marchantia, Anthoceros* and *Funaria*
B. Pteridophyta: *Rhynia, Lycopodium, Equisetum*, and *Marselia*
C. Gymnosperms: *Cycadeoidea, Pentoxylon*, *Cycas*, *Ginkgo* and *Gnetum*

2. Field trip to a Botanic garden or local floristic area/forest.

SEMESTER-II

COURSE 4: ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has to:
1. Deliberate about various types of tissues in plants and their organization.
2. Explain anomalous secondary growth in plants and economic value of woods.
3. Debate on structure of anther and development of male gametophyte in plants.
4. Discuss the structure of ovules and process of fertilization.
5. Explain the embryo development and seed structure in monocots and dicots.

II. Course Outcomes: On completion of this course students will be able to:
1. Categorize various tissues and evaluate their role in plants.
2. Explain anomalous secondary growth in some plants and justify the value of timber plants.
3. Summarize the events in micro-sporogenesis and development of male gametophyte.
4. Illustrate the events in mega-sporogenesis and development of female gametophyte.
5. Propose the incidents in embryogenesis and structure of seeds in angiosperms.

III. Syllabus of Theory:

Unit – 1: Tissues in plants **8 Hrs.**

1. Meristematic tissues: Definition, classification, structure and functions.
2. Apical meristems: Generalized structure of shoot apex, theories on organization of Shoot Apical Meristem (SAM) - Apical cell theory, Tunica-Corpus theory and Histogen theory.
3. Permanent tissues (simple and complex); a brief account of plant secretory tissues/cells.

Unit-2: Anomalous growth in plants **10Hrs.**

1. Tissue systems–Epidermal, ground and vascular.
2. Anomalous secondary growth in root of *Beta vulgaris;* anomalous secondary growth in stems of *Boerhaavia* and *Dracaena*
3. Study of timbers of economic importance - Teak, Red-sanders and Rosewood; applications of anatomy forensics and pharmacognosy.

Unit-3: Anther and pollen **10Hrs.**

1. Anther: Structure and functions of anther wall, micro-sporogenesis.
2. Pollen wall structure, NPC system; development of male gametophyte, MGU (male germ unit).
3. Pollen wall proteins; pollen viability, storage and germination; abnormal features: Pseudomonads and polyads; Nemec phenomenon.
4. A brief account of palynology and its scope.

Unit-4: Ovules, fertilization and endosperm **10Hrs.**

1. Structure and types of ovules, megasporogenesis; monosporic (*Polygonum*), bisporic (*Allium*) and tetrasporic (*Peperomia*) types of embryo sacs.
2. Pollination: types of self and cross pollination – contrivances; agents of pollination.
3. Double fertilization in angiosperms – process and consequences.
4. Perisperm; endosperm – types (free nuclear, cellular, helobial and ruminate) and biological importance.

Unit-5: Embryogeny and seeds **7Hrs.**

1. Embryo development in dicot (*Capsella bursa-pastoris*) and monocot (*Sagittaria sagittifolia*) plants.
2. Seed structure in monocot and dicot; importance of seed and seed dispersal mechanisms.
3. Polyembryony and apomixes: Introduction, classification, causes and applications.

IV. Text Books:

1. Pandey, B.P. (2013) College Botany, Volumes-II& III, S. Chand Publishing, New Delhi
2. Bhattacharya, K., G. Hait & Ghosh, A. K., (2011) A Text Book of Botany, Volume-II, New Central Book Agency Pvt. Ltd., Kolkata

V. Reference Books:

1. Esau, K. (1971) Anatomy of Seed Plants. John Wiley and Son, USA.
2. Fahn, A. (1990) Plant Anatomy, Pergamon Press, Oxford.
3. Cutler, D.F., T. Botha & D. Wm. Stevenson (2008) Plant Anatomy: An Applied Approach, Wiley, USA
4. Paula Rudall (1987) Anatomy of Flowering Plants: An Introduction to Structure and Development. Cambridge University Press, London
5. Bhojwani, S. S. and S. P. Bhatnagar (2000) The Embryology of Angiosperms (4th Ed.),Vikas Publishing House, Delhi.
6. Pandey, A. K. (2000) Introduction to Embryology of Angiosperms. CBS Publishers & Distributors Pvt. Ltd., New Delhi
7. Maheswari, P. (1971) An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London.
8. Johri, B.M. (2011) Embryology of Angiosperms. Springer-Verlag, Berlin

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Microscopic observations on different tissues in plants and recording characteristics.
Evaluation method: Judgement of the report/seminar on comparative and contrasting features of various tissues in plants.
Unit-2: Activity: Visits to timber depots and furniture shops and making a report on various woods.
Evaluation method: Assessment of report submitted with data, photographs and summary.
Unit-3: Activity: Study of pollen structure, germination and viability in some local plant species.
Evaluation method: Evaluating the report/seminar presentation with collected data.
Unit-4: Activity: Group discussion/quiz on endosperm types and functions. Evaluation method: Assessment of the best performing group.
Unit-5: Activity: Drawings of embryogeny in some angiosperms and making comparative report.
Evaluation method: Evaluating the best drawings and comparative report.

SEMESTER-II

COURSE 4: ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Conduct dissections of various plant organs and study the internal structures by staining.
2. Explain the embryological characteristics from sex organs to seeds in angiosperms.
3. Demonstrate skills in studying anatomical and embryological features of angiosperms.

II. Laboratory/field exercises:

1. Observation of meristems in dicot and monocot plants.
2. Tissue organization in shoot apices using permanent slides.
3. Anomalous secondary growth in root of *Beta vulgaris*
4. Anomalous secondary growth in stems of *Boerhaavia* and *Dracaena.*
5. Study of anther and ovules using permanent slides/photographs.
6. Study of pollen germination and pollen viability.
7. Dissection and observation of embryo sac haustoria in *Santalum* or *Argemone*.
8. Structure of endosperm (nuclear and cellular) using permanent slides/photographs.
9. Dissection and observation of endosperm haustoria in *Crotalaria* or *Coccinia.*
10. Developmental stages of dicot and monocot embryos using permanent slides/photographs.

SEMESTER-III

COURSE 5: MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has:

1. To understand the vegetative and reproductive morphology of Angiospermic plant.
2. To acquire knowledge of the taxonomic aids and classification systems.
3. To read the vegetative and floral characteristics of some forms of angiospermic families along with their economic value.
4. To study the significance of other branches of botany in relation to plant taxonomy.

II. Learning Outcomes: On completion of this course students will be able to:

1. Illustrate the vegetative and reproductive morphology of angiosperms
2. Discuss about some Taxonomic aids and their applications in plant systematics.
3. Compare and contrast the vegetative and floral characteristics of some angiospermic families
4. Evaluate the economic value of plant species from the families under the study.
5. Defend the utility of evidences from different branches of botany in solving the taxonomic lineages of some species.

III. Syllabus of Theory:

Unit-1: Vegetative morphology **10Hrs.**

1. Parts of an angiospermic plant-root system and shoot system
2. Root -Characteristics, types of root system, modification of root
3. Stem-Characteristics, modification of stem (Aerial, sub aerial and underground)
4. Leaf-Parts of leaf, venation-types, phyllotaxy-types, leaf modifications

Unit-2: Reproductive morphology **8Hrs.**

1. Inflorescence: Types of inflorescences; Racemose and its types, Cymose and its types and special types of inflorescences
2. Flower in general: Parts of a flower, structure of a flower, symmetry of a flower, position of gynoecium on thalamus, nature of flower based on perianth, aestivation-types.
3. Flower in detail: Calyx, corolla, Androecium (parts of stamen, attachment of filament to anther. length of stamens, union of stamens and dehiscence of anthers); Gynoecium-Number of carpels, fusion of carpels, number of locules in ovary, placentation, style-types.
4. Fruits: True and false fruits; simple fruits-types; aggregate fruits and composite fruits

Unit-3: Principles of Plant Taxonomy **10 Hrs.**

1. Aim and scope of taxonomy, species concept, taxonomic hierarchy-major and minor categories.
2. Plant nomenclature: Binomial system, ICBN- rules for nomenclature.
3. Herbarium and its techniques, BSI herbarium and Kew herbarium; concept of digital herbaria.
4. Bentham and Hookers system of classification; a brief account of APG-IV classification.

Unit-4: Descriptive Plant Taxonomy **10Hrs.**

Systematic description and economic importance of the following families:

1. Polypetalae: (a) Annonaceae (b) Fabaceae (c) Curcurbitaceae
2. Gamopetalae: (a) Asteraceae (b) Asclepiadaceae
3. Monochlamydae: (a) Amaranthaceae (b) Euphorbiaceae
4. Monocotyledonae: (a) Orchidaceae (b) Poaceae

Unit-5: Evidences for Plant systematics **7Hrs.**

1. Anatomy and embryology in relation to plant systematics.
2. Cytology and cytogenetics in relation to plant systematics.
3. Phytochemistry in relation to plant systematics.
4. Numerical taxonomy

IV. Text Books:

1. Singh, G. (2019). Plant systematics: Theory and practice (3rd ed.). Oxford & IBH Publishing Co. Pvt. Ltd.
2. Stuessy, T. F. (2009). Plant taxonomy: The systematic evaluation of comparative data (2nd ed.). Columbia University Press.
3. Simpson, M. G. (2019). Plant systematics (3rd ed.). Academic Press (Elsevier).
4. Naik, V. N. (1984). Taxonomy of angiosperms. Tata McGraw-Hill Publishing Company.

V. Reference Books:

1. Pandey, B. P. (2022). Taxonomy of Angiosperms (Latest Ed.). S. Chand & Company Pvt. Ltd.
2. Heywood, V. H. (2007). Flowering plant families of the world. Kew Publishing.
3. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2016). Plant systematics: A phylogenetic approach (4th ed.). Sunderland, MA: Sinauer Associates.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Botanical field trip and collecting plant specimens for herbarium.
Evaluation method: Attendance in field trip and submission of field note book and herbarium sheets with filled in labels.

Unit-2: Activity: Making good models or drawings or collection of photographs of some important plant species from the families included in the syllabus.
Evaluation method: Authorize the quality of the work and conferring reward.

Unit-3: Activity: Collection of scientific literature on solving taxonomic problems by taking evidences from other branches of Botany.
Evaluation method: Validation of the collection submitted along with summary.

Unit-4: Activity: Field visit to identify plants belong to various families included in syllabus.
Evaluation method: Evaluating the field note book data, plant specimens collected and herbarium made.

Unit-5: Activity: Collection of literature on evidences from different branches of Botany useful for plant systematics.
Evaluation method: Evaluating the quality of report made using a rubric.

SEMESTER-III

COURSE 5: MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Make systematic classification of plant species using vegetative and floral characters.
2. Identify angiosperm plant species and make herbarium specimens.

II Laboratory/field exercises:

1. Technical description of an Angiosperm plant

II. Technical description of locally available plant species from the following angiosperm families:

(a) Annonaceae (b) Fabaceae (c) Curcurbitaceae (d) Asteraceae (e) Asclepiadaceae

(f) Amaranthaceae (g) Euphorbiaceae (h) Orchidaceae (i) Poaceae

III. Demonstration of herbarium techniques.

IV. Field trip to a local floristic area/forest (Submission of 30 number of Herbarium sheets of wild plants with the standard system are mandatory).

SEMESTER-III

COURSE 6: PLANT RESOURCES AND UTILIZATION

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has to:

1. Identify different plants domesticated by humans and utility of their products.
2. Gain knowledge on commercial and timber products obtained from plants.
3. Know the facts on economic value of plants products in relation to human welfare.

II. Learning Outcomes: On successful completion of the course, the students will be able to

1. Explain the significance of plants in human nutrition
2. List out different plant products used by human beings
3. Evaluate the commercial plant products and their utilization
4. Discuss the uses of medicinal and aromatic plants for human health care.
5. Appraise the importance of timber and non-timber products for value added products

III. Syllabus of Theory:

Unit-1: Field crops (Cereals, Millets and Pulses) **9 Hrs.**

1. Centers of origin (diversity) of crop plants and their domestication.
2. A general account of cereals, millets and pulses.
3. A brief account of Botany (origin, distribution, botanical name, family and morpho- logical description only) and economic significance of: Cereals -Rice and Maize; Millets -Sorghum and finger millet; Pulses-Chickpea and Red gram

Unit-2: Oilseeds and Commercial field and horticultural crops **9 Hrs.**

1. A general account of oilseed crops and vegetable oil yielding trees.
2. A brief account of Botany (origin, distribution, botanical name, family and morpho- logical description only) and economic significance of Oilseeds (Groundnut and Sesame) and Sugarcane.
3. Botanical name, family, nutritional value of major tropical and temperate fruits and nuts.
4. Botanical name, family, nutritional value of vegetable crops (root and tuber crops, cucurbits, cruciferous, solanaceous and leafy vegetables).

Unit-3: Fiber crops, Spices, Condiments; Beverages and Narcotics **9 Hrs.**

1. Classification of plant fibers: A brief account of Botany (origin, distribution, botanical name and family) and economic importance of fiber crops (Cotton, Jute, Flax and Hemp)
2. Botanical name, family and economic importance of :Spices (Cinnamon, Cloves, Cardamom and Pepper); Beverages (Coffee, Tea and Cocoa);Plants used as fumitories, masticatories and narcotics.

Unit-4: Medicinal and aromatic plants-their products **9 Hrs.**

1. Traditional and modern uses of some medicinal plants of India.
2. Botanical name, family and economic importance of *Rauwolfia, Withania, Emblica, Andrographis, Senna*.
3. Essential oils and their uses; aromatic plants in perfumery and cosmetics.
4. Botanical name, family and economic importance of rubber, latex, gums, resins and dye yielding plants.

Unit-5: Timber yielding plants and energy plantations 9 Hrs.

1. A general account on important timber yielding plants of India with an emphasis on Sal, Arjun, babul, Mahogony
2. Uses of wood: Wood as a construction and manufacturing material and other uses of wood
3. Energy Plantations and biofuels
4. Bamboos, Eucalyptus, Casuarina - generation of paper industry raw material.

IV. Textbooks:

1. Kochhar, S. L. (2016). Economic Botany in the Tropics (4th ed.). Macmillan Publishers India.
2. Sambamurty, A. V. S. S. (2005). Textbook of Economic Botany. Wiley Eastern Ltd.
3. Rao, K. N., & Rao, G. R. (2012). A Textbook of Economic Botany. McGraw Hill Education.
4. Sundara Rajan, S. (2002). Introduction to Economic Botany. Popular Book Depot.

V. Reference Books:

1. Hill, A. F. (1952). Economic Botany: A Textbook of Useful Plants and Plant Products (2nd ed.). McGraw-Hill Book Company Inc.
2. Wickens, G. E. (2001). Economic Botany: Principles and Practices. Springer.
3. Simpson, B. B., & Ogorzaly, M. C. (2015). Economic Botany: Plants in Our World (4th ed.). McGraw Hill.
4. Jain, S. K., & DeFilipps, R. A. (1991). Medicinal Plants of India. Reference Publications Inc.
5. Heywood, V. H. (1999). Use and Potential of Wild Plants in Farm Households. FAO, Rome.

VI Suggested activities and evaluation methods:

Unit-1: Activity: A critical assignment on origin of crop plants.
Evaluation method: Evaluate the extent and quality of data collected to support the assignment's arguments.

Unit-2: Activity: Group discussion on various plant products and their source plants.
Evaluation method: Assess the logical flow and coherence of the group's discussion based on a grading scale.

Unit-3: Activity: A survey report on commercial plant products available in local markets.
Evaluation method: Evaluate the clarity and comprehensibility of the survey questions.

Unit-4: Activity: A case study report on phytomedicines used in human health care.
Evaluation method: Examine the depth and coherence of the discussion and interpretation based on a rubric.

Unit-5: Activity: A field trip to timber depots and silviculture plantations in their locality.
Evaluation method: Evaluate the level of student engagement and active participation during the trip based on a grading scale.

SEMESTER-III

COURSE 6: PLANT RESOURCES AND UTILIZATION

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Characterize various plant products based on morphological and microscopic observations.
2. Identify economically valuable plants and their products.
3. Categorize distinct plant products utilized by humans.

II. Laboratory/field exercises:

1. Identification of following plant resources mentioned in the theory syllabus
   a) Food crops
   b) Oilseeds and Commercial field and horticultural crops
   c) Fibre crops, Spices, Condiments; Beverages and Narcotics
   d) Medicinal and aromatic plant products
   e) Timber yielding plants and energy plantations
2. Collection of different types of locally available rice varieties
3. Submission of any five economically important useful plant parts
4. Collection of different cereals and pulses.

SEMESTER-III

COURSE 7: PLANT ECOLOGY, BIODIVERSITY AND PHYTOGEOGRAPHY

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has to:

1. Figure-out the components of ecosystem and energy flow among different trophic levels.
2. Apprise the characteristics of autecology and synecology.
3. Understand the climatic change and associated impacts on biotic components.
4. Discern the value of biodiversity, threats and conservation strategies.
5. Know the distribution of various plant groups in different geographical areas.

II. Learning Outcomes: On completion of this course students will be able to:

1. Explain the interactions among the biotic and abiotic components in an ecosystem.
2. Summarize the characteristics of a population and a community.
3. Anticipate the environmental problems arising due to climate change.
4. Assess the value of biodiversity and choose appropriate conservation strategy.
5. Make a survey on the distribution of various plant groups in a specified geographical area.

III. Syllabus of Theory:

Unit-1: Basic concepts in ecology **10 Hrs.**

1. Ecology: definition, branches and significance; relation with other sciences.
2. Structure and functions of ecosystems- abiotic and biotic components; flow of energy.
3. Cycling of materials: water, carbon, nitrogen and phosphorus; trophic pyramids, food chains and food webs.
4. Plants and environment: Climatic (light and temperature) and edaphic.
5. Interactions among plants; interactions between plants and animals.

Unit-2: Population and community ecology **10Hrs.**

1. Population ecology: definition, characteristics -natality, mortality, and growth curves; ecads and ecotypes
2. Community ecology: characteristics -frequency, density, cover, life forms, competition, biological spectrum, methods of studying plant communities.
3. Ecological succession: Hydrosere and Xerosere; ecological adaptations of plants.
4. Concepts of productivity: GPP, NPP and Community Respiration; Secondary production, P/R ratio and Ecosystems.

Unit-3: Climate change-impacts **8Hrs.**

1. Soil degradation – causes, consequences and management strategies.
2. Deforestation, forest fires – causes, consequences and management strategies.
3. Global warming, ozone layer depletion, acid rains, ocean acidification – causes and effects.
4. Carbon foot prints, carbon credits and carbon sequestration; The Montreal and the Kyoto protocol; Plant indicators and their role in environmental monitoring.

Unit-4: Concepts of Biodiversity **10Hrs**

1. Biodiversity: Basic concepts, Convention on Biodiversity - Earth Summit.
2. Value of Biodiversity; types and levels of biodiversity and Threats to biodiversity
3. Biodiversity Hot spots in India: North Eastern Himalayas and Western Ghats.
4. Ex situ and In situ conservation methods, IUCN threat-categories, RED data book
5. Role of NBPGR and NBA in the conservation of Biodiversity.

Unit-5: Phytogeography 7 Hrs.

1. Principles of Phytogeography, Distribution (wides, endemic, discontinuous species)
2. Endemism – types and causes.
3. Phytogeographic regions of World; phytogeographic regions of India.
4. Vegetation types in Andhra Pradesh.

IV. Text Books:

1. Odum, E. P., & Barrett, G. W. (2005). Fundamentals of ecology (5th ed.). Brooks/Cole.
2. Kormondy, E. J. (2012). Concepts of ecology (4th ed.). Pearson Education.
3. Shukla, R. S., & Chandel, P. S. (2020). Plant ecology and soil science (20th ed.). S. Chand & Company Pvt. Ltd.
4. N.S.Subrahmanyam& A.V.S.S. Sambamurty (2008) Ecology Narosa Publishing House, New Delhi
5. Sharma, P.D. (2012) Ecology and Environment. Rastogi Publications, Meerut, India.
6. Chaudhuri, A. B. (2012). *Biodiversity and conservation*. Oxford University Press.
7. Krishnamurthy, K. V. (2003). *Textbook of biodiversity*. Science Publishers.

V. Reference Books:

1. Primack, R. B. (2014). *Essentials of conservation biology* (6th ed.). Sinauer Associates.
2. Begon, M., J.L. Harper & C.R. Townsend (2003) Ecology, Blackwell Science Ltd., U.S.A.
3. Eugene P. Odum (1996) Fundamentals of Ecology, Natraj Publishers, Dehradun
4. Kumar, H.D. (1992) Modern Concepts of Ecology (7th Edn.,). Vikas Publishing Co.,New Delhi.
5. Newman, E.I. (2000): Applied Ecology Blackwell Scientific Publisher, U.K.
6. Kumar H.D. (2000) Biodiversity & Sustainable Conservation Oxford & IBH Publishing Co Ltd. New Delhi.
7. Cox, C. B., & Moore, P. D. (2010). Biogeography: An ecological and evolutionary approach (8th ed.). Wiley-Blackwell.
8. Ambasht, R.S., & Ambasht, N. K. (2023). A Textbook of Plant Ecology *(16th ed.). CBS Publishers & Distributors.*

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Field visit to local ecosystems and making a report on biotic and abiotic components and their interactions.
Evaluation method: Valuation of record of attendance and report submission with conclusions
Unit- 2: Activity: Case studies on population and community ecologies and making a comprehensive report
Evaluation method: Assessing the report and awarding grade
Unit -3: Activity: Case studies on global and local climatic changes and their impacts, preparing a comprehensive report.
Evaluation method: Assessing the report and awarding grade.
Unit- 4: Activity: Making a survey in their locality to identify endangered and threatening species.
Evaluation method: Assessing the survey report and assigning a grade based on a rubric. **Unit-5: Activity:** Collection of data on flora of their locality and preparing a project report.
Evaluation method: Assessing the project report and awarding a grade.

SEMESTER-III

COURSE 7: PLANT ECOLOGY, BIODIVERSITY AND PHYTOGEOGRAPHY

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Handle instruments used in ecological studies.
2. Perform experiments and collect data on autecology and synecology.
3. Identify various plant groups based on their morphological and anatomical adaptations.
4. Collect data on biodiversity and phytogeography.

II. Laboratory/field exercises:

1. Study of instruments used to measure microclimatic variables;
   a. Soil thermometer, b. Maximum and minimum thermometer,
   c. Anemometer, d. Rain gauze, e. Lux meter.
2. Visit to the nearest/local meteorology station where the data is being collected regularly and record the field visit summary for the submission in the practical.
3. Study of morphological and anatomical adaptations of any two hydrophytes.
4. Study of morphological and anatomical adaptations of any two xerophytes.
5. Quantitative analysis of herbaceous vegetation in the college campus for frequency, density and abundance
6. Identification of vegetation/various plants in college campus and comparison with Raunkiaer's frequency distribution law.
7. Find out the alpha-diversity of plants in an area
8. Mapping of biodiversity hotspots of the world and India.
9. Mapping of phytogeographical regions of the globe and India.

SEMESTER-IV

COURSE 8: CELL AND MOLECULAR BIOLOGY

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has:

1. To look into the ultra-structure of plant cell and its organelle
2. To know the morphology and functions of chromosomes
3. To understand the principles of autocatalysis and heterocatalysis of DNA

II. Learning Outcomes: On completion of this course students will be able to:

1. Sketch the ultra-structural aspects of plant cell and its components.
2. Hypothesise the role of chromosomes in inheritance.
3. Justify the role of genes in inheritance of characters by descent.
4. Correlate the functions of the nucleic acid with their structure.
5. Explain molecular mechanisms of DNA replication, transcription, translation, and gene regulation**.**

III. Syllabus of Theory:

Unit-1: Cell and its organelle **8 Hrs.**

1. Cell theory; prokaryotic vs eukaryotic cell; animal vs plant cell; a brief account on ultra-structure of a plant cell.
2. Ultra-structure and functions of cell wall.
3. Ultra-structure and functions of plasma membrane and various models on its organization.
4. Polymorphic cell organelles (Plastids); ultra-structure of chloroplast, plastid DNA.
5. Ultrastructure of mitochondria, mitochondrial DNA.

Unit-2: Chromosomes **8 Hrs.**

1. Nucleus-Nuclear membrane, nuclear pore complex
2. Prokaryotic vs eukaryotic chromosome; morphology of a eukaryotic chromosome.
3. Euchromatin and Heterochromatin; Karyotype and ideogram.
4. Organization of DNA in a chromosome (nucleosome and solenoid models).
5. Special types of chromosomes-Lampbrush chromosomes, polytene chromosomes, B chromosomes

Unit-3: Cell cycle and its regulation **10 Hrs.**

1. Cell cycle-phases of cell cycle, amitosis.
2. Mitosis-Phases of mitosis and significance of mitosis.
3. Meiosis-phases of meiosis and significance of meiosis
4. Cell cycle check points, apoptosis

Unit-4: Nucleic acids **10 Hrs.**

1. Primary structure of DNA, Watson and Crick model of DNA, types of DNA
2. Experimental evidences for DNA as genetic material
3. Methods of DNA replication, mechanism of DNA replication
4. DNA damage and repair
5. Structure, functions and types of RNA.

Unit-5: Transcription and Translation **9 Hrs.**

1. Transcription: Mechanism of transcription in prokaryotes and eukaryotes
2. RNA processing –Post transcriptional changes
3. Genetic code: Nature of Genetic code, essential features of genetic code
4. Translation: Process of translation, post translational modifications, protein trafficking and sorting
5. Regulation of gene expression-Lac, Trp operons

IV. Text Books:

1. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Matsudaira, P. (2021). Molecular Cell Biology (9th ed.). W.H. Freeman.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2019). Molecular Biology of the Cell (6th ed.). Garland Science.
3. Karp, G. (2021). Cell and Molecular Biology: Concepts and Experiments (9th ed.). Wiley.
4. De Robertis, E. D. P., & De Robertis, E. M. F. (2006). Cell and Molecular Biology (8th ed.). Lippincott Williams & Wilkins.
5. Cooper, G. M., & Hausman, R. E. (2019). The Cell: A Molecular Approach (8th ed.). Oxford University Press.
6. Verma, P. S., & Agarwal, V. K. (2020). Cell Biology. S. Chand & Company Ltd.

V. Reference Books:

1. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2020). Lewin's Genes XII (12th ed.). Jones & Bartlett Learning.
2. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). Molecular Biology of the Gene (7th ed.). Pearson Education.
3. Pollard, T. D., Earnshaw, W. C., & Lippincott-Schwartz, J. (2017). Cell Biology (3rd ed.). Elsevier.
4. Kleinsmith, L. J. (1995). Principles of Cell and Molecular Biology (2nd ed.).
5. HarperCollins College Publishers.
6. Robert H. Tamarin (2002) Principles of Genetics, Tata McGraw –Hill Publishing Company Limited, New Delhi.
7. Gardner, E.J., M. J. Simmons & D.P. Snustad (2004) Principles of Genetics, John Wiley & Sons Inc., New York
8. Micklos, D.A., G.A. Freyer & D.A. Cotty (2005) DNA Science: A First Course, I.K.International Pvt. Ltd., New Delhi

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Group discussion on different types of cells and their components.
Evaluation method: Identifying the best group or performer and giving a reward.
Unit-2: Activity: Making nucleosome model
Evaluation method: Selecting the best and assigning a grade.
Unit-3: Activity: Observation of cell division in online root tip
Evaluation method: Selecting the best for any stage of cell division.
Unit-4: Activity: Making models of nucleic acids.
Evaluation method: Selecting the best and assigning a grade.
Unit-4: Activity: Making model for operons
Evaluation method: Selecting the best and assigning a grade.

SEMESTER-IV

COURSE 8: CELL AND MOLECULAR BIOLOGY

Practical **Credits: 1** **2 hrs/week**

I Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Identify the stages of mitotic and meiotic cell divisions.
2. Infer the structure and functions of nucleic acids.

II Laboratory/field exercises:

1. Study of ultra structure of a plant cell and its organelles using lectron microscopic photographs /models.
2. Demonstration of mitosis in *Allium cepa/Aloe vera* roots using squash technique.
3. Observation of various stages of mitosis in permanent slides.
4. Demonstration of meiosis in P.M.C.s of *Allium cepa* flower buds using squash technique.
5. Observation of various stages of meiosis in permanent slides.
6. Study of structure of DNA and RNA molecules using models.

SEMESTER-IV

COURSE 9: GENETICS AND PLANT BREEDING

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has:

1. To look into the ultra-structure of plant cell and its organelle
2. To know the morphology and functions of chromosomes
3. To understand the principles of genetics, structure and functions of gene

II. Learning Outcomes: On completion of this course students will be able to:

1. Sketch the ultra-structural aspects of plant cell and its components.
2. Hypothesise the role of chromosomes in inheritance.
3. Justify the role of genes in inheritance of characters by descent.
4. Correlate the functions of the nucleic acid with their structure.
5. Explain the discoveries led to understand the fine structure of a gene.

III. Syllabus of Theory:

Unit-1: Mendelian and non-Mendelian Genetics **10 Hrs.**

1. Mendel's laws of inheritance- Law of Dominance, Law of segregation, and Law of independent assortment, Test cross and back cross.
2. Incomplete dominance and co-dominance; Multiple allelism.
3. Complementary, supplementary and duplicate gene interactions (plant-based examples are to be dealt).
4. Gene and alleles: Classical, and modern concepts of gene, structure of a gene

Unit-2: Linkage and crossing over **9 Hrs.**

1. Linkage: Coupling phase and repulsive phase, chromosomal theory of linkage and kinds of linkage
2. Crossing over: Mechanism of crossing over, theories of crossing over, tetrad analysis
3. Construction of chromosomal maps: 2 point and 3 point test cross.

Unit-3: Mutations **9 Hrs.**

1. Mutation: Types of mutations, mutagens. Gene mutations and types.
2. Chromosomal aberrations-variation in chromosomal number and structure.
3. Transposons: types, structure and mechanism of transposition.

Unit-4: Basic concepts of plant breeding **8 Hrs.**

1. Definition, aim, objectives and scope of plant breeding; concepts in plant breeding: genetic variation, heritability, and selection
2. Self-incompatibility in plants – Definition, heteromorphic and homomorphic systems; exploitation of self-incompatibility in hybrid production.
3. Male sterility- Genetic, cytoplasmic and cytoplasmic-genetic sterility, utilization in plant breeding.

Unit-5: Breeding methods in plants **9 Hrs.**

1. Plant introduction-objectives plant introduction agencies in India, procedure, merits and demerits
2. Selection-natural and artificial selection; pureline, clonal and mass selection, advantages, disadvantages and achievements
3. Hybridization-objectives, procedure, advantages, disadvantages and achievements, Heterosis.
4. Mutational breeding –method, advantages, limitations and achievements
5. DNA markers and their applications in plant breeding: RFLP, RAPD

IV. Text Books:

1. Griffiths, A. J. F., Wessler, S. R., Carroll, S. B., & Doebley, J. (2020). Introduction to Genetic Analysis (12th ed.). W. H. Freeman and Company.
2. Snustad, D. P., & Simmons, M. J. (2019). Principles of Genetics (7th ed.). Wiley.
3. Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2022). Concepts of Genetics (12th ed.). Pearson Education.
4. Acquaah, G. (2021). Principles of Plant Genetics and Breeding (3rd ed.). Wiley-Blackwell.
5. Singh, B. D. (2020). Plant Breeding: Principles and Methods (11th ed.). Kalyani Publishers.
6. Allard, R. W. (1999). Principles of Plant Breeding (2nd ed.). Wiley.

V. Reference Books:

1. Hartl, D. L., & Ruvolo, M. (2020). Genetics: Analysis of Genes and Genomes (9th ed.). Jones & Bartlett Learning.
2. Strickberger, M. W. (2012). Genetics (3rd ed.). PHI Learning Pvt. Ltd.
3. Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2006). Principles of Genetics (8th ed.). Wiley India Pvt. Ltd.
4. Chaudhari, H. K. (2022). Elementary Principles of Plant Breeding (Oxford & IBH).
5. Sharma, J. R. (2015). Principles and Practice of Plant Breeding. Tata McGraw-Hill Education.
6. Jain, H. K., & Kharkwal, M. C. (Eds.). (2004). Plant Breeding: Mendelian to Molecular Approaches. Narosa Publishing House.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Solving the problems on classical genetics.
Evaluation method: Assessing the accuracy in solving the problems and awarding a grade.
Unit-2: Activity: Construction of chromosomal maps
Evaluation method: Selecting the best and assigning a grade.
Unit-3: Activity: Hands on activity of making models for chromosomal aberrations
Evaluation method: Selecting the best and assigning a grade.
Unit-4: Activity: Field trip to an agriculture or a horticulture research station to learn hybridization techniques.
Evaluation method: Active participation and learning skills on production of hybrid plants.
Unit-5: Activity: Case studies of modern applications of molecular techniques in crop improvement.
Evaluation method: Based on a rubric with specified criteria and performance levels of the learner.

SEMESTER-IV

COURSE 9: GENETICS AND PLANT BREEDING

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Apply Mendelian principles to solve genetic problems and analyze segregation and independent assortment using monohybrid and dihybrid crosses.
2. Conduct experiments to determine linkage, recombination, and gene mapping using test cross and three-point test cross data.
3. Perform emasculation and artificial hybridization techniques in self-pollinated and cross- pollinated crops.

II. Laboratory/field exercises:

1. Solving problems on monohybrid, dihybrid, back and test crosses.
2. Solving problems on gene interactions (at least one problem for each of the gene interactions in the syllabus).
3. Chromosomes mapping using problems of 3- point test cross data.
4. Floral biology in a self and a cross pollinated plant species.
5. Practicing emasculation technique.
6. Practicing selfing and crossing techniques.

SEMESTER-IV

COURSE 10: PLANT PHYSIOLOGY AND METABOLOSM

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has to:

1. Understand the concept of Soil-Plant-Atmosphere continuum based on plant-water relations.
2. Discuss the anabolic and catabolic processes in plants.
3. Explain the role of plant growth regulators on growth, development and flowering.

II. Learning Outcomes: On successful completion of this course, the students will be able to:

1. Comprehend the importance of water in plant life and mechanisms for transport of water and solutes in plants.
2. Explain the role of minerals in plant nutrition and their deficiency symptoms.
3. Hypothesize the light reactions and carbon assimilation processes responsible for synthesis of food in plants.
4. Analyze the biochemical reactions in relation to Nitrogen and lipid metabolisms.
5. Evaluate the physiological factors that regulate growth, development and flowering in plants.

III. Syllabus of Theory:

Unit – 1: Plant-Water relations **8 Hrs.**

1. Importance of water to plant life, physical properties of water, diffusion, imbibition, osmosis. water potential, osmotic potential, pressure potential.
2. Absorption and lateral transport of water; Ascent of sap
3. Transpiration: stomata structure and mechanism of stomatal movements (K^+ ion flux).
4. Mechanism of phloem transport; source-sink relationships.

Unit – 2: Mineral nutrition, Enzymes and Respiration **10 Hrs.**

1. Essential macro and micro mineral nutrients and their role in plants; symptoms of mineral deficiency
2. Absorption of mineral ions; passive and active processes.
3. Characteristics, nomenclature and classification of Enzymes. Mechanism of enzyme action, enzyme kinetics.
4. Respiration: Aerobic and Anaerobic; Glycolysis, Krebs cycle; electron transport system, mechanism of oxidative phosphorylation, Pentose Phosphate Pathway (HMP shunt).

Unit – 3: Photosynthesis and Photorespiration **10 Hrs.**

1. Photosynthesis: Photosynthetic pigments, absorption and action spectra; Red drop and Emerson enhancement effect
2. Concept of two photosystems; mechanism of photosynthetic electron transport and evolution of oxygen; photophosphorylation
3. Carbon assimilation pathways (C3, C4 and CAM).
4. Photorespiration - C2 pathway

Unit – 4: Nitrogen and lipid metabolism **9 Hrs.**

1. Nitrogen metabolism: Biological nitrogen fixation – asymbiotic and symbiotic nitrogen fixing organisms. Nitrogenase enzyme system.
2. Lipid metabolism: Classification of Plant lipids, saturated and unsaturated fatty acids.
3. Anabolism of triglycerides, β-oxidation of fatty acids, Glyoxylate cycle.

Unit – 5: Plant growth - development **8Hrs.**

1. Growth and Development: Definition, phases and kinetics of growth.
2. Physiological effects of Plant Growth Regulators (PGRs) - auxins, gibberellins, cytokinins, ABA, ethylene and brassinosteroids.
3. Physiology of flowering:Photoperiodism, role of phytochrome in flowering.
4. Seed germination and senescence; physiological changes during seed germination.

IV. Text Books:

1. Pandey, B.P. (2013) College Botany, Volume-III, S. Chand Publishing, New Delhi
2. Ghosh, A. K., K. Bhattacharya &G. Hait (2011) A Text Book of Botany, VolumeIII, New Central Book Agency Pvt. Ltd., Kolkata

V. Reference Books:

1. Hans Mohr & P. Schopfer (2006) Plant Physiology, Springer (India) Pvt. Ltd.,New Delhi
2. Hopkins, W.G. & N.P.A. Huner (2014) Introduction to Plant Physiology, Wiley India Pvt. Ltd., New Delhi
3. Noggle Ray & J. Fritz (2013) Introductory Plant Physiology, Prentice Hall (India),New Delhi
4. Salisbury, Frank B. & Cleon W. Ross (2007) Plant Physiology, Thomsen & Wadsworth, Austalia&U.S.A
5. Taiz, L.&E. Zeiger (2003) Plant Physiology, Panima Publishers, New Delhi.
6. Verma, V. (2007) Text Book of Plant Physiology, Ane Books India, New Delhi.

VI. Suggested activities and evaluation method

Unit-1: Activity: Observe and tabulate the water content of different plant parts and justify the importance of the water based on the morphological nature.
Evaluation method: Assess the report and assign the grade points based on a rubric.

Unit-2 Activity: Survey report on various inorganic and organic fertilizers available in the local markets.
Evaluation method: Assess the record and award the grades on a specified point scale.

Unit-3 Activity: Identify the C4 plants from their locality and make a report.
Evaluation method: Assessing the clarity, organization, and effectiveness of the report's presentation and communication based on a rubric**.**

Unit-4 Activity: Group discussion on various Nitrogen fixing microbes. **Evaluation method:** Assessing the group members' ability to think critically and analyze the topic being discussed.

Unit-5 Activity: A critical assignment on photoperiodic responses in plants in their locality.
Evaluation method: Evaluating the logical coherence and reasoning in the assignment.

SEMESTER-IV

COURSE 10: PLANT PHYSIOLOGY AND METABOLISM

Practical **Credits: 1** **2 hrs/week**

I. Course outcomes: On successful completion of this practical course, students shall be able to:

1. Conduct lab and field experiments pertaining to plant physiology.
2. Estimate the quantities and qualitative expressions using experimental results and calculations
3. Interpret the factors responsible for growth and development in plants.

II. Laboratory/field exercises:
Major experiments:

1. Determination of osmotic potential of plant cell sap by plasmolytic method using *Rhoeo*/ *Tradescantia* leaves.
2. Calculation of stomatal index and stomatal frequency of a mesophyte, a hydrophyte and a xerophyte.
3. Determination of rate of transpiration using Cobalt chloride method / Ganong's potometer (at least for a dicot and a monocot).
4. Effect of temperature on membrane permeability by colorimetric method.
5. Study of mineral deficiency symptoms using plant material/photographs.
6. Demonstration of amylase enzyme activity and study the effect of substrate and Enzyme concentration.
7. Separation of chloroplast pigments using paper chromatography technique.
8. Demonstration of Polyphenol oxidase enzyme activity (Potato tuber or Apple fruit)
9. Anatomy of C3, C4 and CAM leaves.

Minor experiments:

1.Osmosis 2. Arc-auxonometer 3.Ascent of sap through xylem

SEMESTER-V

COURSE 11: PLANT BIOTECHNOLOGY

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has:

1. Understand the fundamental principles of plant biotechnology and genetic engineering.
2. Learn the techniques involved in plant tissue culture and genetic transformation.
3. Explore the molecular tools used in the manipulation of plant genomes.
4. Study the development and application of genetically modified (GM) crops.

II. Learning Outcomes: On completion of this course students will be able to:

1. Explain the basic principles of plant molecular biology, tissue culture, and genetic engineering.
2. Explain the principles of plant tissue culture, including totipotency, differentiation, and aseptic techniques.
3. Perform basic techniques such as Agrobacterium-mediated transformation, PCR
4. Discuss the use of biotechnology in crop improvement (e.g., pest resistance, herbicide tolerance, stress resistance, nutritional enhancement).

III. Syllabus of Theory:

Unit-1: Basic concepts & techniques in Plant Tissue culture 10 Hrs.

1. Plant tissue culture: Definition, scope and significance; Concept of totipotency, differentiation, dedifferentiation and redifferentiation, explant and callus
2. Infrastructure and equipment required to establish a tissue culture lab
3. Nutrition medium: Preparation media, composition, inorganic nutrients, Carbon and energy source, Vitamins, Growth regulators, Organic supplements, Gelling agent and types of media
4. Sterilization techniques: Steam sterilization, Dry sterilization, Filter sterilization, Ultra violet sterilization, Alcohol sterilization, Flame sterilization and chemical sterilization.

Unit-2: Culture techniques 10 Hrs.

1. Types of cultures: Meristem culture, embryo culture, anther culture.
2. Protoplast isolation and fusion: Enzymatic and mechanical methods of isolation; Protoplast fusion- Spontaneous, induced methods- treatment with sodium nitrate, Calcium ions at high pH, Polyethylene glycol method, Electrofusion.
3. Somatic embryogenesis, synthetic seeds and their applications.
4. Somaclonal variations and their applications.

Unit-3: Genetic Engineering 8Hrs.

1. Introduction, outlines of genetic engineering
2. Cutting and joining DNA Molecules: Enzymes for cutting: Restriction endonucleases-Type I, II, III, ligages, Linkers and adaptors, restriction modification
3. Gene cloning vectors: characteristics, natural and artificial vectors (pBR322, pUC18)
4. Gene cloning :c DNA cloning, genomic cloning, PCR mediated gene cloning
5. Genomic libraries: Construction of genomic and c-DNA libraries, screening of DNA libraries to obtain gene of interest by Complementation technique, colony hybridization.

Unit-4: Methods of gene transfer **10Hrs**

1. Agrobacterium mediated gene transfer
2. Physical methods of gene transfer: Electroporation, Microinjection, Micro projectile bombardment
3. Chemical method of gene transfer: PEG mediated gene transfer, Calcium phosphate co-precipitation
4. Selection of transgenics-selectable markers, reporter genes

Unit-5: Applications of Genetic engineering **7 Hrs.**

1. Transgenic plants-Herbicide resistance(glyphosphate), insect resistance (alpha amylase inhibitor, Bt-toxin gene),virus resistance(coat protein mediated, nucleocapsid gene), disease resistance (antifungal proteins and PR proteins)
2. Value addition: Quality improvement (Golden rice), Shelf life-enhancement (Flavr- savr tomato).
3. Biofortification and genetically modified foods.
4. Plant vaccines, Biodegradable plastics

IV. Text Books:

1. Chawla, H. S. (2010).Introduction to Plant Biotechnology (3rd ed.) Oxford & IBH Publishing, 2010.
2. Slater, A., Scott, N., & Fowler, M. (2008). Plant Biotechnology: The Genetic Manipulation of Plants (2nd ed.) Oxford University Press.
3. Singh, B. D. Biotechnology (2020) Expanding Horizons (5th ed.) Kalyani Publishers.
4. Dubey, R. C.(2014) A Textbook of Biotechnology (Revised ed.) S. Chand Publishing.

V. Reference Books:

1. Christou, P., & Klee, H. J. (Eds.) *Handbook of Plant Biotechnology* (Vol. 1 & 2) John Wiley & Sons, 2004.
2. Bhojwani, S. S., & Razdan, M. K (1996). *Plant Tissue Culture: Theory and Practice* Elsevier, 1996.
3. Heldt, H. W., & Piechulla, B (2021). *Plant Biochemistry* (5th ed.) Academic Press.
4. George, E. F., Hall, M. A., & De Klerk, G. J.(2008). *Plant Propagation by Tissue Culture* (Vol. 1 & 2) Springer

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Preparation of media for tissue culture.
Evaluation method: Assessment of skill in preparation of media in an effective manner.
Unit-2: Activity: Group discussion on various tissue culture practices.
Evaluation method: Active participation, critical thinking, content presentation, collaboration skills etc., based on a rubric.
Unit-3: Activity: Making a model of artificial chromosomes
Evaluation method: Awarding grade based on skills performed in making a model
Unit-4: Activity: Group discussion on gene transfer methods
Evaluation method: Active participation, critical thinking, content presentation, collaboration skills etc., based on a rubric.
Unit-5: Activity: Collection of scientific literature on various transgenic plants developed.
Evaluation method: Assess credibility and relevance of literature collected, analysis and conclusions made.

SEMESTER-V

COURSE 11: PLANT BIOTECHNOLOGY

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: **On successful completion of this practical course, student shall be able to:**

1. Operate all the equipment and instruments in a plant tissue culture laboratory.
2. Establish callus and organ culture.
3. Obtain quality plants using micro-propagation techniques.

II. Laboratory/field exercises:

1. Equipment used in plant tissue culture.
2. Sterilization techniques in plant tissue culture laboratory.
3. Preparation of culture media
4. Demonstration of protoplast culture.
5. Demonstration of organ cultures.
6. Isolation of Plasmid DNA
7. Study of gene transfer methods through photographs: Electroporation, Microinjection, Micro projectile bombardment
8. Study of transgenic plants through photographs: Bt Cotton, Golden Rice, Flavr savr tomato

SEMESTER-V

COURSE 12 A: ETHNOBOTANY AND PHYTOMEDICINE

Theory **Credits: 3** **3 hrs/week**

I. Learning objectives: By the end of this course the learner has to:

1. Understand basic concepts of ethnobotany with emphasis on plant-human interactions.
2. Discuss about the indigenous plants used by ethnic people.
3. Get familiarity with scientific methods of collecting data in ethnobotany.
4. Explain about plants used in making phytomedicines.
5. Discuss the techniques to screen the phytomedicines.

II. Course outcomes: On completion of this course students will be able to:

1. Infer the traditional knowledge among ethnic groups in utilizing plants.
2. Assess and determine the medicinal value of plants used by ethnic groups.
3. Take part in a ehnobotanical survey using standard methods.
4. Evaluate phytomedicines used for drug development.
5. Test the efficacy of phytomedicines using various techniques.

III. Theory syllabus

Unit –1: Introduction to Ethnobotany **10 Hrs.**

1. Ethnobotany- definition, concept, scope and objectives; ethnobotany as an interdisciplinary science; the relevance of ethnobotany in the present context.
2. Major and minor ethnic groups - tribals of India and Andhra Pradesh, and their life styles.
3. Plants used by ethnic groups as food, medicines, beverages, fodder, fibre, resins, oils, fragrances and other uses.

Unit-2: Role of ethnobotany in modern Medicine **10 Hrs.**

1. Role of ethnobotany in modern medicine with special reference to *Rauvolfia sepentina, Trichopus zeylanicus, Artemisia annua, Withania somnifera*
2. Medico-ethnobotanical sources in India : Ancient Indian scriptures; CCRAS (Central Council for Research in Ayurvedic Sciences)
3. Significance of *Azadirachta indica, Vitex negundo, Curcuma longa, Tribulus terrestris* and *Senna auriculata* in ethno botanical practices (along with their habitat and morphology)

Unit-3: Data collection in Ethnobotany **9 Hrs.**

1. A brief account of data collection methods in Ethnobotany.
2. Authentication of plant species (Field Book, Herbarium), field and lab procedures, preparation of data Sheet and data base; Peoples Biodiversity Register (PBR).
3. Impact of Ethnobotany in herbal-medicine industry, land-use development, agriculture, forestry, betterment of rural livelihoods and education.

Unit-4: Concepts of Phytomedicine **8 Hrs.**

1. History of phytomedicine; taxonomy, morphology and ecology of medicinal plants: a botanical perspective; economic value of phytomedicnes.
2. Bioactive compounds in phytomedicine; role of plant-derived compounds in drug development.

3. Recent developments in drug discovery from plants; examples of plant-derived compounds currently involved in clinical trials; India contribution in phytomedicine.

Unit -5: Screening of phytomedicine **8 Hrs.**

1. Application of phytomedicine in modern drug development; phyto-complexes versus single-entity drug, bioavailability issue.
2. Drug delivery system for herbal-based therapeutics; Reverse pharmacology approach for Phytomedicine development.
3. Methods for testing the anti-microbial, anti-cancer, anti-HIV, anti-diabetic, and neuroprotective activities of plant extracts.

IV. Text Books

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2. Glimpses of Indian. Ethnobotany, Oxford and I B H, New Delhi – 1981.
3. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
4. S.K. Jain, 1990. Contributions of Indian ethnobotny.Scientific publishers, Jodhpur.
5. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
6. Rama Rao, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.

V. References

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.
3. Pal, D.C. & Jain, S.K., 1998. Tribal Medicine. Naya Prakash Publishers,Calcutta
4. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol.1, Today& Tomorrow's printers and publishers, New Delhi

VI. Suggested Activities:

Unit-1: Activity: Collection of data on plants utilized by ethnic people for various purposes and making a document.
Evaluation method: Assessing the quality of the data based on a rubric and awarding grade.

Unit-2: Activity: Collecting different medicinally important plants and making a herbarium.
Evaluation method: Grading can be given based on authentication of specimens collected.

Unit-3: Activity: Field visit to a place of ethnic groups and making a document using data recorded.
Evaluation method: Assign grade based on the evidences along with document submitted.

Unit-4: Activity: Collecting literature on drugs developed based on phytomedicines used by ethnic people.
Evaluation method: Assessment of the number of articles collected and their quality**.**

Unit-5: Activity: Visit to a laboratory or industry making phytomedicines.
Evaluation method: Grade has to give based on participation and observations submitted.

SEMESTER-V

COURSE 12 A: ETHNOBOTANY AND PHYTOMEDICINE

Practical **Credits: 1** **2 hrs/week**

I Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Collect data from ethnic people based on the knowledge of theory course.
2. Identify the plants used by ethnic people in the field and institutional herbarium.
3. Perform various assays to determine the potential of herbal drugs.

II Laboratory/Field exercises:

1. Survey, document and frame hypothesis on people-plant relationship in a tribal settlement.
2. Review of a Peoples Biodiversity Register (PBR) in collaboration with BMC of a local self-government.
3. Collection, processing and preservation of ethnobotanical specimens in the institutional repository.
4. Identify and document plant parts used in preparation of crude drugs/herbal formulations.
5. Demonstration of antimicrobial activity of herbal drug of by disc diffusion method.
6. Estimation of antioxidant activity of a herbal drug.
7. Testing of cytotoxicity of herbal drug using web resources.

SEMESTER-V

COURSE 12 B: BIOINSTRUMENTATION TECHNIQUES

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has to:
1. Explain the centrifugation techniques and their significance.
2. Discuss different types of microscopic techniques.
3. Understand various types of chromatography techniques.
4. Tell about electrophoretic techniques for specified purposes.
5. Discuss various spectroscopic techniques used in biological sciences.

II. Course Outcomes: On completion of this course students will be able to:
1. Make use of pH meter and centrifuge during practical.
2. Observe and identify plant samples using different microscopes.
3. Test plant samples using different chromatography techniques.
4. Utilize electrophoretic techniques to characterize given plant sample.
5. Determine composition, structure and properties of plant samples using spectroscopy.

III. Theory Syllabus:

Unit-1: Basic laboratory techniques **10 Hrs.**

1. Biosafety measures in laboratories: General safety measures, personal protection, chemical and biological hazards, spillage and waste disposal, first aid.
2. Theory, principle, working and applications of: pH meter and Laminar Air Flow.
3. Centrifuge machine types and centrifugation: Differential, Rate zonal, Density gradient, Rotor types and Ultra centrifugation.

Unit -2: Microscopic techniques **11 Hrs.**

1. Bright field Microscopy: Objectives, eyepiece, condenser; characteristics of lenses- resolution, magnification, numerical aperture, focal length, working distance, depth of focus.
2. Theory, principle, apparatus, methods and applications of: Dark Field Microscopy, Phase Contrast, Fluorescence Microscopy, Electron Microscopy: TEM and SEM

Unit- 3: Chromatography techniques **8 Hrs.**

1. Theory, principle, apparatus, methods and applications of: Paper chromatography, Soxhlet extraction, Thin Layer Chromatography (TLC), High-Performance Liquid Chromatography (HPLC), Gas Chromatography (GC).

Unit -4: Electrophoretic techniques **8 Hrs.**

1. Theory, principle, apparatus, methods and applications of: Paper Electrophoresis, Agarose gel electrophoresis, Poly Acrylamide Gel Electrophoresis (PAGE), SDS-PAGE.

Unit-5: Spectroscopic techniques **8 Hrs.**

1. Principle, working, instrumentation and applications of: Colorimetry, Flame photometry, Visible spectrophotometry, UV/Vis spectrophotometry, Fourier Transform Infrared Spectroscopy (FTIR).

IV. Textbooks:

1. Veerakumari, L. (2015) Bioinstrumentation, MJP Publishers, Chennai

2. Avinash Mancharkar, Ashok Jadhavar and Ashok Jadhav (2020) Bioinstrumentation, Vision Publications, Pune

V. Reference books:

1. Dr. Priyanka Pandey (2023) Text Book on Bioinstrumentation. Walnut Publication

2. John Enderle (2007) Bioinstrumentation (Synthesis Lectures) Springer

VI. Suggested Activities:

Unit-1: Activity: Handling centrifuges and separation of samples using them.

Evaluation method: Grading has to be done based on performance.

Unit-2: Activity: Group discussion on various types of microscopic techniques.

Evaluation method: Assigning a grade to the active participant based on a rubric.

Unit-3: Activity: Separation of biomolecules using a chromatography technique.

Evaluation method: Skills performed are to be assessed to award a grade.

Unit-4: Activity: Characterization of a sample using a spectroscopy technique.

Evaluation method: Skills of the students are to be observed for assigning a grade.

Unit-5: Activity: Visit to a research laboratory to observe advanced spectroscopic techniques.

Evaluation method: Observation report submitted has to be assessed.

SEMESTER-V

COURSE 12 B: BIOINSTRUMENTATION TECHNIQUES

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Perform skills related to centrifugation and microscopy.
2. Perform skill of using chromatography and electrophoresis techniques.
3. Handle the spectroscopic instruments.

II. Laboratory/Field exercises:

1. Determination of pH of biological samples using pH meter
2. Demonstration of fractionation of a plant sample using centrifugation.
3. Observation of plant samples/slides using different microscopes.
4. Paper chromatography for chlorophyll/amino acid separation
5. Thin layer chromatography (TLC) for lipid separation
6. Demonstration of colorimetry for a plant sample.
7. SDS-PAGE for protein separation

SEMESTER-V

COURSE 12 C: CONCEPTS OF HORTICULTURE

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has to:
1. Discuss about the significance and branches of Horticulture.
2. Understand the potential of Horticulture sector in India and abroad.
3. Explain the characteristics of soil as an essential medium for horticultural plants.
4. Discuss various types of horticultural gardens with their requirements and usages.
5. Understand the water and weed management practices in a horticultural garden.

II. Course outcomes: Students at the successful completion of the course will be able to:
1. Classify the horticultural plants based on different criteria.
2. Estimate and infer the value of horticultural plants from various perspectives.
3. Compile the characteristics of soil with respect to cultivation of plants.
4. Appraise the raising of different types of horticultural gardens based on specific needs.
5. Compile the weed and water management practices in horticultural gardens.

III. Theory syllabus

Unit -1: Scope and importance of Horticulture **10 Hrs.**

1. Horticulture: Definition, branches of Horticulture; value in terms of income/employment generation, industrial/religious value, export value, nutritional value, aesthetic value etc.
2. Classification of Horticultural crops: based on life cycle, nature of stem, season, ripening behaviour, light requirement, fruit type, edible portion, Botanical, growth habit, etc. with examples of fruit, vegetable, flower, spice and plantation crops.
3. Nutritive value of Horticultural crops- role and deficiency of vitamins and minerals, and their sources.

Unit -2: Horticulture-scenario **8 Hrs.**

1. Area and production, exports and imports of fruit and vegetables: Global, Indian and State scenario in major fruit and vegetable crops.
2. Fruit and vegetable zones of India and Andhra Pradesh.
3. Nursery techniques and their management: Bed preparation, growing media, methods of propagation- sexual, and asexual.

Unit -3: Concepts of Soil Science **10 Hrs.**

1. Soil types and properties (loamy, sandy, clayey soils).
2. Soil pH and its effect on plant growth.
3. Soil amendments and their role in fertility (organic and inorganic fertilizers).
4. Methods of fertilization (fertigation, foliar feeding).
5. Soil testing and its significance in horticulture.

Unit -4: Horticultural gardens **9 Hrs.**

1. Kitchen garden, market garden, truck garden, vegetable garden for processing, vegetable garden for seed production, vegetable forcing and floating vegetable garden.
2. Principles, planning, layout and management of orchards - points to be considered, features of orchard.

3. Planting systems and planting densities: Square, rectangle, diagonal, hexagonal, contour etc.
4. Pruning and training of fruit crops - Principles, objectives, types and methods.

Unit -5: Management practices in Horticultural gardens 8 Hrs.

1. Water management in horticultural crops - Role of water, methods of irrigation, merits and demerits.
2. Weed management in horticultural crops- Definition, methods of weed control in horticultural crops.
3. Cropping systems in Horticultural crops - Types, advantages, cropping systems, intercropping, multi-tier cropping.

IV. Textbooks:

1. Goh, M. K., and Tan, K. C. *Principles of Horticulture* 5th Edition, Oxford: Butterworth-Heinemann, 2009.
2. Purseglove, J. W. *Tropical Crops: Monocotyledons* Vol. 1, London: Longman Group Ltd, 1972.
3. Hessayon, D. G. *The New Vegetable & Herb Expert* London: Expert Books, 1998.
4. Bose, T. K., and Yadav, L. P. *Tropical Horticulture* New Delhi: Naya Prakash, 2002.
5. Kumar, V., and Singh, B. *Introductory Horticulture* New Delhi: Kalyani Publishers, 2007.

V. Reference Books:

1. Hale, M. G., and Ormrod, D. P. *Crop Production and Soil Management in Horticulture* New York: Wiley, 1999.
2. Thompson, J. F., and Larson, R. C. *Principles of Horticultural Practices* New York: Prentice Hall, 2002.
3. Wills, R. B. H., McGlasson, W. B., Graham, D., and Joyce, D. C. *Postharvest: An Introduction to the Physiology and Handling of Fruit and Vegetables* Sydney: UNSW Press, 2007.
4. Banting, E. C. *Practical Horticulture* 2nd Edition, New York: John Wiley & Sons, 1993.
5. Naidu, R. *Soil Science and Management in Horticulture* Chennai: Orient Longman, 2004.
6. McGraw-Hill *Landscape Design and Construction* New York: McGraw-Hill Education, 2006.

VI. Suggested Activities:

Unit-1: Activity: Identifying and classifying different horticultural plants.
Evaluation method: Grading based on perfection of the activity.
Unit-2: Activity: Preparation of nursery beds and raising a nursery.
Evaluation method: Skills of the learner are to be assessed.
Unit-3: Activity: Visit to a soil testing laboratory.
Evaluation method: Observation report submitted by the student has to be graded.
Unit-4: Activity: Designing and developing a horticultural garden.
Evaluation method: Skills of the student has to evaluated based on a rubric.
Unit-5: Activity: A study report on various management practices in a horticultural field.
Evaluation method: Grading based on quality of the report submitted.

SEMESTER-V

COURSE 12 C: CONCEPTS OF HORTICULTURE

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: Students at the successful completion of the course will be able to:

1. Handle the the tools and equipment used in horticultural firms.
2. Identify the horticultural plants and grow them in college campus.
3. Acquire managerial skills on handling horticultural garden.

II. Laboratory/Field exercises:

1. Study of Horticultural tools and equipment
2. Identification of different horticultural plants.
3. Pruning and training techniques.
4. Soil sampling and analysis.
5. Crop rotation and intercropping practices.
6. Identification of weeds in horticultural gardens.
7. Study of irrigation methods in horticultural gardens.
8. Visit to a local horticultural firm.

SEMESTER-V

COURSE 13 A: TRADITIONAL SYSTEMS OF MEDICINE

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has to:

1. Understand various traditional systems of medicine and organizations working on them.
2. Explain the concepts of Ayurveda from philosophy to practices.
3. Discuss the diagnostic techniques and treatment methods in Siddha system of medicine.
4. Understand the practices and plants useful in Unani medicine.
5. Discuss about the Homeopathy and Naturopathy systems of medicine.

II. Course Outcomes: On completion of this course students will be able to:

1. Defend the significance of different traditional systems of medicine for human health care.
2. Judge the utilization of certain plants in preparation of Ayurveda formulations.
3. Recommend the Siddha system of medicine to keep up human health.
4. Interpret the use of some plants in making Unani medicines.
5. Justify the importance of Homeopathy and Naturopathy to cure ailments of human-beings.

III. Theory syllabus

Unit -1: Introduction to traditional medical systems **7 Hrs.**

1. Definition and scope of traditional medicine; historical context, emergence and evolution of traditional healing practices.
2. Overview of major traditional systems: Ayurveda, Siddha, Unani, Homeopathy, Naturopathy and Yoga. Ministry of AYUSH, national AYUSH mission; CCRAS, CCRUM and NIN
3. Role of traditional medicine in modern healthcare systems; globalization and WHO's traditional medicine strategy. Intellectual Property Rights (IPR) and Traditional Knowledge Digital Library (TKDL) related to traditional medicine.

Unit -2: Ayurveda **10 Hrs.**

1. Origin and history, goals of Ayurveda; philosophical foundations of Ayurveda (Panchamahabhutas, tridosha theory, dhatus (body tissues) and malas (waste products).
2. Ayurvedic diet and nutrition; diagnostic methods: Darshana, Sparshana, Prashna; treatment methods: shamana and shodhana.
3. Plants used in Ayurveda: *Withania somnifera, Emblica officinalis, Bacopa monnieri, Tinospora cordifolia, Terminalia chebula,* and *Terminalia arjuna*

Unit- 3: Siddha medicine **10 Hrs.**

1. Historical background and evolution; contributions of Siddhars; concept of macrocosm and microcosm; elements of human composition; three humors (Mukkutram) – vali, azhal, and iyyam. concept of Uyir Thathukkal.
2. Diagnostic techniques and treatment modalities in Siddha medicine; Siddha in contemporary health treatments.
3. Plants used in Siddha medicine: *Andrographis paniculata, Adhatoda vasica, Piper longum, Gymnema sylvestre, Boerhavia diffusa* and *Zingiber officinale*

Unit -4: Unani Medicine **10 Hrs.**

1. Origin and development of the Unani system; contributions of ancient scholars: Hippocrates, Galen, Avicenna (Ibn Sina), Al-Razi.; basic philosophy and principles: Concept of Tabi'at, four elements (Arkan), four humors (Akhlat) and temperament (Mizaj).
2. Diagnostic methods and principles of treatment in Unani medicine.
3. Plants used in Unani medicine: *Glycyrrhiza glabra, Aloe vera, Curcuma longa, Acorus calamus, Trigonella foenum-graecum* and *Commiphora wightii*

Unit 5: Homeopathy and Naturopathy **8 Hrs.**

1. Homeopathy-origin and history; fundamental principles of Homeopathy.
2. Remedy preparation; Materia Medica and Repertory; clinical applications and Homeopathy in practice.
3. Plants used in Homeopathy: *Aegle marmelos, Strychnos nux-vomica, Bryonia alba, Achyranthes aspera, Arnica montana* and *Caesalpinia bonducella*
4. A brief account of Naturopathy system of medicine.

IV. Textbooks:

1. Wujastyk, Dominik *The Roots of Ayurveda* New York: Penguin Books, 2003
2. Hassan, Syed Zafarul *Unani Medicine: A Brief Introduction* New Delhi: All India Unani Tibbi Conference, 2002.
3. Wane, M. L. R. H. M. *Healing Traditions: African Medicine, Culture, and the Politics of Health* New York: M. E. Sharpe, 2008.
4. Lad, Vasant *Fundamentals of Ayurveda: A Guide to Understanding Ayurvedic Medicine* Albuquerque: The Ayurvedic Press, 1995.

V. Reference Books:

1. Ni, Maoshing (Translator) *The Yellow Emperor's Classic of Medicine* New York: Shambhala, 1995.
2. Avicenna (Ibn Sina) *The Canon of Medicine (Al-Qanun fi al-Tibb)* Translated by Laleh Bakhtiar, New York: Great Neck Publishing, 1993.
3. Pole, Sebastian *Ayurvedic Medicine: The Principles of Traditional Practice* Edinburgh: Churchill Livingstone, 2006..
4. Rakel, David (Editor) *Integrative Medicine* 4th Edition, Philadelphia: Elsevier, 2018.
5. Lumsden, Mary Ann (Editor) *Traditional Medicine and Health Care Coverage: A Reader for Health Care Practitioners and Researchers* Geneva: World Health Organization, 2001.
6. Johnson, Bruce B. *Indigenous Healing: A Cross-Cultural History* London: Routledge, 2015.

VI. Suggested Activities:

Unit-1: Activity: Visit to any national or regional institute working on traditional medical systems.
Evaluation method: Assigning grade based on the report with observations made during the visit.
Unit-2: Activity: Visit to an Ayurveda hospital to study the diagnostic and treatment procedures.
Evaluation method: Assessment of document submitted based on a rubric.
Unit-3: Activity: A group discussion/quiz on the Siddha system of medicine and plants used.
Evaluation method: Grade has to be assigned to the members of active group.
Unit-4: Activity: Collection of plants used in Unani medicine and making a herbarium.
Evaluation method: Quality and number of herbarium sheets submitted are to be evaluated.
Unit-5: Activity: Visit to an Ayurveda hospital to study the diagnostic and treatment procedures.
Evaluation method: Assessment of document submitted based on a rubric.

SEMESTER-V

COURSE 13 A: TRADITIONAL SYSTEMS OF MEDICINE

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Identify various plants used in different systems of traditional medicine.
2. Perform analysis of the crude drugs prepared from plants.
3. Acquaint with the diagnosis and treatment of different traditional systems of medicine.

II. Laboratory/Field exercises:

1. Collection and identification of plants used in various traditional medicinal systems.
2. Preparation of crude drugs from the medicinal plants.
3. Demonstration of extraction methods for phytochemicals using web resources.
4. Chemical analysis of some phytomedicines using web resources.
5. Treatment protocols in different traditional systems of medicine.
6. Diagnostic methods in various traditional systems of medicine.
7. Documentation of symptoms associated with diseases of human beings by visiting hospitals.

SEMESTER-V

COURSE 13 B: PLANT GENETIC ENGINEERING

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has to:

1. Explain natural and modified restriction enzymes used in genetic engineering.
2. Discuss the characteristics of different vectors used in gene cloning.
3. Understand the methods for construction of DNA libraries.
4. Explain various techniques to create recombinant DNA.
5. Discuss the applications of genetic engineering in various fields to address the problems.

II. Course outcomes: Students at the successful completion of the course will be able to:

1. Appraise the role of restriction endonucleases in splicing of DNA molecule.
2. Choose appropriate vector for cloning the required gene.
3. Recommend the techniques for screening of recombinant DNA molecules.
4. Elaborate the techniques used in recombinant DNA technology.
5. Justify the role of genetic engineering in various fields with examples.

III. Syllabus of theory:

Unit-1: Tools in genetic engineering **8 Hrs.**

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-2: Gene cloning **10 Hrs.**

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, Cosmids, BACs), yeast (YACs, shuttle vectors), higher plants (Ti plasmid derivatives, caulimovirus)

Unit-3: DNA libraries **9 Hrs.**

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; DNA microarrays.

Unit-4: Techniques in rDNA technology **10 Hrs.**

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-5: Applications of genetic engineering **8 Hrs.**

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.

IV. Textbooks:

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

V. Reference Books:

1. John Hammond and Brian G. Atkinson (2019) Plant Genetic Engineering, Springer,Cham, Switzerland
2. Trevor A. Thorpe (2005) Plant Genetic Engineering, Blackwell Publishing, Oxford, UK
3. C. Neal Stewart Jr. (2016) Plant Biotechnology and Genetics: Principles, Techniques, and Applications Wiley-Blackwell, Hoboken, NJ.
4. T. Gerats and J. H. A. Schell (2000) Genetic Engineering of Plants: An Agricultural Perspective Springer, Dordrecht.
5. S.K. Sopory and R.B. Fenton (2015) Plant Genetic Engineering Springer, Dordrecht.
6. J. Sambrook, E. Frisch and T. Maniatis (2000) Molecular Cloning: Laboratory manual, Cold Spring Harbor Laboratory Press New York.
7. M.K.Sateesh,Bioethics and Biosafety 2008 I K International Publishing House.
8. Goel and Parashar, IPR, Biosafety and Bioethics 1e Paperback-2013,Pears

VI. Suggested Activities:

Unit-1: Activity: Collection of literature on various enzymes used in genetic engineering.
Evaluation method: Assessing the quality of report based on a rubric.
Unit-2: Activity: Group discussion/quiz/JAM on vectors used in genetic engineering.
Evaluation method: Grade has to be given to best performing group/individual.
Unit-3: Activity: Making a report on DNA libraries using resources over the websites.
Evaluation method: Quality of the report has to be evaluated based on a rubric.
Unit-4: Activity: A seminar using power point on rDNA technology
Evaluation method: The performance and quality of PPT has to be evaluated.
Unit-5: Activity: Collection of literature on application of genetic engineering in various fields.
Evaluation method: Assessing the quality of report based on a rubric.

SEMESTER-V

COURSE 13 B: PLANT GENETIC ENGINEERING

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: Students at the successful completion of the course will be able to:

1. perform techniques of DNA isolation, gel electrophoresis, and gene transformation in plants.
2. demonstrate the ability to analyze genetically modified plants using molecular tools like PCR and marker analysis.
3. understand the biosafety, and ethical guidelines related to genetic engineering experiments.

II. Laboratory/Field exercises:

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.

SEMESTER-V

COURSE 13 C: GARDENING AND LANDSCAPING

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has to:
1. Summarize the elements of gardening.
2. Explain the routine operations in a garden
3. Discuss the common pests and diseases of garden plants.
4. Name the famous gardens in India and abroad.
5. Explain about landscape designs of public places.

II. Course Outcomes: Students at the successful completion of the course will be able to:
1. Elaborate the principles of garden design with examples.
2. Decide the necessary operations for garden maintenance.
3. Formulate best practices for management of gardens.
4. Design and develop a landscape for garden with various elements.
5. Create an aesthetic landscape for a public place with the knowledge and skills acquired.

III. Syllabus of theory:

Unit-1: Introduction to gardening **10 Hrs.**

1. Gardening: Definition, history, scope and aesthetic values; environmental benefits of gardening- carbon sequestration, pollinator support, microclimate control;
2. Principles of garden design: symmetry, balance, unity, rhythm, focal point, color harmony.
3. Types of gardens: formal, informal, botanical, landscape, rooftop, vertical, xeriscape.
4. Elements of garden design: paths, hedges, lawns, water features, statuary, lighting.

Unit-2: Procedures in gardening **9 Hrs.**

1. Site selection and landscape planning: soil, topography, climate, drainage, utilities.
2. Basic themes of gardens viz. circular, rectangular and diagonal themes.
3. Selection of plants for different garden types (herbaceous, woody, flowering, ornamental, medicinal).
4. Routine and seasonal operations for garden maintenance.

Unit-3: Management of gardens **10 Hrs.**

1. Herbal gardens, bonsai, terrariums and hydroponic gardens.
2. Indoor and rooftop gardening techniques; urban and therapeutic gardening.
3. Irrigation systems and water management; pest and disease management in gardens.
4. Waste management and sustainable gardening practices.

Unit-4: Introduction to landscaping **9 Hrs.**

1. Historical importance of Indian gardens, gardens of ancient world; Famous gardens of India and abroad.
2. Software tools in garden design (AutoCAD, SketchUp basics).
3. Elements of landscape gardens viz. tangible and intangible elements.
4. Bio-aesthetic planning -definition, objectives, planning and designing of home gardens, colonies, country planning, urban landscape.

Unit-5: Landscaping of Public places **7 Hrs.**

1. Development of institutional gardens, planning and planting of avenues, beautifying educational Institution, railway stations and air ports.
2. Gardens for places of religious importance viz. temples, churches, mosques, tombs etc.
3. Importance, features and establishment of English garden, Japanese gardens, Mughal, gardens, Hindu gardens and Buddhist gardens - principles and practice.

IV. Textbooks:

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

V. Reference books:

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

VI. Suggested Activities:

Unit-1: Activity: Seminar on various types of gardens and their requirements.

Evaluation method: Quality of presentation has to be assessed based on a rubric.

Unit-2: Activity: Group discussion/quiz on plants used in gardening.

Evaluation method: Best performing group/individual has to be graded.

Unit-3: Activity: Collection of data and submission of a report on management practices in gardens.

Evaluation method: Report has to be assessed based on a rubric.

Unit-4: Activity: Making a design of a garden landscape using software tools.

Evaluation method: Quality design is to be decided based on a rubric.

Unit-5: Activity: Collection of literature on various styles of gardens in the world.

Evaluation method: Report has to be evaluated based on quality.

SEMESTER-V

COURSE 13 C: GARDENING AND LANDSCAPING

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: Students at the successful completion of the course will be able to:

1. Identify suitable garden plants to grow at his/her home or college.
2. Design and develop a garden with the theoretical knowledge and practical skills acquired.
3. Perform management skills related to landscape gardening.

II. Laboratory/Field exercises:

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

SEMESTER-VI

COURSE 14 A: HERBAL TECHNOLOGY

Theory **Credits: 3** **3 hrs/week**

I. Learning objectives: By the end of this course the learner has to:

1. Explain about herbal medicines and their nutraceutical values.
2. Discuss the utilization of hebal medicines to cure human ailments.
3. Summarize the extraction and formulation of herbal medicines.
4. Explain the screening methods used for herbal medicines.
5. Illustrate the standardization methods for herbal medicines.

II. Course outcomes: On completion of this course students will be able to:

1. Appraise the utilization of herbal medicines by Indians.
2. Justify the significance of herbal medicines to cure health problems of human beings.
3. Determine the dosage of herbal medicines for human beings based on different criteria.
4. Design and develop a screening method for a given herbal drug.
5. Predict a standardization method for a given herbal medicine.

III. Syllabus of theory:

Unit-1: Introduction to Herbal medicines **8 Hrs.**

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. Classification of herbs and their taxonomy; herbs used as nutraceuticals and healing agents; herbal cosmetics, herbal pesticides.

Unit-2: Herbal medicines and excipients **10 Hrs.**

1. Herbal medicines for viral infections - Cold 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, Gymnema sylvestre*

Unit-3: Herbal extraction and formulation methods **10 Hrs.**

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 **9 Hrs.**

1. Pharmacological actions of herbal constituents, herb-drug interactions.
2. Anti-fertility agents, anti-diabetic drugs, antianginal drugs.
3. Cardiac glycosides, analgesic activity, antipyretic activity.
4. Legal and ethical considerations on dispensing herbal medicines.

Unit-5: Standardization of herbal drugs **8 Hrs.**

1. Importance of standardization, problems involved in the standardization of herbal drugs.
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.

IV. Text books:

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

V. Reference books:

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

VI. Suggested Activities:

Unit-1: Activity: A case study report on use of herbal medicine in their native place.
Evaluation method: Assigning grade based on the quality of the report.
Unit-2: Activity: Group discussion/quiz on herbal medicines used for various health problems of human beings.
Evaluation method: Grading can be done based on a rubric to best performing group.
Unit-3: Activity: Masking a report by collecting literature on extraction and formulation methods used for some herbal medicines.
Evaluation method: Assign grade to the individual who submit a quality report base on a rubric.
Unit-4: Activity: Visit to a research institute or firm working on herbal formulations to learn the screening methods.
Evaluation method: Grading based on the report submitted based on observations.
Unit-5: Activity: Collection of literature pertaining to standardization methods for herbal medicines.
Evaluation method: Grading can be done based on the quality of report submitted.

SEMESTER-VI

COURSE 14 A: HERBAL TECHNOLOGY

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Identify and classify medicinal plants used as herbal medicines.
2. Determine the basic chemical constituents of the herbal drugs.
3. Make some herbal formulations that can be used by humans.

II. Laboratory/Field exercises:

1. Taxonomic identification of medicinal plants used for herbal formulations.
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.

SEMESTER-VI

COURSE 14 B: BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

Theory **Credits: 3** **3 hrs/week**

I. Learning objectives: By the end of this course the learner has to:

1. Understand the fundamental concepts, and key data sources in bioinformatics.
2. Explain the secondary bioinformatics databases, data formats, organism-specific resources.
3. Discuss the principles and algorithms behind global and local pairwise sequence alignment.
4. Understand the interdisciplinary and distinctive nature of the computational biology.
5. Understand how biological sequences such as DNA and proteins are represented computationally.

II. Course Outcomes: On completion of this course students will be able to:

1. Select the appropriate primary database for his/her work on bioinformatics.
2. Identify and interpret standard biological data formats like FASTA and GenBank.
3. Evaluate global and local sequence alignments using appropriate algorithms and scoring matrices.
4. Construct phylogenetic trees, and critically assess computational approaches used in various fields of biology.
5. Apply basic statistical and probabilistic methods to interpret and analyze biological datasets.

III. Theory syllabus:

Unit-1: Primary data bases in Bioinformatics **9 Hrs.**

1. Bioinformatics: Definition history and scope; Interdisciplinary nature and applications.
2. Role of bioinformatics in modern biology, agriculture and medicine; types of biological data.
3. Primary databases: Nucleotide sequence databases (GenBank, EMBL); Protein Sequence Databases (UniProtKB, UniProt); Metagenomic and Environmental Sequences-UniMES.
4. Literature Databases- PubMed, PLos, BioMed Central.

Unit-2: Secondary data bases in Bioinformatics **10 Hrs.**

1. A brief account of secondary databases (PDB and BRENDA); Data formats: FASTA, GenBank format
2. Viral genome database (ICTV db), Bacterial Genome database (GOLD), Organism specific database (OMIM) and Genome Browsers (Ensembl, VEGA)
3. Bioinformatics Database search engines:-Text-based search engines (Entrez, LinkDB).

Unit-3: Tools in Bioinformatics **12 Hrs.**

1. Sequence alignment: Pairwise alignment; scoring matrices: PAM, BLOSUM
2. BLAST software including ALGORITHM of BLAST; Interpreting BLAST results.
3. Multiple Sequence Alignment (MSA): CLUSTALW, MUSCLE; applications in phylogenetics and functional prediction.
4. Gene prediction and annotation:ORF finding tools, Ab initio and evidence-based methods, AUGUSTUS, GENSCAN

Unit-4: Algorithms in Computational Biology **8 Hrs.**

1. Definition, scope, and distinction from bioinformatics; historical background and interdisciplinary nature;

2. Applications in systems biology, drug discovery, and genomics.
3. Sequence alignment algorithms: dynamic programming (Needleman-Wunsch, Smith-Waterman).
4. Hidden Markov Models (HMMs) in gene prediction; Phylogenetic tree construction (UPGMA, Neighbor-Joining).

Unit-5: Biological Data Modeling **6 Hrs.**

1. DNA and protein sequence representation.
2. Graph models in biology (gene networks, protein interactions).
3. Basic probability and statistics for biological data.

IV. Text books:

1. Lesk, A.M. 2002. Introduction to Bioinformatics, 1st Edn. Oxford University Press, Oxford, UK.
2. Momand, J. & McCurdy, M. 2017. Concepts in Bioinformatics and Genomics. Oxford University Press.
3. Claverie, J.M. & Notredame C. 2003 Bioinformatics for Dummies. Wiley Editor.
4. Choudhuri, S. 2014. Bioinformatics for Beginners. 1st Edition. Academic Press.
5. Jeremy, R. 2015. Bioinformatics: An Introduction. Springer Publishing Co.

V. Reference books:

1. Rocha, M. & Ferreira, P.G. 2018. Bioinformatics Algorithms: 1st Edition. Academic Press.
2. Xiong, J. 2007. Essential Bioinformatics, Cambridge University Press India, Pvt Ltd.
3. Higgs, P. G. 2005. Bioinformatics and Molecular Evolution, Ane Books India Pvt Ltd.
4. Evens, W.J. & Grant, G.R. 2005. Statistical Methods in Bioinformatics: An Introduction. Springer.
5. Mount, D.W. 2001. Bioinformatics – Sequence and Genome Analysis, 1st Edn, Cold Spring Harbor Laboratory Press, New York, USA.
6. Pierre Baldi & Soren Brunak. 2001. Bioinformatics: The Machine Learning Approach. 2nd Edition. The MIT Press

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Exploring bioinformatics repositories by small groups of students.
Evaluation Method: Grading based on team collaboration and participation.

Unit-1I: Activity: Identifying protein structures and enzyme functions using secondary databases.
Evaluation Method: Grading based on retrieval of data and making a clear presentation.

Unit-1II: Activity: Using NCBI BLAST to Identify Unknown DNA Sequence.
Evaluation Method: Correct use of BLAST and sequence input, and making a report with clarity.

Unit-1V: Activity: Build and interpret a phylogenetic tree using UPGMA and Neighbor-Joining methods.
Evaluation Method: Assessment of correct tree construction and Logical interpretation of tree topologies.

Unit-V: Activity: Constructing and analyzing a simple Gene Interaction Network.
Evaluation Method: Correct graph construction and labelling with biological interpretation of network patterns.

SEMESTER-VI

COURSE 14 B: BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Demonstrate proficiency in accessing and analyzing genomic and transcriptomic data using public databases and bioinformatics tools.
2. Apply sequencing data analysis techniques, including alignment, phylogenetic tree construction, and differential gene expression analysis using R-based tools.
3. Utilize programming libraries for biological data processing, visualization, and interpretation in genomics and transcriptomics research.

II. Laboratory/field exercises:

1. Databases: NCBI, UniProt
2. Downloading genome/transcriptome data.
3. Hands on experience with BLAST analysis on protein/DNA.
4. Phylogenetic tree building (MEGA, PhyML) .
5. Hands on experience with BEDTools, SAMtools.
6. Sequencing technologies: Illumina, Nanopore.
7. Differential expression using DESeq2 or edgeR (R/Bioconductor).
8. Study of Libraries: Biopython, pandas, matplotlib, Bioconductor packages.

SEMESTER-VI

COURSE 14 C: PLANT PROPAGATION TECHNIQUES

Theory **Credits: 3** **3 hrs/week**

I. Learning objectives: By the end of this course the learner has to:

1. Understand the fundamental principles of plant propagation.
2. Explain the concepts of apomixis and polyembryony, and their significance in Horticulture.
3. Understand the principles and methods of plant propagation by cuttings.
4. Discuss various types of layering techniques used for propagation of plants.
5. various grafting methods and budding techniques for effective plant propagation

II. Course Outcomes: On completion of this course students will be able to:

1. Explain and differentiate between sexual and asexual propagation methods.
2. Differentiate types of apomixis and polyembryony based on advantages and disadvantages.
3. Predict different cutting methods for plant propagation across various stem types.
4. Demonstrate the ability to apply air layering techniques effectively for propagation of woody trees.
5. Perform different grafting and budding techniques for plant propagation.

III. Theory syllabus:

Unit – 1: Basics of plant propagation **10 Hrs.**

1. Propagation: Definition, need and potentialities for plant multiplication; asexual and sexual methods of propagation - advantages and disadvantages.
2. Propagation facilities: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, phytotrons; nursery - tools and implements.
3. Identification and propagation by division and separation: Bulbs, pseudobulbs, corms, tubers and rhizomes; runners, stolons, suckers and offsets.

Unit – 2: Apomictics in plant propagation **8 Hrs.**

1. Apomixis: Definition, facultative and obligate; types – recurrent, non-recurrent, adventitious and vegetative; advantages and disadvantages.
2. Polyembryony: Definition, classification, horticultural significance; chimera and bud sport.
3. Propagation of mango, *Citrus* and *Allium* using apomictic embryos.

Unit – 3: Propagation by cuttings **10 Hrs.**

1. Cuttings: Definition, different methods of cuttings; root and leaf cuttings.
2. Stem cuttings: Definition of stem tip and section cuttings; plant propagation by herbaceous, soft wood, semi hard wood, hard wood and coniferous stem cuttings.
3. Physiological and bio chemical basis of rooting; factors influencing rooting of cuttings; use of plant growth regulators in rooting of cuttings.

Unit – 4: Propagation by layering **9 Hrs.**

1. Layering and layer: Definition, principle and factors influencing layering.
2. Plant propagation by layering: Ground layering – tip layering, simple layering, trench layering, mound (stool) layering and compound (serpentine layering).
3. Air layering technique – application in woody trees.

Unit –5: Propagation by grafting and budding **8 Hrs.**

1. Grafting: Definition, principle, types, graft incompatibility, collection of scion wood stick, scion-stock relationship, and their influences, bud wood certification; micrografting.
2. Propagation by veneer, whip, cleft, side and bark grafting techniques.
3. Budding: Definition; techniques of 'T', inverted 'T', patch and chip budding.

IV. Text books:

1. Sharma RR and Manish Srivastav.2004. Plant Propagation and Nursery Management International Book Distributing Co. Lucknow.
2. Sadhu, M.K. 1996. Plant Propagation. New Age International Publishers, New Delhi.

V. Reference books:

1. Prasad, V. M. and Balaji Vikram, 2018. Practical Manual on Fundamentals of Horticulture and Plant Propagation, Write & Print Publications, New Delhi
2. Upadhyay S. K. (Ed.) 2013. Practical Manual Basic Horticulture-I, Akashdeep Printers, New Delhi
3. Hartman, HT and Kester, D.E.1976. Plant Propagation: Principles and Practices, Prentice Hall of India Pvt. Ltd. Bombay.
4. Bal, J.S. (2014). Advances in Horticulture and Nursery Techniques. Kalyani Publishers.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Visit to Horticulture University/nursery to study the plant propagation structures.
Evaluation Method: Assess the quality of the observation report submitted.

Unit-1I: Activity: Group discussion/quiz on apomictics and polyembryony.
Evaluation Method: Grade assigned to best performing group based a rubric.

Unit-1II: Activity: Seminar on various types of cuttings used in propagation of plants.
Evaluation Method: Performance of the student has to be assess based on a rubric.

Unit-1V: Activity: Seminar with PPT on layering techniques in plants.
Evaluation Method: Performance of the student has to be assess based on a rubric.

Unit-V: Activity: Hands-on practice of whip grafting on potted rootstock.
Evaluation Method: Performance of the student has to be assess based on a rubric.

SEMESTER-VI

COURSE 14 C: PLANT PROPAGATION TECHNIQUES

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Demonstrate hands-on skills in both sexual and asexual propagation.

2. Propagate a plant species by identifying a suitable method.

3. Operate horticultural tools and implenets, and manage plant propagation structures.

II. Laboratory/field exercises:

1. Preparation of nursery beds – flat, raised and sunken beds.

2. Practicing propagation using apomictic embryos.

3. Practicing propagation by separation and division technique.

4. Practicing propagation by cuttings.

5. Practicing propagation by layering

6. Practicing propagation by grafting.

7. Practicing propagation by budding.

8. Preparation of potting mixture, potting and repotting.

9. Visit to a Horticulture University/ local nursery.

SEMESTER-VI

COURSE 15 A: PHARMACOGNOSY AND PHYTOCHEMISTRY

Theory **Credits: 3** **3 hrs/week**

I. Learning objectives: By the end of this course the learner has to:
1. Discuss the classification of drugs based on some criteria.
2. Explain the organoleptic and microscopic evaluation of herbals.
3. Summarize the secondary metabolites in plants and their anabolic pathways.
4. Explain the chemical nature and therapeutic uses of

II. Course Outcomes: On completion of this course students will be able to:
1. Categorize and elaborate the drug evaluation methods.
2. Compile the common adulterants of some herbal plants based on the knowledge acquired.
3. Classify various secondary metabolites in plants and conclude their biosynthetic pathways.
4. Assess the key phytochemical classes and discuss their medical applications.
5. Infer the characteristics of some phytochemical compounds.

III. Theory syllabus

Unit-1: Drugs-evaluation methods **8 Hrs.**
1. Pharmacognosy: Definition, history and importance of pharmacognosy; a brief account of plant based crude drugs.
2. Classification of drugs -Morphological, chemical and pharmacological
3. Drug evaluation methods - organoleptic, microscopic, physical and chemical.

Unit –2: Active principles of some herbal plants **8 Hrs.**

1. Organoleptic and microscopic studies with reference to nature of active principles and common adulterants of *Alstonia scholaris* (bark), *Adhatoda vasica* (leaf), *Strychnos nux-vomica* (seed), R*auwolfia serpentina* (root), *Zingiber officinale* (rhizome),and C*atharanthus roseus* (flower).

Unit-3: Secondary metabolites in plants **10 Hrs.**
1. Biosynthesis of secondary metabolites - Shikimate pathway, Mevolanate pathway, Acetate pathway.
2. Alkaloids-Classification and extraction of alkaloids.
3. Volatile oils: Classification and pharmacological applications.
4. Aroma therapy: Essential oils, mode of action, application methods.

Unit-4: Chemistry and applications of secondary metabolites **11 Hrs.**

1. General introduction, chemistry, biosources, therapeutic uses and commercial applications of following secondary metabolites:
   a) Alkaloids: *Vinca*, *Rauwolfia*, Opium
   b) Phenylpropanoids and flavonoids: Lignans, tea, *Ruta*
   c) Steroids, cardiac glycosides and triterpenoids: Liquorice, *Dioscorea*, *Digitalis*
   d) Volatile oils: *Mentha*, Clove, Cinnamon
   e) Tannins: Catechu, *Pterocarpus*

UNIT-5: Phytoconstituents **8 Hrs.**

1. Source, chemistry and biological action of the following phytoconstituents:
   a) Terpenoids: Menthol, Citral, Artemisin
   b) Glycosides: Glycyrhetinic acid, Rutin
   c) Alkaloids: Atropine, Quinine, Reserpine, Caffeine
   d) Resins: Podophyllotoxin, Curcumin

IV. Text Books

1. Trease, G. E., & Evans, W. C. (2009). Pharmacognosy (16th ed.). Saunders Elsevier.
2. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2021). Pharmacognosy (51st ed.). Nirali Prakashan.
3. Tiwari, K. N. (2012). Phytochemistry and Pharmacognosy (1st ed.). CBS Publishers & Distributors.
4. Wallis, T. E. (1985). Textbook of Pharmacognosy (5th ed.). CBS Publishers & Distributors.

V. Reference Books

1. Harborne, J. B. (1998). Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis (3rd ed.). Springer.
2. Daniel, M. (2006). Herbal Technology: Concepts and Approaches. Satish Serial Publishing House.
3. W.C.Evans, Trease and Evans Pharmacognosy, 16thedition, W.B. Sounders & Co., London, 2009.
4. Mohammad Ali. Pharmacognosy and Phytochemistry, CBS Publishers & Distribution, New Delhi.
5. C.K. Kokate, Purohit, Gokhlae (2007) Text book of Pharmacognosyby, 37thEdition, Nirali Prakashan, New Delhi.
6. R.D. Choudhary(1996), Herbal drug industry by Ist Edn, Eastern Publisher, New Delhi.

VI. Suggested activities and evaluation methods

Unit-1: Activity: Group discussion/Quiz on drug evaluation methods.
Evaluation Method: Assign grade to the best performing group based on the performance.

Unit-2: Activity: Seminar using a PPT on organoleptic studies of herbal plants.
Evaluation Method: Assigning a grade to the best performing student using a rubric.

Unit-3: Activity: Collection of literature on secondary metabolites in plants and submitting a report.
Evaluation Method: Evaluate conceptual understanding and clarity of the report submitted.

Unit-4: Activity: A class room seminar using PPT on the secondary metabolites of plants and their commercial uses.
Evaluation Method: Assigning a grade to the best performing student using a rubric.

Unit-5:Activity: Group discussion/quiz on analytical methods for phytoconstituents.
Evaluation Method: Assign grade to the best performing group based on the performance.

SEMESTER-VI

COURSE 15 A: PHARMACOGNOSY AND PHYTOCHEMISTRY

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Identify the herbal plants having applications in traditional systems of medicine.
2. Perform physical and chemical evaluation of some plant drugs.
3. Summarize the secondary metabolites and phytochemicals of commercial applications.

II. Laboratory/field exercises:

1. Identification of herbal plants – *Aloe, Vinca*, Punarnava etc.,
2. Physical and chemical tests for evaluation of unorganized drugs- Asaphoetida, Honey, Castor oil. *Acacia*
3. Identification of bark drugs – *Cinchona*, Cinnamon
4. Identification of fruit drugs – Cardamom, Coriander
5. Identification of root and rhizome drugs- Ginger, Garlic, Turmeric
6. A brief report on chemistry of secondary metabolites in plants.
7. A brief report on medicinal uses of phytochemicals.
8. Collection of locally available crude drugs from local vendors (minimum of 20)
9. Herbarium of medicinal plants (minimum of 20 plants)

SEMESTER-VI

COURSE 15 B: OMICS IN PLANT SCIENCES

Theory **Credits: 3** **3 hrs/week**

I. Learning objectives: By the end of this course the learner has to:

1. Understand the principles and applications of omics technologies in plant sciences.
2. Explain the use of transcriptomics in studying plant development and stress responses.
3. Discuss the protein interactions and their role in plant physiology and stress resonses.
4. Tell about the principles, techniques, and analytical tools used in plant metabolomics.
5. Explain the integrative omics approaches for analyzing complex biological data in plant research.

II. Course Outcomes: On completion of this course students will be able to:

1. Appraise the application of omics for trait improvement and functional gene studies in plants.
2. Justify the gene regulatory networks involved in plant growth, development, and stress adaptation.
3. Analyze proteomics data and predict roles in plant interactions, signalling, and stress responses.
4. Interpret the roles of plant metabolites in secondary metabolism, stress adaptation, and nutritional improvement.
5. Judge the role of omics in plant breeding, stress resilience, and synthetic biology while considering ethical and societal implications.

III. Theory syllabus:

Unit-1: Introduction to Omics **10 Hrs.**

1. Introduction to omics: concept, history, and scope in plant sciences; overview of plant genome organization and complexity.
2. Plant genome sequencing technologies (Sanger, NGS, third-generation sequencing).
3. Genome assembly, annotation, and comparative genomics.
4. Applications of genomics in crop improvement and functional genomics.

Unit-2: Trancriptomics **9 Hrs.**

1. Transcriptomics: Introduction, concepts and scope; techniques: Microarrays, RNA-Seq, qRT-PCR.
2. Transcriptome assembly and annotation; Gene expression profiling and functional analysis.
3. Applications of trancriptomics in stress responses, developmental biology, and gene discovery in plants.

Unit-3: Proteomics **10 Hrs.**

1. Basics of plant proteomics: types and workflows.
2. Protein extraction, separation (2D-GE, SDS-PAGE), and identification (MALDI-TOF, LC-MS/MS).
3. Protein-protein interactions and functional proteomics.
4. Applications in plant-pathogen interactions, signalling, and stress physiology.

Unit-4: Metabolomics **9 Hrs.**

1. Introduction to plant metabolomics and metabolite profiling.
2. Techniques in metabolomics- GC-MS, LC-MS, NMR, FT-IR.

3. Metabolome databases and data analysis tools.
4. Role of metabolomics in secondary metabolism, stress response, and nutritional enhancement.

Unit-5: Applications of Omics **7 Hrs.**

1. Systems biology and integrative omics approaches.
2. Multi-omics data integration: challenges and strategies.
3. Bioinformatics tools and databases (KEGG, STRING, TAIR, PlantCyc).
4. Applications of omics in plant breeding, stress tolerance, synthetic biology; ethical, legal, and societal issues in plant omics research.

IV. Text books:

1. Ohyanagi, H., Yano, K., Yamamoto, E. & Kitazumi, A. (eds.) (2022). Plant Omics: Advances in Big Data Biology. CABI, Wallingford, UK.
2. Barh, D. (ed.) (2014). OMICS Applications in Crop Science. CRC Press (Taylor & Francis), Boca Raton, FL, USA.
3. Chen, J. T. (ed.) (2021). Phytochemical Omics in Medicinal Plants. MDPI Books, Basel, Switzerland.

V. Reference books:

1. Arthur M. Lesk 2017 Introduction to genomics (3rd Edition)Oxford University Press
2. Ghamkhar, K., Williams, W. M. & Brown, A. H. D. (eds.) (2023). Plant Genetic Resources for the 21st Century: The OMICS Era. Apple Academic Press (Taylor & Francis), Palm Bay, FL, USA..
3. Jorrín Novo, J. V., Komatsu, S., Weckwerth, W. & Wienkoop, S. (eds.) (2014). Plant Proteomics: Methods and Protocols. Humana Press (Springer), Totowa, NJ, USA.
4. Jansson, S., Bhalerao, R. & Groover, A. (eds.) (2010). Genetics and Genomics of Populus. Springer, New York, NY, USA.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Case study analysis – genomic approaches in improving drought tolerance in crops.
Evaluation Method: Depth of analysis of the case study with useful scientific literature and data.

Unit-1I: Activity: Mini project related to transcriptomic insights into plant stress response.
Evaluation Method: Biological understanding of transcriptomic data, quality and creativity of poster/visuals.

Unit-1II: Activity: Comparative proteomics case study – protein changes in plants under stress.
Evaluation Method: Depth and accuracy of biological interpretation, presentation and communication skills.

Unit-1V: Activity: Group discussion/quiz on metabolomic insights into plant secondary metabolism.
Evaluation Method: Grading based on originality and relevance of application suggestion.

Unit-V: Activity: Seminar with PPT on applications of omics in Agriculture and Horiculture.
Evaluation Method: Assigning a grade based on quality of presentation and communication skills.

SEMESTER-VI

COURSE 15 B: OMICS IN PLANT SCIENCES

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Perform key molecular techniques for DNA, RNA, and protein extraction and analysis.
2. Analyze and interpret omics data from genomics, transcriptomics, proteomics, and metabolomics.
3. Predict molecular interactions and pathways in plant systems using omics approaches.

II. Laboratory/field exercises:

1. DNA extraction from plant leaves and PCR amplification of a gene of interest.
2. DNA sequencing technologies (e.g., Sanger, NGS) and data analysis.
3. RNA extraction, quantification, and quality assessment.
4. Microarray and RNA sequencing (RNA-Seq) data analysis.
5. Protein extraction, quantification, and purification from plant tissues.
6. Protein-protein interaction analysis.
7. Metabolite extraction, purification, and derivatization.
8. Metabolite profiling and pathway analysis.

SEMESTER-VI

COURSE 15 C: ORNAMENTAL HORTICULTURE AND COMMERCIAL FLORICULTURE

Theory **Credits: 3** **3 hrs/week**

I. Learning objectives: By the end of this course the learner has to:
1. Explain the role of ornamental horticulture for creating aesthetic look of surroundings.
2. Understand the use of ornamental plants in various landscape settings.
3. Discuss about the cultivation, and management of loose flower crops.
4. Tell about global trends and best practices in cut flower production.
5. Understand the post-harvest management of flowers.

II. Course Outcomes: On completion of this course students will be able to:
1. Classify different types of ornamental plants based on design value and usage.
2. Plan, establish, and maintain lawns using appropriate methods.
3. Demonstrate skills of cultivation practices for plants that yield loose flowers.
4. Assess flower quality based on established standards for marketing.
5. Create value-added floral products such as garlands, dry flowers and perfumes.

Unit-1: Introduction to Ornamental Horticulture **8 Hrs.**
1. Ornamental Horticulture: Definition and scope of ornamental horticulture; role in environmental sustainability and urban greening
2. Area and production of ornamental plants in India and Andhra Pradesh; industrial importance of ornamental plants.
3. Classification of ornamental plants, their design values and general cultivation practices.

Unit-2: Types of Ornamental Plants **10 Hrs.**
1. Uses of ornamental plants in landscaping, homes, institutions, and public places.
2. Importance, design values, propagation, plating, climbers and creepers, palms, ferns, grasses, cacti and succulents.
3. Making and maintenance of lawn; Bonsai-history, philosophy, styles, making of bonsai plants.

Unit-3: Commercial Floriculture – Loose Flowers **10 Hrs.**
1. Importance and scope of loose flower production in India and Andhra Pradesh.
2. Cultivation practices of Jasmine, Marigold, *Chrysanthemum, Crossandra*.
3. Pest, disease, and weed management in loose flower crops.
4. Harvesting, yield, and marketing of loose flowers.

Unit -4: Commercial Floriculture – Cut Flowers **10 Hrs.**
1. Global trends in cut flower production and exports.
2. Cultivation practices of Rose, Gerbera, Carnation, *Gladiolus*.
3. Protected cultivation practices for cut flowers – structures, inputs, fertigation.
4. Flower quality standards and grading.

Unit -5: Post-Harvest and Value Addition **7 Hrs.**
1. Harvesting methods and post-harvest handling of flowers.
2. Storage, packaging, transportation, and cold chain management.
3. Value-added products – garlands, floral arrangements, dry flowers, perfumes.
4. Marketing channels, e-commerce platforms, and export potential.

IV. Textbooks:

1. Arora, J.S. (2018). Introductory Ornamental Horticulture. Kalyani Publishers.
2. Reddy, S. (2020). Commercial Floriculture. Kalyani Publishers.
3. Bose, T.K., Maiti, R.G., Dhua, R.S. (2022). Floriculture and Landscaping. Naya Udyog.
4. Prasad, S. & Kumar, U. (2022). Floriculture: Principles and Species. Agrobios.

V. Reference Books:

1. Sheela, V.L. (2021). Horticulture Science Series: Floriculture. New India Publishing Agency.
2. Dole, J.M. & Wilkins, H.F. (2019). Floriculture: Principles and Species. Pearson.
3. Lauria, A. & Smith, A. (2023). Postharvest Handling of Cut Flowers. Springer.
4. Kumar, N. (2020). Introduction to Horticulture. Oxford Book Company.
5. Randhawa, G.S. & Mukhopadhyay, A. (2021). Floriculture in India. Allied Publishers

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Seminar on classification of ornamental plants using a PPT.
Evaluation Method: Grading based on the performance of the individual.

Unit-1I: Activity: Group discussion/quiz on types of ornamental plants.
Evaluation Method: Active participation and content to be evaluated.

Unit-1II: Activity: Field visit to a local floriculture field.
Evaluation Method: Quality of the field report submitted has to be assessed.

Unit-1V: Activity: Seminar on cultivation of plants that produce cut flowers.
Evaluation Method: Grading based on the performance of the individual.

Unit-V: Activity: Visit to local flower market to observe value added products.
Evaluation Method: Quality of the field report submitted has to be assessed.

SEMESTER-VI

COURSE 15 C: ORNAMENTAL HORTICULTURE AND COMMERCIAL FLORICULTURE

Practical **Credits: 1** **2 hrs/week**

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Identify and classify ornamental and floricultural plants.
2. Demonstrate propagation and nursery techniques for floricultural crops.
3. Prepare floral products and manage post-harvest processes effectively.

II. Laboratory/Field Exercises:

1. Identification and classification of ornamental and flowering plants.
2. Preparation of floral arrangements and garlands.
3. Harvesting and post-harvest handling of cut flowers.
4. Packaging and grading of loose and cut flowers.
5. Drying and preservation of flowers and foliage.
6. Study of Bonsai techniques, Bonsai practicing and training.
7. Identification of sutable grasses and making a lawn.
8. Visit to a floriculture nursery or flower market.