APSCHE/ Botany – Single Major w.e.f. 2023-24 Academic Year

Semester	Course	Title	Hrs./ Week	Credits	Evaluation-Marks		Total Marks
					External	Internal	
FIRST YEAR							
II	Major & Minor (Th.)	2.1- Non-vascular Plants	3	3	75	25	100
	2.1- Non-vascular Plants (Pr.)		2	1	50	-	50
	Major (Th.)	2.2- Origin of Life and Diversity of Microbes	3	3	75	25	100
	2.2- Origin of Life and Diversity of Microbes (Pr.)		2	1	50	-	50
Community Service Project of 8 weeks duration after II Semester i.e., in summer vacation.							
SECOND YEAR							
III	Major & Minor (Th.)	3.1- Vascular Plants	3	3	75	25	100
	3.1- Vascular Plants (Pr.)		2	1	-	50	50
	Major (Th.)	3.2- Plant Pathology and Plant Diseases	3	3	75	25	100
	3.2- Plant Pathology and Plant Diseases (Pr.)		2	1	-	50	50
	Major (Th.)	3.3- Plant Breeding	3	3	75	25	100
	3.3- Plant Breeding (Pr.)		2	1	-	50	50
	Major (Th.)	3.4 – Plant Biotechnology	3	3	75	25	100
	3.4 – Plant Biotechnology (Pr.)		2	1	-	50	50
IV	Major & Minor (Th.)	4.1 – Anatomy and Embryology of Angiosperms	3	3	75	25	100
	4.1 – Anatomy and Embryology of Angiosperms (Pr.)		2	1	50	-	50
	Major & Minor (Th.)	4.2- Plant Ecology, Biodiversity and Phytogeography	3	3	75	25	100
	4.2- Plant Ecology, Biodiversity and Phytogeography (Pr.)		2	1	50	-	50
	Major (Th.)	4.3 –Plant Resources and Utilization	3	3	75	25	100
	4.3 –Plant Resources and Utilization (Pr.)		2	1	50	-	50

Internship Project -1 of 8 weeks duration after IV Semester i.e., in summer vacation							
THIRD YEAR							
V/VI	Major & Minor (Th.)	5.1- Cell Biology and Genetics	3	3	75	25	100
	5.1- Cell Biology and Genetics (Pr.)		2	1	-	50	50
	Major & Minor (Th,)	5.2– Plant Physiology and Metabolism	3	3	75	25	100
	5.2– Plant Physiology and Metabolism (Pr.)		2	1	-	50	50
	Major (Th.)	5.3 (A) Organic Farming	3	3	75	25	100
	5.3 (A) Organic Farming (Pr.)		2	1	-	50	50
	Major (Th.)	5.4 (A): Mushroom Culture Technology	3	3	75	25	100
	5.4 (A): Mushroom Culture Technology (Pr.)		2	1	-	50	50
	(OR)						
	Major (Th.)	5.3 (B): Seed Technology	3	3	75	25	100
	5.3 (B): Seed Technology		2	1	-	50	50
	Major (Th.)	5.4 (B): Plant Propagation Techniques	3	3	75	25	100
	5.4 (B): Plant Propagation Techniques (Pr.)		2	1	-	50	50
	(OR)						
	Major (Th.)	5.3 (C): Vegetable Crops – Cultivation Practices	3	3	75	25	100
	5.3 (C): Vegetable Crops – Cultivation Practices (Pr.)		2	1	-	50	50
	Major (Th.)	5.4 (C): Vegetable Crops – Post Harvest Practices	3	3	75	25	100
	5.4 (C): Vegetable Crops – Post Harvest Practices (Pr.)		2	1	-	50	50
	(OR)						
	Major (Th.)	5.3 (D): Gardening and Landscaping	3	3	75	25	100
	5.3 (D): Gardening and Landscaping (Pr.)		2	1	-	50	50

	Major (Th.)	5.4 (D): Agroforestry	3	3	75	25	100
	5.4 (D): Agroforestry (Pr.)		2	1	-	50	50
Internship Project -2 of 6 months duration during Semester-V/ Semester-VI							

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major/Minor Course - II Semester
2.1: Non-vascular Plants
(Algae, Fungi, Lichens and Bryophytes)
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

1. To realize the characteristics and diversity of non-vascular plants.
2. To recognize the ecological and economic value of algae, fungi, lichens and bryophytes.
3. To inquire the habit, habitat, morphological features and life cycles of selected genera of non-vascular plants.

II. Learning 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. Summarise the important features of fungi and their economic value.
4. Distinguish the characteristics of different groups of fungi.
5. Elaborate the features and significance of amphibians of plant kingdom
6. Explain the diversity among non-vascular plants.

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. Classification of algae: F.E.Fritsch (1935) and Lee (2008)
3. Thallus organization and life cycles in algae.
4. 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*
   (c) Xanthophyceae: *Vaucheria* (d) Rhodophyceae:*Polysiphonia*
2. A brief account of Bacillariophyceae
3. Culture and cultivation of *Chlorella*

Unit-3: Introduction to Fungi 8Hrs.

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

Unit-4: Biology of selected Fungi 10Hrs.

1. Occurrence, structure, reproduction and life cycle of:
   (a) Mastigomycotina: *Phytophthora* (b) Zygomycotina: *Rhizopus*
   (c) Ascomycotina: *Penicillium* (d) Basidiomycotina: *Puccinia*
2. Occurrence, structure and reproduction of lichens; ecological and economic importance of lichens.

Unit-5: Biology of Bryophytes 9Hrs.

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 evolution of sporophytes in Bryophyta.

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.
9. Shaw, A.J.& B.Goffinet (2000) Bryophyte Biology .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 or laboratory culture of fungi and reporting the important features.

Evaluation method: Evaluating the report/conducting JAM/Quiz/Group discussion.

Unit-4: 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.

Unit-5: Collection, characterization, identification and classification of any four bryophytes from their native locality or college campus.

Evaluation method: Assessment of observations and documentation accuracy/presentation or report summarizing findings based on a rubric.

Practical syllabus of Botany Major/Minor Course: Semester – II
2.1: Non-vascular Plants (Algae, Fungi, Lichens, and Bryophytes)
(Total hours of laboratory exercises 30 Hrs. @ 02 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 and Bryophytes based on morphological, anatomical and reproductive features.

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:** *Phytophthora, Rhizopus, Penicillium* and *Puccinia*
5. Identification of some fungal products available in the local market.
6. **Lichens:** Crustose, foliose and fruiticose
7. **Bryophyta:** *Marchantia, Anthoceros* and *Funaria.*

CBCS / Semester System (w.e.f. 2023-24 Admitted Batch)
Botany Major Course – II Semester
2.2: Origin of Life and Diversity of Microbes
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

1. To get awareness on origin and evolution of life.
2. To understand the diversity of microbial organisms.
3. To get awareness on importance of microbes in nature and agriculture.

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

1. Illustrate diversity of viruses, multiplication and economic value.
2. Discuss the general characteristics, classification and economic importance of special groups of bacteria.
3. Explain the structure, nutrition, reproduction and significance of eubacteria.
4. Evaluate the interactions among soil microbes.
5. Compile the value and applications of microbes in agriculture.

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.
2. Five kingdom classification of R.H. Whittaker
3. Shape and symmetry of viruses; structure of TMV and Gemini virus.
4. Multiplication of TMV; A brief account of prions, viroids and virusoids; Transmission of plant viruses and their control.
5. Significance of viruses in vaccine production, bio-pesticides and as cloning vectors.

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

1. General characteristics, outline classification and economic importance of following special groups of bacteria:
   a) Archaebacteria b) Chlamydiae c) Actinomycetes
   d) Mycoplasma e) Phytoplasma f) Cyanobacteria
2. Culture and cultivation of *Spirulina*

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

1. Occurrence, distribution and cell structure of eubacteria.
2. Classification of Eubacteria based on nutrition.
3. Reproduction- Asexual (Binary fission and endospores) and bacterial recombination (Conjugation, Transformation, Transduction).
4. 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 soil microorganisms in soil.
2. Factors influencing the soil microflora - Role of microorganisms in soil fertility.
3. Interactions among microorganisms, mutualism, comensalism, competition, amensalism, parasitism, predation.
4. Microorganisms of rhizosphere, phyllosphere and spermophere; microbial interactions and their effect on plant growth.

Unit-5: Microbes in agriculture **10 Hrs.**

1. Mass production, mode of applications, advantages and limitations of bacterial inoculants (*Rhizobium*, *Azotobacter*, *Azospirillum*, Cyanobacteria).
2. Role of Frankia and VAM in soil fertility.
3. Microbial biopesticides: mode of action, factors influencing, target pests; microbial herbicides.

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: Culture and mass production of bioinoculants.
Evaluation method: Skills performed in establishing the culture and mass production.

Practical syllabus of Botany Major Course: Semester – II
2.2: Origin of Life and Diversity of Microbes

(Total hours of laboratory exercises 30 Hrs. @ 02 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. Microbiology good laboratory practices and biosafety.
2. 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.
3. Study of Viruses (Gemini and TMV) using electron micrographs/ models.
4. Gram staining technique of Bacteria.
5. Microscopic study of Cyanobacteria using temporary/permanent slides.
6. Microscopic study of Eubacteria using temporary/permanent slides.
7. Study of Archaebacteria and Actinomycetes using permanent slides/ electron micrographs/diagrams.

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major/Minor Course - III Semester
3.1: Vascular Plants
(Pteridophytes, Gymnosperms and Taxonomy of Angiosperms)
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

1. To recognize the morphology, anatomy and reproduction in two groups of archegoniates.
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. Infer the evolution of vasculature, heterospory and seed habit in Pteridophytes.
2. Illustrate the general characteristics of Gymnosperms along with their uses
3. Discuss about some Taxonomic aids and their applications in plant systematics.
4. Compare and contrast the vegetative and floral characteristics of some angiospermic families
5. Evaluate the economic value of plant species from the families under the study.
6. Defend the utility of evidences from different branches of botany in solving the taxonomic lineages of some species.

III. Syllabus of Theory:

Unit-1: Pteridophytes **10Hrs.**

1. General characteristics of Pteridophyta; Smith (1955) classification.
2. Occurrence, morphology,anatomy, reproduction (developmental details are notneeded) and life history of: (a) Lycopsida:*Lycopodium* and (b) Filicopsida: *Marsilea*
3. Stelar evolution in Pteridophytes; Heterospory and seed habit.
4. Ecological and economic importance of Pteridophytes.

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

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* and (b) Gnetopsida: *Gnetum*
3. Ecological and economic importance of Gymnosperms.

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 Hooker system of classification.
5. Phylogenetic systematics: primitive and advanced, homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly, clades. synapomorphy, symplesiomorphy, apomorphy. APG-IV classification.

Unit-4: Descriptive Plant Taxonomy **8 Hrs.**

Systematic description and economic importance of the following families:

1. Polypetalae: (a) Annonaceae (b) Curcurbitaceae
2. Gamopetalae: (a) Asteraceae (b) Asclepiadaceae
3. Monochlamydae: (a) Amaranthaceae (b) Euphorbiaceae
4. Monocotyledonae: (a) Arecaceae (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
5. Origin and evolution of angiosperms.

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. Smith, G.M. (1971) CryptogamicBotanyVol. II., Tata McGraw Hill, New Delhi
2. Sharma,O.P.(2012) Pteridophyta. Tata McGraw-Hill, New Delhi
3. Sporne, K.R. (1971) The Morphology of Gymnosperms.Hutchinsons Co. Ltd.,London
4. Coulter, J.M. & C.J.Chamberlain(1910) Morphology of Gymnosperms,The University of Chicago Press, Chicago, Illinois
5. Bhatnagar, S.P. &AlokMoitra (1996) Gymnosperms. New Age International, NewDelhi
6. Sambamurty, A.V.S.S. (2005) Taxonomy of Angiosperms I. K .InternationalPvt. Ltd., New Delhi
7. Singh, G. (2012). Plant Systematics: Theory and Practice.Oxford& IBH Pvt.Ltd., NewDelhi.
8. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA,U.S.A.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Making temporary slides/models/drawings of Pteridophytes in the syllabus.

Evaluation method: Assessment of the temporary slides/model/drawing.

Unit-2: Activity: Study of wood elements in locally available Gymnosperms and making temporary slides.

Evaluation method: Validation of prepared slides submitted by the learner.

Unit-3: 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-4: 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-5: 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.

Practical syllabus of Botany Major/Minor Core Course: Semester – III
3.1: Vascular Plants (Pteridophytes, Gymnosperms and Angiosperm Taxonomy)
(Total hours of laboratory exercises 30 Hrs. @ 02 Hrs./Week)

I. Course Outcomes: On successful completion of this practical course, 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:

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

1. Pteridophyta: *Lycopodium* and *Marselia*
2. Gymnosperms: *Cycas* and *Gnetum*

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

1. Annonacae	2. Cucurbitaceae	3. Asteraceae	4. Asclepiadaceae
5. Amaranthaceae	6. Euphorbiaceae	7. Arecaceae	8. 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).

CBCS / Semester System (w.e.f. 2023-24 Admitted Batch)
Botany Major Course – III Semester
3.2: Plant Pathology and Plant Diseases
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

1. To study various plant pathogens, their survival and dispersal mechanisms.
2. To understand the processes involved in infection and pathogenesis in plants.
3. To study the common diseases of some important field and horticultural crops.

II. Learning Outcomes:

1. Identify major groups of plant pathogens and classify plant diseases.
2. Explain various stages in infection, plant pathogenesis and responsible factors.
3. Elaborate the preventive and control measures for plant diseases.
4. Discuss about some diseases of field crops and their management.
5. Discuss about some diseases of horticultural crops and their management.

III. Syllabus of Theory:

Unit-1: Plant pathogens, survival and dispersal 8 Hrs.

1. Plant pathology: definition, importance of plant diseases, important famines in world; scope and objectives of plant pathology.
2. Important plant pathogenic organisms with examples of diseases caused by them.
3. Classification of plant diseases based on important criteria.
4. A brief account on survival of plant pathogens.
5. Dispersal of plant pathogens – active and passive processes.

Unit-2: Infection and pathogenesis in plants 8 Hrs.

1. Infection process – pre-penetration, penetration and post-penetration.
2. Role of enzymes in plant pathogenesis.
3. Role of toxins in plant pathogenesis.
4. Role of growth regulators in plant pathogenesis.
5. Defense mechanisms in plants against pathogens.

Unit-3: Plant disease management 8 Hrs.

1. Plant disease epidemiology; plant disease forecasting; remote sensing in plant pathology.
2. General principles of plant diseases management.
3. Regulatory methods, cultural methods; biological control and PGPR.
4. Physical methods, chemical methods; host plant resistance.
5. Integrated plant disease management (IDM) – Concept, advantages and importance.

Unit-4: Diseases of field crops 12 Hrs.

Symptoms, etiology, disease cycle and management of major diseases of following crops:

a) Rice: Blast of rice, bacterial blight and Tungro
b) Bajra: Downy mildew and Ergot
c) Pigeon-pea: Phytophthora blight, wilt and sterility mosaic
d) Groundnut: Tikka leaf spot, rust and root rot

Unit-4: Diseases of horticultural crops 9 Hrs.

Symptoms, etiology, disease cycle and management of major diseases of following crops:

a) Brinjal: Phomopsis blight and Little leaf
b) Okra: Powdery mildew and Yellow vein mosaic
c) Pomegranate: Alternaria fruit spot and Anthracnose
d) Coconut: Bud rot and Basal stem rot

IV. Text Books:

1. P.D. Sharma (2011) Fundamentals of Plant Pathology, Tata McGraw-Hill Education, New Delhi
2. R.S. Singh and U.S. Singh (2017) Plant Pathology: An Introduction, CRC Press, Boca Raton, Florida, USA
3. R.S. Mehrotra (2008) Plant Pathology, Tata McGraw-Hill Education, New Delhi
4. M. S. Reddy and Gopal Singh (2016) Plant Pathology: Concepts and Laboratory Exercises, Scientific Publishers, Jodhpur, India

V. Reference Books:

1. Agrios, G. N. (2005). Plant Pathology (5th ed.). Academic Press, San Diego, California.
2. Dehne, H. W. (Ed.). (2012). Plant Pathology: From Molecular Biology to Biological Control. Springer, Dordrecht, Netherlands.
3. Dicklow, M. B., & Beaudry, R. M. (Eds.). (2013). Plant Pathology Concepts and Laboratory Exercises (2nd ed.). CRC Press, Boca Raton, Florida.
4. Lucas, J. A. (1998). Plant Pathology and Plant Pathogens. Blackwell Science, Oxford, UK.
5. Lucas, J. A. (1998). Plant pathology and plant pathogens. Blackwell Science, Oxford, UK.
6. Schumann, G. L., & D'Arcy, C. J. (2010). Essential Plant Pathology (2nd ed.). APS Press, St. Paul, Minnesota.
7. Schumann, G. L., and C. D'Arcy (2010). Essential plant pathology. APS Press, St. Paul, MN.
8. Singh, R. P., and U. S. Singh (2020). Plant diseases: Identification, management and challenges. Springer, Singapore.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Field Survey and making a report on various plant pathogens, their survival and dispersal mechanisms.

Evaluation method: Field reports, presentations and visual documentation based on a rubric.

Unit-2: Activity: Case studies on plant infections and factors contributing to disease development.

Evaluation method: Diagnostic evaluation of case study report for problem-solving and critical thinking skills.

Unit-3: Activity: A survey report on various preventive and control measures for plant diseases practiced by the farmers in their locality.

Evaluation method: Peer review by students on the quality of report.

Unit-4: Activity: Field survey and data collection on diseases of local field crops.

Evaluation method: Assessment of the quality of report bases on a rubric.

Unit-5: Activity: Microscopic observations and making drawings of diseased samples.

Evaluation method: Formative assessment of presentation of findings through visuals/ drawings.

Practical syllabus of Botany Major Course: Semester – III
3.2: Plant Pathology and Plant Diseases
(Total hours of laboratory exercises 30 Hrs. @ 02 Hrs./Week)

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

1. Handle equipment and instruments in plant pathology laboratory.
2. Isolate plant pathogenic microbes.
2. Identify the plant diseases based of histopathological observations.

II. Laboratory/field exercises:

1. Familiarity with general plant pathological laboratory and field equipment.
2. Isolation and Identification of plant pathogenic fungi.
3. Isolation and Identification of plant pathogenic bacteria.
4. Identification of phanerogamic plant parasites.
5. Isolation and Identification of plant pathogenic nematodes.
6. Demonstration of Koch's postulates
7. Identification and histopathological studies of selected diseases of field crops.
8. Identification and histopathological studies of selected diseases of horticultural crops.

CBCS / Semester System (w.e.f. 2023-24 Admitted Batch)
Botany Major Course – III Semester
3.3: Plant Breeding
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

1. To learn the objectives and scope of plant breeding along with reproductive methods in plants.
2. To understand the breeding methods in plant for production of new varieties.
3. To have a comprehensive knowledge on tools and techniques in plant breeding.

II. Learning Outcomes:

1. Compare and contrast the methods of reproduction and also pollination mechanisms.
2. Design appropriate pollination method for a given crop plant.
3. Recommend the best possible breeding method for a crop species.
4. Propose the steps for production of hybrid varieties of crop plants.
5. Apply molecular techniques to develop a tailored plant variety.

III. Syllabus of Theory:

Unit-1: 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. Advantages and disadvantages of asexual and sexual reproduction; apomixis: definition, types and significance.
3. A brief account of self and cross-pollination, their genetic consequences and significance; classification of crop plants based on mode of pollination and mode of reproduction.

Unit-2: Contrivances for cross pollination 7 Hrs.

1. Self-incompatibility in plants – Definition, heteromorphic and homomorphic systems; exploitation of self-incompatibility in hybrid production.
2. Male sterility- Genetic, cytoplasmic and cytoplasmic-genetic, utilization in plant breeding.
3. Domestication of plants, centres of origin of crop plants.

Unit-3: Breeding methods in plants 9 Hrs.

1. Plant introduction – types, objectives, plant introduction agencies in India, procedure, merits and demerits; germplasm collections, genetic erosion, gene sanctuaries.
2. Selection – natural and artificial selection – basic principles of selection.
3. Self-pollinated crops: pure line selection method – procedure, advantages and disadvantages, achievements.
4. Vegetatively propagated crops: Clonal selection - procedure, advantages and disadvantages, achievements.

Unit-4: Breeding methods in cross-pollinated plants 12 Hrs.

1. Hybridization – objectives, types, procedure, advantages and disadvantages, achievements.
2. Cross-pollinated crops: back cross method - procedure, advantages and disadvantages, achievements.
3. Heterosis: definition, genetic bases of heterosis – dominance, over dominance and epistasis hypotheses; physiological bases of heterosis – commercial utilization.
4. Synthetics and composites – production procedures – merits, demerits and achievements.

Unit-5: Modern methods in plant breeding 9 Hrs.

1. Mutation breeding: spontaneous and induced mutations – characteristic features of mutations – procedure of mutation breeding – applications – advantages, limitations and achievements.

2. Polyploidy breeding: auto-polyploids and allopolyploids – applications in crop improvement and limitations.
3. DNA markers and their applications in plant breeding: RFLP, SSR, and SNP
4. Marker Assisted Selection (MAS) and its applications in plant breeding.

IV. Text Books:

1. Singh, B. D. (2001) Plant breeding: Principles and methods. Kalyani Publishers, New Delhi, India.
2. Poehlman, J. M. and Sleper, D. A. (1995) Breeding field crops, 4th ed. Iowa State University Press, Ames, Iowa, USA.
3. Patil, J.V., S.S. Patil, and R.A. Balikai (2019) Principles and Methods in Plant Breeding, Scientific Publishers (India), Jodhpur
4. Purohit, S.S. (2014) Plant Breeding: Principles and Methods, Agrobios (India), Jodhpur

V. Reference Books:

1. Acquaah, G. 2012. Principles of plant genetics and breeding, 2nd ed. Wiley-Blackwell, Ames, Iowa, USA.
2. Allard, R. W. 1999. Principles of plant breeding. John Wiley & Sons, New York, USA.
3. Stuber, C. W., Edwards, M. D. and Wendel, J. F. 1987. Molecular markers in plant breeding: Applications and potential. Science 238: 1659-1664.
4. Hayes, H. K., R. E. Kirk, and R. H. Jones (1951). Methods for the Statistical Analysis of Plant Breeding Experiments. Iowa State College Press, Ames, IA.
5. Simmonds, N. W. (1979). Principles of Crop Improvement (2nd ed.). Longman, Harlow, UK.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Written assessment on reproduction and pollination mechanisms in plants.
Evaluation method: Awarding grade based on writing appropriate points in a descriptive way.
Unit-2: Activity: Collection of scientific literature on contrivances in plants to promote cross fertilization.
Evaluation method: Quality and organization of the report in a systematic way with data collected and analysis made.
Unit-3: Activity: Hands on activity of selection procedure for a given crop plant.
Evaluation method: Assessment of understanding and applying appropriate selection procedure.
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.

Practical syllabus of Botany Major Course: Semester – III
3.3: Plant Breeding
(Total hours of laboratory exercises 30 Hrs. @ 02 Hrs./Week)

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

1. Distinguish self and cross-pollinated plant species based on floral biology.
2. Perform skills related to self and cross pollination in plants.
3. Make hybridization to produce new varieties.

II. Laboratory/field exercises:

1. Floral biology in a self and a cross pollinated plant species.
2. Identification and classification of plants based on pollination mechanism.
3. Pollen viability test.
4. Observation on pollen germination.
5. Practicing emasculation technique.
6. Practicing selfing and crossing techniques.
7. Assessment of genetic variability.
8. Estimation of heterosis and inbreeding depression.
9. Studying mutant and polyploids in crop plants.

CBCS / Semester System (w.e.f. 2023-24 Admitted Batch)
Botany Major Course – III Semester
3.4: Plant Biotechnology
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

1. To acquire knowledge of sterilization techniques used in plant tissue culture.
2. To learn about various types of plant tissue culture practices.
3. To know the applications of plant biotechnology in production of novel plants.

II. Learning Outcomes: Students at the successful completion of the course will be able to:

1. Explain the scientific techniques and tools used in plant tissue culture laboratories.
2. Appraise the applications of plant tissue culture in agriculture and horticulture sectors.
3. Acquire skills related to various aspects in plant tissue culture.
4. Evaluate the role of transgenic plants in solving certain plant related beneficiary issues.
5. Justify the role of plant biotechnology in bioenergy and phytoremediation.
6. Judge the biosafety and bioethics related to plant biotechnology.

III. Syllabus of Theory:

UNIT-1: Basic techniques in plant tissue culture 10 Hrs.

1. Plant tissue culture: Definition, scope and significance; infrastructure and equipment required to establish a tissue culture laboratory.
2. Sterilization techniques; formulation of media for plant tissue culture.
3. Concept of totipotency, initiation and maintenance of callus cultures; induction of morphogenesis in vitro.
4. Somatic embryogenesis and organogenesis; factors affecting somatic embryogenesis and organogenesis synthetic seeds and their applications.

UNIT-2: Organ and haploid culture techniques 8 Hrs.

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

UNIT-3: Cell and protoplast cultures 12 Hrs.

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

UNIT-4: Transgenic plants 8 Hrs.

1. Transgenic plants – definition, biosafety and ethical issues associated with transgenic plants.
2. Herbicide resistance (glyphosphate), insect resistance (alpha amylase inhibitor).
3. Virus resistance (coat protein mediated, nucleocapsid gene), disease resistance (antifungal proteins, PR proteins).
4. Quality improvement (Golden rice), Shelf-life enhancement (Flavr savr tomato).

UNIT-5: Advances in plant biotechnology 7 Hrs.

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

remediation.

IV. Text Books:

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

V. Reference Books:

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

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 presentaion, collaboration skills etc., based on a rubric.
Unit-3: Activity: Designing a bioreactor system for mass cultivation of plant cells.
Evaluation method: Awarding grade based on **s**kills performed in designing a prototype bioreactor.
Unit-4: Activity: Collection of scientific literature on various transgenic plants developed.
Evaluation method: Assess credibility and relevance of literature collected, analysis and conclusions made.
Unit-5: Activity: Case studies on applications of plant biotechnology.
Assessment method: Based on data and Information collected, analysis and interpretation made, presentation and organization of the report.

Practical syllabus of Botany Major Course: Semester – III
3.4: Plant Biotechnology

(Total hours of laboratory exercises 30 Hrs. @ 02 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. Callus induction and subculturing.

5. Organogenesis using PGRs’
6. Demonstration of cell and protoplast culture.
7. Demonstration of organ cultures.
8. Demonstration of anther and pollen cultures.

CBCS / Semester System (w.e.f. 2023-24 Admitted Batch)
Botany Major/Minor Course - IV Semester
4.1: Anatomy and Embryology of Angiosperms
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

1. To know about various types of tissues in plants and their organization.
2. To obtain awareness on anomalous secondary growth in plants and economic value of woods.
3. To acquire knowledge on development of male and female gametophytes in plants.
4. To probe into embryogenesis in angiosperms.

II. Learning 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. Discuss the events in mega-sporogenesis and development of female gametophyte.
5. Propose the incidents in embryogenesis of an angiospermic plant species.
6. Compile the aspects of developmental and reproductive biology in plants.

III. Syllabus of Theory:

Unit – 1: Tissues in plants 8 Hrs.

1. Meristematic tissues: Definition, classification, structure and functions.
2. Apical meristems: Generalised 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).
4. 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*
3. Anomalous secondary growth in stems of *Boerhaavia* and *Dracaena*
4. Study of timbers of economic importance - Teak, Red-sanders and Rosewood.
5. Applications of anatomy in plant systematics, forensics and pharmacognosy.

Unit-3: Anther and pollen 10Hrs.

1. Anther: Structure and functions of anther wall, micro-sporogenesis, callose deposition and its significance.
2. Pollen wall structure, MGU (male germ unit) structure, NPC system; a brief account of Palynology and its scope; development of male gametophyte.
3. Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: pseudomonads, polyads, massulae, pollinia.

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. Outlines of pollination; self-incompatibility- basic concepts; methods to overcome self-incompatibility (mixed pollination, bud pollination, stub 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. Embryogeny in dicot (*Capsella bursa-pastoris*)
2. Embryogeny in monocot (*Sagittariasagittifolia*).

3. Seed structure in monocot and dicot.
4. Importance of seed and seed dispersal mechanisms.
5. 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.

Practical syllabus of Botany Major/Minor Course: Semester – IV

4.1: Anatomy and Embryology of Angiosperms

(Total hours of laboratory exercises 30 Hrs. @ 02 Hrs./Week)

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. Look into the embryological characteristics from sex organs to seeds in angiosperms.

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 ovule s 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.

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major/Minor Course - IV Semester
4.2: Plant Ecology, Biodiversity and Phytogeography
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

1. To figure-out the components of ecosystem and energy flow among different trophic levels.
2. To apprise the characteristics of autecology and synecology.
3. To understand the climatic change and associated impacts on biotic components.
4. To discern the value of biodiversity, threats and conservation strategies.
5. To 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, growth curves, ecotypes, ecads.
2. Community ecology: characteristics -frequency, density, cover, life forms, competition, biological spectrum.
3. Ecological succession: Hydrosere and Xerosere.
4. Concepts of productivity: GPP, NPP and Community Respiration
5. 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 and carbon credits; The Montreal and the Kyoto protocol.
5. 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. Principles of conservation: 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.
4. Phytogeographic regions of India.
5. Vegetation types in Andhra Pradesh.

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, VolumeII, New Central Book Agency Pvt. Ltd., Kolkata
3. N.S.Subrahmanyam& A.V.S.S. Sambamurty (2008) Ecology Narosa Publishing House, New Delhi
4. Sharma, P.D. (2012) Ecology and Environment. Rastogi Publications, Meerut, India.
5. U. Kumar (2007) Biodiversity: Principles & Conservation, Agrobios (India), Jodhpur
6. Mani, M.S (1974) Ecology & Biogeography of India Dr. W. Junk Publishers, The Hague

V. Reference Books:

1. Kormondy, Edward J. (1996) Concepts of Ecology,Prentice-Hall of India Private Limited, New Delhi
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. Chapman, J.L&M.J. Reiss (1992): Ecology - Principles & Applications. Cambridge University Press, U.K.
7. Kumar H.D. (2000) Biodiversity & Sustainable Conservation Oxford & IBH Publishing Co Ltd. New Delhi.
8. Cain, S.A . (1944) Foundations of Plant Geography Harper & Brothers, N.Y.
9. Good, R. (1997) The Geography of flowering Plants (2nd Edn.) Longmans, Green & Co., Inc., London & Allied Science Publishers, New Delhi

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.

Practical syllabus of Botany Major/Minor Core Course: Semester – IV
4.2: Plant Ecology, Biodiversity and Phytogeography
(Total hours of laboratory exercises 30 Hrs. @ 02 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.

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major Course - IV Semester
4.3: Plant Resources and Utilization
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

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

II. Learning Outcomes: Students at the successful completion of the course 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: Food plants 10 Hrs.

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

UNIT-2: Other economic plant products 8 Hrs.

1. A general account of oil seed crops and vegetable oils.
2. A general account of fruit and vegetable yielding plants.
3. Plant sources and economic importance of rubber, latex, gums, resins, dyes, alkaloids and tannins.
4. A general account of major fibre crops in India; textile production from plant fibres.

UNIT-3: Commercial plant products 8 Hrs.

1. A general account and economic potential of spices and condiments.
2. Plant sources and economic importance of flavouring products, beverages, fumitories and masticatories and narcotics.
3. Utilization of some important ornamentals, flowering plants and orchids.

UNIT-4: Medicinal and aromatic plant products 10 Hrs.

1. Traditional and modern uses of some medicinal plants of India.
2. Active compounds in medicinal plants and their pharmacological effects.
3. Essential oils and their uses; aromatic plants in perfumery and cosmetics.
4. Phytochemicals and their potential health benefits.

UNIT-5: Timber products and energy crops 9 Hrs.

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

IV. Textbooks:

1. S. K. Jain and R. A. Jain, (2015) Handbook of Plant Resources, Springer, New York.
2. H. Panda and A. K. Padhi, (2017) Medicinal Plants and Their Utilization, Springer, Singapore.
3. G.E. Wickens (1998) Economic Botany: Principles and Practices, Chapman & Hall, London.

4. S.L. Kochhar (1990) The Economic Botany of the Tropics, Macmillan, London.

V. Reference Books:

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

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.

Practical syllabus of Botany Major Course: Semester – IV

4.3: Plant Resources and Utilization

(Total hours of laboratory exercises 30 Hrs. @ 02 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. Study of morphology and micro-chemical test for stored material of any 3 food crops.
2. Study of morphology and microscopic study anatomy of some plant fibres (cotton, jute, hemp,
   ramie, sisal).
3. Study of morphology, medicinal and aromatic plants and their useful parts.
4. Study of some oil yielding crops and properties of their oils.
5. Study of some gum, resin, tannin, dye yielding plants.

6. Study of firewood, biofuel and timber yielding plants.

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major/Minor Course - V Semester
5.1: Cell Biology and Genetics
Total hours of teaching – Theory: 45 @ 03 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: 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 of cell wall.
3. Ultra-structure of plasma membrane and various theories 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. Prokaryotic vs eukaryotic chromosome; morphology of a eukaryotic chromosome.
2. Euchromatin and Heterochromatin; Karyotype and ideogram.
3. Brief account of chromosomal aberrations - structural and numerical changes
4. Organization of DNA in a chromosome (nucleosome and solenoid models).

Unit-3: Mendelian and non-Mendelian Genetics 10 Hrs.

1. Mendel's laws of inheritance. Incomplete dominance and co-dominance; Multiple allelism.
2. Complementary, supplementary and duplicate gene interactions (plant-based examples are to be dealt).
3. A brief account of linkage and crossing over; Chromosomal mapping - 2 point and 3 point test cross.
4. Concept of maternal inheritance (Corren's experiment on *Mirabilis jalapa*).

Unit-4: Structure and function of DNA 10 Hrs.

1. Watson and Crick model of DNA. Brief account on DNA Replication (Semiconservative method).
2. Brief account on transcription, types and functions of RNA.
3. Genetic code and a brief account of translation.
4. Regulation of gene expression in prokaryotes - Lac Operon.

Unit-5: Gene concept and Sex determination 9 Hrs.

1. Evolution of gene concept: classical vs molecular concepts of gene.
2. Cis–Trans complementation test for functional allelism, gene as unit of function, mutation and recombination.
3. Pattern of sex determination in plants.
4. Allele and genotype frequencies, Hardy-Weinberg law.

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, Volume-III, New Central Book Agency Pvt. Ltd., Kolkata
3. A.V.S.S. Sambamurty (2007) Molecular Genetics,Narosa Publishing House,New Delhi
4. S. C. Rastogi (2008) Cell Biology,New Age International (P) Ltd. Publishers, New Delhi

V. Reference Books:

1. P. K. Gupta (2002) Cell and Molecular biology, Rastogi Publications, New Delhi
2. B. D. Singh (2008) Genetics,Kalyani Publishers, Ludhiana
3. Cooper, G.M. & R.E. Hausman (2009) The Cell – A Molecular Approach, A.S.M. Press, Washington
4. Becker, W.M., L.J. Kleinsmith& J. Hardin (2007) The World of Cell, Pearson, Education, Inc., New York
5. De Robertis, E.D.P. & E.M.F. De Robertis Jr. (2002) Cell and Molecular Biology, Lippincott Williams & Wilkins Publ., Philadelphia
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: Observation of chromosomal aberrations in *Allium cepa* root cells exposed to industrial effluent/ heavy metals
Evaluation method: Validation of report and assigning a grade based on a rubric.
Unit-3: Activity: Solving the problems on classical genetics.
Evaluation method: Assessing the accuracy in solving the problems and awarding a grade.
Unit-4: Activity: Making models of nucleic acids.
Evaluation method: Selecting the best and assigning a grade.
Unit-5: Activity: Making a comprehensive report on sex determination in plants by collecting scientific literature.
Evaluation method: Validation of report and assigning a grade based on a specified point scale.

Practical syllabus of Botany Major/Minor Course: Semester – IV
5.1: Cell Biology and Genetics

(Total hours of laboratory exercises 30 Hrs. @ 02 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.
3. Predict the consequences of a particular genetic condition.

II. Laboratory/field exercises:

1. Study of ultra structure of plant cell and its organelles using electron 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.
7. Solving problems on monohybrid, dihybrid, back and test crosses.
8. Solving problems on gene interactions (at least one problem for each of the gene interactions in the syllabus).
9. Chromosomes mapping using problems of 3- point test cross data.

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major/Minor Course - V Semester
5.2: Plant Physiology and Metabolism
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

1. To understand the concept of Soil-Plant-Atmosphere continuum based on plant-water relations.
2. To study the anabolic and catabolic processes in plants.
3. To understand 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. Interpret the role of enzymes in plant metabolism.
4. Hypothesise the light reactions and carbon assimilation processes responsible for synthesis of food in plants.
5. Analyze the biochemical reactions in relation to Nitrogen and lipid metabolisms.
6. 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. Aravind Kumar & S.S. Purohit (1998) Plant Physiology – Fundamentals and Applications, Agro Botanica, Bikaner
2. Datta, S.C. (2007) Plant Physiology, New Age International (P) Ltd., Publishers,New Delhi
3. Hans Mohr & P. Schopfer (2006) Plant Physiology, Springer (India) Pvt. Ltd.,New Delhi
4. Hans-Walter heldt (2005) Plant Biochemistry,Academic Press, U.S.A.
5. Hopkins, W.G. & N.P.A. Huner (2014) Introduction to Plant Physiology, Wiley India Pvt. Ltd., New Delhi
6. Noggle Ray & J. Fritz (2013) Introductory Plant Physiology, Prentice Hall (India),New Delhi
7. Pandey, S.M. &B.K.Sinha (2006)Plant Physiology, Vikas Publishing House, New Delhi
8. Salisbury, Frank B. & Cleon W. Ross (2007) Plant Physiology, Thomsen & Wadsworth, Austalia&U.S.A
9. Sinha, R.K. (2014) Modern Plant Physiology, Narosa Publishing House,New Delhi
10. Taiz, L.&E. Zeiger (2003) Plant Physiology, Panima Publishers, New Delhi.
11. 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.

Practical Syllabus of Botany Major/Minor Course: Semester –V
5.2: Plant Physiology and Metabolism
(Total hours of laboratory exercises 30 Hrs. @ 02 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:

1. Determination of osmotic potential of plant cell sap by plasmolytic method using *Rhoeo*/ *Tradescantia* leaves.
3. 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.
10. Estimation of protein by biuret method/Lowry method.
11. Minor experiments – Osmosis, Arc-auxonometer, ascent of sap through xylem, cytoplasmic streaming

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major and Minor Course - IV Semester
5.3 (A): Organic Farming
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

I. I. Learning Objectives: By the end of this course the learner has:
1. To know the beneficial aspects of organic farming against chemical farming.
2. To gain knowledge about soil fertility, organic pest and disease management strategies.
3. To understand the organic certification process, including the standards and regulations that govern organic farming practices.

II. Learning Outcomes: Students at the successful completion of the course will be able to:
1. Compare and contrast the advantages and disadvantages of conventional and organic farming.
2. Acquire skills on different composting methods.
3. Acquaint with cultural and crop protection practices related to organic farming.
4. Acquire knowledge on various management practices in organic farming.
5. Discuss about the certification and marketing of organic foods.
6. Explain the initiatives of government in promoting organic farming

III. Syllabus of Theory:

UNIT-1: Basic concepts of organic farming 8 Hrs.
1. Organic farming: Definition, ecological social and economic benefits.
2. Organic farming and its components; concepts and principles.
3. Biodynamic and natural farming approaches; permaculture and LEISA farming approaches.
4. Sustainable agriculture, key indicators of sustainable agriculture.
5. Living soil and healthy plant concepts.

UNIT-2: Organic inputs for soil 8 Hrs.
1. Vermicompost production technology.
2. Organic manures: Farmyard Manure (FYM), enrichment of FYM.
3. Compost, methods of composting (Bangalore, Indore, Coimbatore, NADEP methods).
4. Green manuring, classification of green manures.
5. Classification of organic residues; recycling of organic residues.

UNIT-3: Organic crop management 10 Hrs.
1. Introduction to organic crop management – land preparation, planting technic, nutrient management.
2. Factors considered for nutrient management; recommended nutrient quantity –blanket, major problems; balance sheet method.
3. Nutrient composition of some organic resources, right timing of nutrient application.
4. Right method of nutrient application, nutrient use efficiency.

UNIT-4: Cultural and crop protection practices 10 Hrs.
1. Pre-sowing irrigation; crop rotation, intercropping and mixed cropping.
2. Use of tolerant and resistant varieties; manipulation in sowing dates, irrigation/flooding, destruction of volunteer plants.
3. Pest and disease management – preventive, physical and mechanical methods.
4. Organic crop management – rice, red gram, groundnut, and tomato.
5. Government interventions to promote organic farming: NPOF, NPMSHF, NHM, RKVY, KVK and APEDA.

UNIT-5: Certification and Marketing of Organics 9 Hrs.
1. Organic certification process – definition, need, aim and scope, requirements to maintain

certification.
2. Organic certification process – labelling of products, NPOP, organic quality control, standards,
accreditation, inspection, and certification.
3. Operational structure of organic certification.
4. Marketing of organic products.

IV. Text Books:

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

V. Reference Books:

1. Richard Wiswall (2009), The Organic Farmer's Business Handbook Chelsea Green Publishing, White River Junction, VT, USA.
2. William Lockeretz (2007), Organic Farming: An International History CABI Publishing, Wallingford, UK.
3. Ann Larkin Hansen (2010), The Organic Farmer's Manual: A Comprehensive Guide to Starting and Running a Certified Organic Farm Storey Publishing, North Adams, MA, USA. Masanobu Fukuoka (1978), The One-Straw Revolution: An Introduction to Natural Farming Rodale Press, Emmaus, PA, USA.
4. Gary Zimmer (2000), The Biological Farmer: A Complete Guide to the Sustainable & Profitable Biological System of Farming Acres U.S.A., Austin, TX, USA
5. Albert Howard (1947), The Soil and Health: A Study of Organic Agriculture University Press of Kentucky, Lexington, KY, USA.
6. Terri Paajanen (2014), The Complete Guide to Organic Livestock Farming Atlantic Publishing Group, Inc., Ocala, FL, USA.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Group discussion on advantages and disadvantages of organic and in-inorganic farming methods.

Evaluation method: Analyzing the quality and depth of the content discussed, identifying key ideas, arguments, and supporting evidences.

Unit-2: Activity: Internship on preparation of composts and other organic inputs.

Evaluation method: Performance evaluations, team feedback and competition results.

Unit-3: Activity: Case study report on management practices in organic farming.

Evaluation method: Evaluating the clarity, coherence, and logical structure of the case study report.

Unit-4: Activity: Critical written assignment on support from government agencies to promote organic farming.

Evaluation method: Evaluating the application of critical thinking skills, such as analysis, evaluation, and interpretation of information or ideas presented in the assignment.

Unit-5: Activity: A survey report on marketing of organic food products.

Evaluation method: Evaluating the appropriateness and effectiveness of the survey design, including the clarity of questions, survey structure, and response options.

Practical syllabus of Botany Major Course: Semester – IV

5.3 (A): Organic Farming

(Total hours of laboratory exercises 30 Hrs. @ 02 Hrs./Week)

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

1. Prepare different organic formulations for organic farming.
2. Design a vermicompost unit and prepare the compost.
3. Identify various manures for organic farming.

II. Laboratory/field exercises:

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

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major Course - IV Semester
5.4 (A): Mushroom Culture Technology
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

1. To learn about the morphology and nutritional value of some edible mushrooms.
2. To gain knowledge on basic requirements for establishing a mushroom culture unit.
3. To learn the cultivation methods and management practices specific to certain edible mushrooms.

II. Learning Outcomes: Students at the successful completion of the course will be able to:

1. Understand the structure and life of a mushroom and discriminate edible and poisonous mushrooms.
2. Identify the basic infrastructure to establish a mushroom culture unit.
3. Demonstrate skills preparation of compost and spawn.
4. Acquire a critical knowledge on cultivation of some edible mushrooms.
5. Explain the methods of storage, preparation of value-added products and marketing.

III. Syllabus of Theory:

Unit – 1: Introduction and value of mushrooms 8 Hrs.

1. Mushrooms: Definition, structure of a mushroom and a brief account of life cycle; historical account and scope of mushroom cultivation; difference between edible and poisonous mushrooms.
2. Morphological features of edible mushrooms - Button mushroom (*Agaricus bisporus*), Milky mushroom (*Calocybe indica*), Oyster mushroom (*Pleurotus sajor-caju*) and Paddy straw mushroom (*Volvariella volvacea*).
3. Nutraceutical value of mushrooms; medicinal mushrooms in South India (*Ganoderma lucidum, Phellinus rimosus, Pleurotus florida and Pleurotus pulmonaris*) and their therapeutic value; Poisonous mushrooms - harmful effects.

Unit – 2: Basic requirements of cultivation system 9 Hrs.

1. Small village unit and larger commercial unit; layout of a mushroom farm - location of building plot, design of farm, bulk chamber, composting, equipment and facilities, pasteurization room and growing rooms.
2. Compost and composting: Definition, machinery required for compost making, materials for compost preparation.
3. Methods of composting- long method of composting and short method of composting.

Unit – 3: Spawning and casing 10 Hrs.

1. Spawn and spawning: Definition, facilities required for spawn preparation; preparation of spawn substrate.
2. Preparation of pure culture, media used in raising pure culture; culture maintenance, storage of spawn.
3. Casing: Definition, Importance of casing mixture, Quality parameters of casing soil, different types of casing mixtures, commonly used materials.

Unit – 4: Mushroom cultivation 10 Hrs.

Raw material, compost, spawning, casing, cropping, and problems in cultivation (diseases, pests and nematodes, weed molds and their management strategies), picking and packing of the following mushrooms:

(a) Button mushroom (b) Oyster mushroom (c) Milky mushroom and (d) Paddy straw mushroom

Unit – 5: Post harvest technology **8 Hrs.**

1. Shelf life of mushrooms; preservation of mushrooms - freezing, dry freezing, drying and canning.
2. Quality assurance and entrepreneurship - economics of different types of mushrooms; value added products of mushrooms.
3. Management of spent substrates and waste disposal of various mushrooms.

IV. Text Books:

1. Tavis Lynch (2020) Mushroom Cultivation: An Illustrated Guide to Growing Your Own Mushrooms at Home, Rockridge Press, Emeryville, California, USA
2. Chang, P. and C. P. Bhatnagar (2003) Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact, CRC Press, Boca Raton, Florida, USA
3. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
4. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.

V. Reference Books:

1. Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.
2. Pandey R.K, S. K Ghosh, (1996). A Hand Book on Mushroom Cultivation. Emkey Publications
3. Nita Bhal. (2000). Handbook on Mushrooms (Vol. I and II). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
4. Pathak V.N., Nagendra Yadav and Maneesha Gaur (2000), Mushroom Production and Processing Technology Vedams Ebooks Pvt. Ltd., New Delhi
5. Rattan, S.S. and R.C. Upadhyay (2006) Mushroom Production Technology: Recent Advances, Daya Publishing House, Delhi, India

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Collection of data on various types of mushrooms and making a report.
Evaluation method: Judging the written report, providing feedback on the overall quality, strengths, and areas for improvement.

Unit-2: Activity: Group discussion of mushroom cultivation units and layout.
Evaluation method: Members of the group provide evaluations of their peers' contributions and participation.

Unit-3: Activity: Internship on spawning and casing in mushroom culture.
Evaluation method: A viva-voce at the end of internship based on specific performance metrics and knowledge gained.

Unit-4: Activity: Case study on production techniques for different edible mushrooms.
Evaluation method: Clarity, coherence, and logical structure of the case study report based on identification of key issues, analysis, and synthesis of information.

Unit-5: Activity: A survey report on market demand and consumer preferences for mushrooms and their value-added products.

Evaluation method: Assessing the quality of data analysis, including the use of appropriate statistical techniques, interpretation of results, and meaningful conclusions.

Practical syllabus of Botany Major Course: Semester – IV
5.4 (A): Mushroom Culture Technology

(Total hours of laboratory exercises 30 Hrs. @ 02 Hrs./Week)

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

1. Identify and discriminate different mushrooms based on morphology.
2. Understand facilities required for mushroom cultivation.
3. Demonstrate skills on preparation of spawn, compost and casing material.
4. Exhibit skills on various cultivation practices for an edible mushroom.

II. Laboratory/field exercises:

1. Identification of different types of mushrooms.
2. Preparation of pure culture of an edible mushroom.
3. Preparation of mother spawn.
4. Production of planting spawn and storage.
5. Preparation of compost and casing mixture.
6. Demonstration of spawning and casing.
7. Hands on experience on cropping and harvesting.
8. Demonstration of storage methods.
9. Preparation of value-added products.

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major Course - IV Semester
5.3 (B): Seed Technology
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

I. Learning Objectives: By the end of this course the learner has:
1. To understand the factors responsible for seed dormancy and procedures for break-down.
2. To learn the aspects of seed processing and storage.
3. To acquaint with various practices in seed testing and diagnosis of seed borne diseases.

II. Learning Outcomes: Students at the successful completion of the course will be able to:
1. Explain the causes for seed dormancy and methods to break dormancy.
2. Understand critical concepts of seed processing and seed storage procedures.
3. Acquire skills related to various seed testing methods.
4. Identify seed borne pathogens and prescribe methods to control them.
5. Understand the legislations on seed production and procedure of seed certification.

III. Syllabus of Theory:

Unit - 1: Seed dormancy **8 Hrs.**
1. Seed and grain: Definitions, importance of seed; structure of Dicot and Monocot seed.
2. Role and goals of seed technology; characteristics of quality seed material.
3. Dormancy: Definition, causes for seed dormancy; methods to break seed dormancy.

Unit – 2: Seed processing and storage **10 Hrs.**
1. Principles of seed processing: seed pre-cleaning, precuring, drying, seed extraction; cleaning, grading, pre-storage treatments; bagging and labelling, safety precautions during processing.
2. Seed storage; orthodox and recalcitrant seeds, natural longevity of seeds.
3. Factors affecting longevity in storage; storage conditions, methods and containers.

Unit – 3: Seed testing **10 Hrs.**
1. Definition of seed vigour, viability and longevity; seed sampling and equipment; physical purity analysis.
2. Seed moisture – importance – methods of moisture determination.
3. Seed germination tests using paper, sand or soil – standard germination test; TZ test to determine seed viability; seed health testing.

Unit – 4: Seed borne diseases **10 Hrs.**
1. A brief account of different seed borne diseases and their transmission.
2. Different seed health testing methods for detecting microorganisms.
3. Management of seed borne diseases; seed treatment methods: spraying and dusting.

Unit – 5: Seed certification **7 Hrs.**
1. Objectives - Indian seed Act; seed rules and seed order; new seed policy (1988).
2. Seed Inspector: Duties and responsibilities; classes of seeds, phases of certification standards (i.e., Land requirement, isolation distance) etc.
4. Issue of certificates, tags and sealing; pre and post control check: Genetic purity verification, certification, records and reporting.

IV. Text Books:

1. Sharma G. K. (2012) Seed Science and Technology, Daya Publishing House, New Delhi, India
2. Reddy, M. V. and K. V. Krishna Reddy (2009) Seed Science and Technology: A Comprehensive Manual, BS Publications, Hyderabad, India
3. Lawrence O. Copeland and Miller B. McDonald (2014) Principles of Seed Science and Technology, Springer, New York, USA

4. Agrawal, (2005) Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi

V. Reference Books:

1. Umarani R, Jerlin R, Natarajan N, Masilamani P, Ponnuswamy AS (2006) Experimental Seed Science and Technology, Agrobios, Jodhpur
2. Desai B D 2004. Seeds Hand Book: Processing and Storage, CRC Press
3. Agarwal V K and J B Sinclair 1996, Principles of Seed Pathology, CRC Press
4. Tunwar NS and Singh SN. 1988. Indian Minimum Seed Certification Standards. CSCB, Ministry of Agriculture, New Delhi.
5. McDonald, M.B. and L.O. Copland. 1999. Seed Science and Technology Laboratory Manual, Scientific Publishers, Jodhpur
6. Jagdish Lal and R. C. Saxena (2011) Seed Technology and Seed Pathology, Agrobios (India), Jodhpur, India

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Collection of scientific literature and writing a report on causes for seed dormancy and methods to break down.
Evaluation method: Assessing the overall structure and organization of the report based a pre-determined rubric.
Unit-2: Activity: A critical assignment on factors affecting seeds under storage conditions.
Evaluation method: Assessing the depth of analysis and the originality of ideas presented in the assignment.
Unit-3: Activity: Laboratory experimentation and report preparation on seed germination and viability in some plant species.
Evaluation method: Presentation of report with results, including clear and concise summaries, appropriate visuals (tables, graphs), and effective communication of key findings.
Unit-4: Activity: Collection of diseased seeds, identification of pathogens and presenting a report.
Evaluation method: Judging the appropriateness and effectiveness of the experimental design, selection of variables, and control of confounding factors.
Unit-5: Activity: Group discussion on seed certification process.
Evaluation method: Judging the quality and depth of the content discussed, identifying key ideas, arguments, and supporting evidence.

Practical syllabus of Botany Major Course: Semester – IV
5.3 (B): Seed Technology

(Total hours of laboratory exercises 30 Hrs. @ 02 Hrs./Week)

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

1. Break the seed dormancy using various techniques.
2. Determine seed moisture, seed germination percentage, seed viability and vigour.
3. Identify the seed borne pathogens and prescribe methods to prevent or control them.

II. Laboratory/field exercises:

1. Determination of physical properties of seeds of 3 select local crops (1each from cereals, millets, pulses and oil seeds).
2. Breaking seed dormancy in 3 select local crops.
3. Measurement of seed moisture content by O S W A or moisture meter or oven drying method.
4. Seed germination tests and evaluation.

5. Seed vigour - conductivity test.
6. Accelerated ageing tests.
7. Tetrazolium test.
8. Priming and invigoration treatments for improving germination and vigour.

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major Course - IV Semester
5.4 (B): Plant Propagation Techniques
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

I. Learning Objectives: By the end of this course the learner has:
1. To gain knowledge on asexual propagation methods in plants.
2. To understand the principles pertaining to various vegetative propagation methods.
3. To know the specific propagation method that is applied to a particular species.

II. Learning Outcomes: Students at the successful completion of the course will be able to:
1. Explain various plant propagation structures and their utilization.
2. Understand advantages and disadvantages of vegetative, asexual and sexual plant propagation methods.
3. Assess the benefits of asexual propagation of certain economically valuable plants using apomictics and adventive polyembryony.
4. Demonstrate skills related to vegetative plant propagation techniques such as cuttings, layering, grafting and budding.
5. Apply a specific macro-propagation technique for a given plant species.

III. Syllabus of Thoey:

Unit – 1: Basic concepts of propagation 8 Hrs.
1. Propagation: Definition, need and potentialities for plant multiplication; asexual and sexual methods of propagation - advantages and disadvantages.
3. Propagation facilities: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, phytotrons nursery - tools and implements.
4. 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.
4. 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 10 Hrs.
1. Layering: 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 9 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. Alan Toogood (2003) Plant Propagation, DK Publishing, London, UK
2. Hudson T. Hartmann, Dale E. Kester, Fred T. Davies Jr., and Robert L. Geneve (2010) Plant Propagation: Principles and Practices, Prentice Hall, Upper Saddle River, NJ, USA
3. John Mason (2006) Plant Propagation, Landlinks Press, Collingwood, VIC, Australia
4. Peter Thompson (2006) The Basics of Plant Propagation, Timber Press, Portland, OR, USA

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Preparation of a report on vegetative propagation organs in different plant species of economic importance.
Evaluation method: Assessing the correctness and quality of report prepared using a determined rubric.
Unit-2: Activity: Critical written assignment on polyembryony in various plant species.
Evaluation method: Assessing the depth of analysis and the originality of ideas presented in the assignment.
Unit-3: Activity: Field trip to a horticulture research station to learn propagation of plants by cuttings.
Evaluation method: Participation, observing the student's active involvement, curiosity, and interaction with the experts in the field.
Unit-4: Activity: A case study report on propagation of plants using layering technique.
Evaluation method: Assessing the integration of relevant principles and concepts from the course into the case study analysis.
Unit-5: Activity: Group discussion on grafting techniques in plants.
Evaluation method: Assessing individual participation and contributions during the discussion.

Practical syllabus of Botany Major Course
Semester – IV
5.4 (B): Plant Propagation Techniques

(Total hours of laboratory exercises 30 Hrs. @ 02 Hrs./Week)

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

1. Make use of different plant propagation structures for plant multiplication.
2. Explore the specialized organs or asexual propagules in some plants for their proliferation.
3. Demonstrate skills on micropropagation of plants through vegetative propagation techniques.
4. Evaluate and use a suitable propagation technique for a given plant species.

II. Laboratory/field exercises:

1. Preparation of nursery beds – flat, raised and sunken beds.
2. Propagation through apomictic.
3. Propagation by separation and division technique.
4. Propagation by cuttings.
5. Propagation by layering
6. Propagation by grafting.

7. Propagation by budding.
8. Preparation of potting mixture, potting and repotting.

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major and Minor Course - IV Semester
5.3 (C): Vegetable Crops – Cultivation Practices
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

1. To understand the value of vegetable crops in human nutrition and welfare.
2. To identify various vegetable crops domesticated and being cultivated.
3. To understand the cultivation practices of different vegetable crops.

II. Learning Outcomes:

Students at the successful completion of the course will be able to:

1. Identify different vegetable plants and realize their value in human nutrition.
2. Analyse the types of soils to cultivate vegetable crops.
3. Demonstrate skills on agronomic practices for cultivation of vegetable crops.
4. Acquire knowledge on water, weed and disease managements in vegetable farming.
5. Comprehend aspects related to harvesting and storage of produce.

III. Syllabus of Theory:

Unit – 1: Introduction to Olericulture 9 Hrs.

1. Vegetables and Olericulture: Definitions, nutritive value of vegetables and economic significance of vegetable farming.
3. Classification of vegetable crops (Botanical, based on climatic zones and economic parts used).
4. Types of vegetable gardens (kitchen gardening, terrace gardening, market gardening and truck gardening); implements used in vegetable gardening; vegetable forcing – a brief concept.

Unit – 2: Cultivation of leafy vegetables 10 Hrs.

1. Leafy vegetables: Definition and a brief account of locally cultivated crops.
2. Systematic position, nutritive value, origin, area, production, improved varieties.
3. General cultivation practices such as sowing, planting distance, fertilizer requirements, irrigation, weed management, harvesting; crop specific yield, storage, disease and pest control and seed production of following leafy vegetable crops:
   (a) *Amaranthus* (b) Palak (c) *Hibiscus cannabinus* (d) Fenugreek

Unit – 3: Cultivation of fruity vegetables 10 Hrs.

1. Fruity vegetables: Definition and a brief account of locally cultivated crops.
2. Systematic position, nutritive value, origin, area, production, improved varieties.
3. General cultivation practices such as sowing, planting distance, fertilizer requirements, irrigation, weed management, harvesting; crop specific yield- storage, disease and pest control and seed production of the following fruity vegetable crops:
   (a) Okra (b) Tomato (c) Chillies (d) Brinjal

Unit – 4: Cultivation of peas and beans 8 Hrs.

1. A brief account of locally cultivated peas and beans.
2. Systematic position, nutritive value, origin, area, production, improved varieties.
3. General cultivation practices such as sowing, planting distance, fertilizer requirements, irrigation, weed management, harvesting; crop specific yield, storage, disease and pest control and seed production of the following pea/bean crops:
   (a) *Dolichos* (b) Cluster bean (c) French bean

Unit – 5: Cultivation of root and tuber crops 8 Hrs.

1. A brief account of locally cultivated root and tuber crops.
2. Systematic position, family, nutritive value, origin, area, production, improved varieties.
3. General cultivation practices such as sowing, planting distance, fertilizer requirements, irrigation, weed management, harvesting; crop specific yield, storage, disease and pest control and seed production of the following root/tuber crops:
   (a) Carrot (b) Radish (c) Sweet potato (d) Potato

IV. Text Books:

1. Bose T K et al. (2003) Vegetable crops, Naya Udhyog Publishers, Kolkata.
2. Singh D K (2007) Modern vegetable varieties and production, IBN Publisher Technologies, International Book Distributing Co, Lucknow.
3. Premnath, Sundari Velayudhan and D P Sing (1987) Vegetables for the tropical region, ICAR, New Delhi
4. Shanmugavelu, K. G. 1989. Production Technology of Vegetable Crops. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
5. Rana MK. 2008. Scientific Cultivation of Vegetables. Kalyani Publ., New Delhi
6. Rubatzky VE and Yamaguchi M. (Eds.). 1997. World Vegetables: Principles, Production and Nutritive Values. Chapman & Hall, London.

V. Reference Books:

1. Gregory E. Welbaum (2014) Vegetable Production and Practices, CABI, Wallingford, UK
2. Salunkhe, D. K. and S. S. Kadam (2012) Handbook of Vegetable Science and Technology: Production, Compostion, Storage, and Processing, CRC Press, Boca Raton, FL, USA
3. Ray A. Larson (2018) Vegetable Crop Science, Cengage Learning, Boston, MA, USA
4. Edward C. Smith (2009) The Vegetable Gardener's Bible, Storey Publishing, North Adams, MA, USA
5. Warren R. Henderson, George A. Constantine, and Michael D. Barbercheck (2018) Vegetable Crops,Wiley-Blackwell, Hoboken, NJ, USA

VI. Suggested activities and evaluation methods:

Unit-1: Activity: A study report on vegetable gardens in their local area.
Evaluation method: Evaluate the reliability and validity of data collection based on a rating scale.
Unit-2: Activity: A case study report on various leafy vegetable crops in Andhra Pradesh.
Evaluation method: Examine the depth and coherence of the discussion and interpretation based on a rubric.
Unit-3: Activity: A written assignment on cultivation practices for a fruity vegetable.
Evaluation method: Assess the uniqueness and innovative aspects of the assignment based on a rating scale.
Unit-4: Activity: A written assignment on pests and diseases of peas and beans in their locality.
Evaluation method: Assess the depth and quality of critical thinking, analysis, and synthesis of information.
Unit-5: Activity: Group discussion on cultivation practices for root and tuber crops.
Evaluation method: Assess the level of cooperation, collaboration, and teamwork within the group.

Practical syllabus of Botany Major Course: Semester – IV

5.3 (C): Vegetable Crops – Cultivation Practices

(Total hours of laboratory exercises 30 Hrs. @ 02 Hrs./Week)

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

1. List out, identify and handle different garden implements.
2. Identify the important vegetable crops grown in their locality.
3. Demonstrate various skills in cultivation of vegetable crops.
4. Identify pests, diseases and their remedies that are specific to a vegetable crop.

II. Laboratory/field exercises:

1. Identification of seeds of important local vegetable plants and preparation of herbarium.
2. Identification of local vegetable crops and handling of garden tools.
3. Analysis of garden soil for ratios of physical characteristics by sieve separation.
4. Determination of chemical characters of garden soil (pH, EC, Organic Carbon, SAR).
5. Planning and layout of a vegetable crop farm.
6. Preparation of nursery bed (raised, sunken and flat beds) and sowing of seeds.
7. Transplanting and care of vegetable seedlings.
8. Intercultural operations in vegetable plots.
9. Estimation of Total Soluble Solids (TSS) by Refractometer in a fruit and a leafy vegetable.
10. Estimation of Vitamin - C in a fruit and a leafy vegetable by DCIP method.
11. Identification of pests and disease-causing organisms on any two vegetable plants.
12. Seed extraction in tomato and brinjal.

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major Course - IV Semester
5.4 (C): Vegetable Crops – Post Harvest Practices
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

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

1. To understand the importance of post-harvest practices to safe guard the vegetable products.
2. To gain knowledge on storage and processing of vegetable products.
3. To know the value addition to the vegetable products and their marketing

II. Learning Outcomes: Students at the successful completion of the course will be able to:

1. Understand various practices for vegetable produce from harvesting to marketing.
2. Demonstrate skills on storage, processing and preservation of vegetables.
3. Summarize causes for spoilage of vegetables before and during storage and methods to prevent and control them.
4. Make use of preservation methods to reduce the loss of vegetable produce.
5. Explain about value added products, packaging and marketing of vegetables.

III. Syllabus of Theory:

Unit – 1: Introduction to Post Harvest Practices 8 Hrs.

1. Post Harvest Technology: Definition; importance, scope and future status of post-harvest management of vegetables.
2. Study of maturity standards of vegetables; harvest techniques of vegetables, methods stages, signs of harvesting; harvesting and its relationship with quality, sorting and grading.
3. Careful handling of harvested vegetables; pre-harvest and post-harvest factors responsible for ripening.

Unit – 2: Methods of storage 9 Hrs.

1. Climacteric and non-climacteric types of vegetables.
2. Methods of storage to prolong shelf life of harvested vegetables; on-farm storage, evaporatively cooled stores, ventilated storage, pit storage etc.
3. Refrigerated storage, refrigeration cycle, controlled and modified atmosphere, hypobaric storage.

Unit – 3: Processing of vegetables 10 Hrs.

1. Causes for spoilage of vegetables and control measures during storage; post-harvest disease and pest management.
2. Techniques to prevent deterioration; vegetable processing equipment; minimal processing of vegetables.
3. Safe chemicals and microbial limits; application of growth regulators for quality assurance; grading.

Unit -4: Preservation and value-addition 10 Hrs.

1. Importance and scope of vegetable preservation in India; principles underlying general methods of preservation.
2. Methods of preservation; food additives and food colours.
3. Fried products, process of frying; dried vegetables; sauces and chutneys, pickles and salted vegetables; by-product and waste utilization.

Unit – 5: Marketing of vegetable products 8 Hrs.

1. Packing line operations, packaging of vegetables and their products; transportation; codex norms for export of perishables.
2. Demand supply analysis of important vegetables; market potential of various vegetables products.
3. Important marketing agencies and institutions; importance of cooperative marketing.

IV. Text Books:

1. Giridharilal GS, Siddappa and Tandon GL. (1986) Preservation of Fruits and Vegetables. ICAR, New Delhi.
2. Srivastava RP and Kumar S. (2003) Fruit and Vegetable Preservation: Principles and Practices. International Book Distribution Company, Lucknow.
3. Salunkhe D.K. and Kadam SS. (1998) Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing. Marcel Dekker, New York.

V. Reference Books:

1. Arthey D and Dennis C. (1996) Vegetable Processing. Blackie/Springer-Verlag, New York
2. Verma LR and Joshi VK. (2000) Post-harvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management. Indus Publishing Company, New Delhi
3. Jerry A. Bartz (2018) Postharvest Physiology and Pathology of Vegetables, CRC Press, Boca Raton, Florida, USA
4. Verma L. R. and J. P. Pandey (2014) Postharvest Technology of Fruits and Vegetables: General Concepts and Principles, International Book Distributing Co., Lucknow, India

VI. Suggested activities and evaluation methods:

Unit-1: Activity: A written assignment on pre-harvest and post-harvest factors affecting vegetable products.

Evaluation method: Assess the accuracy and relevance of the content to the assignment's topic based on a rubric.

Unit-2: Activity: Visit to vegetable storage units in public or private sector.

Evaluation method: The level of student engagement and active participation during the trip based on a grading scale.

Unit-3: Activity: A case study report on various processing methods used for vegetables.

Evaluation method: Consider the overall quality of the case study report based on a grading scale.

Unit-4: Activity: A survey report on different value-added products of vegetables available in local markets.

Evaluation method: Examine the depth and coherence of the discussion and interpretation of the results based on a rubric.

Unit-5: Activity: Group discussion on packaging and transport of vegetable products.

Evaluation method: Assess the level of cooperation, collaboration, and teamwork within the group based on a grading scale.

Practical syllabus of Botany Major Course: Semester – IV

5.4 (C): Vegetable Crops – Post Harvest Practices

(Total hours of laboratory exercises 30 Hrs. @ 02 Hrs./Week)

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

1. Identify stages of maturity in vegetable crops.
2. Handle material for storage of vegetables.
3. Identify physical and biological causes for spoilage of vegetables.
4. Make some value-added products of vegetables.

II. Laboratory/field exercises:

1. Maturity selection and harvest, harvesting practices.
2. List and cost of equipment, utensils, and additives required for small scale processing industry.
3. Study of different types of spoilages in fresh as well as processed vegetables.
4. Identification and classification of spoilage organisms.
5. Estimation of total carbohydrates (Anthrone method) in a stored vegetable and un-stored vegetable.
6. Estimation of protein (Lowry method) in a stored vegetable and un-stored vegetable.
7. Sensory evaluation of fresh and processed vegetables.
8. Assessment of quality and grading, pre-packaging and protective treatments.
9. Identification of packaging materials, containers for packaging.
10. Preparation of pickle from a vegetable.
11. Preparation of tomato sauce, ketchup and chutney.

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major Course - IV Semester
5.3 (D): Gardening and Landscaping
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

I. Learning Objectives: By the end of this course the learner has:
1. To study the principles in designing and creating a garden.
2. To learn various techniques practiced in maintenance of gardens.
3. To gain knowledge on planning and execution of landscaping projects.

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

III. Syllabus of Theory:

Unit-1: Introduction to gardening 8 Hrs.
1. Gardening: Definition and its benefits, home garden and its importance.
2. Basic gardening principles - soil preparation, watering, and fertilization.
3. Choosing the right plants for your garden and understanding their needs.
4. Different types of gardening – roof, terrace, vertical gardening; tools and equipment needed for gardening.

Unit-2: Planning and creating a garden 9 Hrs.
1. Planning and designing a garden space; shade loving plants for home garden, suitable annuals, perennials and flowering trees.
2. Introduction to potted plants, terrarium; Introduction, definition, methodology on bonsai planting.
3. Understanding the life cycle of plants; pruning, trimming, and shaping plants for optimal growth.
4. Health, pest and disease management strategies; composting and soil amendment techniques.

Unit-3: Advanced gardening techniques 8 Hrs.
1. Introduction to commercial gardening; brief account of propagation methods for plants (Cuttings, grafting, and seeding).
2. Advanced pruning techniques for trees and shrubs; techniques for creating garden structures (trellises and raised beds).
3. Garden design principles and aesthetics.
4. Introduction to sustainable gardening practices (permaculture and organic gardening).

Unit-4: Introduction to landscaping 10 Hrs.
1. Definition of landscaping; historical and cultural significance of Landscaping.
2. Elements of landscaping design: colour, texture, form, line, and scale.
3. Principles of landscaping design: Balance, proportion, rhythm, unity and contrast.
4. Site analysis and assessment; soil types, texture, and structure.
5. Plant selection and maintenance; water management and conservation.

Unit-5: Implementation of landscaping projects 10 Hrs.
1. Project management and planning; site preparation and excavation.
2. Hard scaping: Materials, design, and installation of walkways, patios, and walls; landscape lighting -design and installation.
3. Soft scaping: Planting, irrigation methods and maintenance.

4. Budgeting and cost estimation; safety practices and regulations in landscaping. sustainable landscaping practice.

IV. Text Books:

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 and evaluation methods:

Unit-1: Activity: A survey report on various gardens and plants in those gardens from their locality.

Evaluation method: Evaluate the reliability and validity of data collection based on a grading scale.

Unit-2: Activity: Making a design of a good ornamental garden.

Evaluation method: Evaluate the overall visual appeal, aesthetics, and attractiveness of the design.

Unit-3: Activity: A case study on various types of garden structures.

Evaluation method: Assess how well the case study presents and discusses lessons learned.

Unit-4: Activity: Making a landscape design and implementation.

Evaluation method: Evaluate the level of technical proficiency and skill demonstrated in the design as per a rubric.

Unit-5: Activity: Group discussion on living and non-living elements in a landscape.

Evaluation method: Assess the level of preparation and knowledge demonstrated by the group members.

Practical syllabus of Botany Major Course: Semester – IV
5.3 (D): Gardening and Landscaping

(Total hours of laboratory exercises 30 Hrs. @ 02 Hrs./Week)

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

1. Identify various components required for a garden.
2. Design and develop a garden.
3. Make landscape designs and manage a landscape.

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. Designing of tray landscape
5. Designing of terrarium
6. Identification of physical elements in landscape
7. Establish and maintenance of lawn and grass suitable for lawn.
8. Making of topiaries.
9. Making of hedges and plant suitable for hedges.

CBCS / Semester System (w.e.f. 2023-'24 Admitted Batch)
Botany Major Course - IV Semester
5.4 (D): Agroforestry
Total hours of teaching – Theory: 45 @ 03 Hrs. /Week.

I. Learning Objectives: By the end of this course the learner has:
1. To understand value of agroforestry to reclaim waste lands.
2. To gain knowledge of diverse systems of agroforestry.
3. To learn various cultivation practices in relation to distinct plant species.

I. Learning Outcomes:
Students at the successful completion of the course will be able to:
1. Explain the concepts and economic value of agroforestry.
2. Acquire a critical knowledge on systems and design of agroforestry.
3. Discuss the silviculture practices in relation to agroforestry.
4. Evaluate the role of agroforestry to reclaim the waste lands.
5. Perform skills in relation to tree measurement techniques.

III. Syllabus of Theory:

Unit-1: Basic concepts of Agroforestry 8 Hrs.
1. Forest and Agroforestry. Definition, objectives, scope and advantages of agroforestry; classification of agroforestry; differences between social forestry and agroforestry.
2. Agroforestry practices as existing in India and Andhra Pradesh.
3. Criteria for selection and screening of tree species; design and diagnosis methodology in relation to agroforestry.

Unit-2: Systems of Agroforestry 8 Hrs.
1. Global agroforestry system: shifting cultivation, taungya cultivation, shelter belt and wind breaks, and energy plantation and homestead gardens.
3. Multipurpose tree species and their characteristics; criteria for selection of agroforestry design, role tree architecture and management in agroforestry.
4. Alley cropping, high density short rotation plantation systems, silvicultural woodlots, energy plantations.

Unit-3: Silviculture of Agroforestry trees 12 Hrs.
1. Silviculture: Definition, objectives and scope and its place in agroforestry.
2. Choice of species, site selection, and pure verses mixed crop, planting techniques and methods, protection of seedlings/ plantations from environmental and biological adversaries, tending operations, concept of coppice etc.
4. Silviculture of agroforestry trees with special reference to: (a) *Azadirachta indica*, (b) *Tectona grandis* (c) *Emblica officinalis* and (d) *Tamarindus indica*.

Unit-4: Waste land reclamation 10 Hrs.
1. Wasteland definition, types: ecological characteristics, landslides, soil erosion, hoods, drought, salinity, water logging and fire.
5. Biological causes of deforestation, grazing, shifting cultivation and faulty agricultural practices.
6. Reclamation of wastelands, scientific land use practices, afforestation, soil conservation practices, improvement of water catchment areas and development of recreational and amenity areas.

Unit-5: Measurements in Agroforestry 7 Hrs.
1. Tree measurement techniques: Instruments and methods for measurement of tree diameter, height, bark thickness, crown volume crown surface area.

2. Tree stem form, yield tables, volume tables, concept of sustained yield, and kind of tree rotation, increment and yield; estimation of biomass.
3. Determination of tree age and introduction of working plan.

IV. Text Books:

1. Dwivedi, A.P. (1992). Agroforestry: Principles and Practices. Oxford & IBH
2. Nair, P.K.R. (1993). An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, Netherlands
3. Rajeshwar Rao G., M. Prabhakar, G. Venkatesh, I. Srinivas and K. Sammi Reddy (2018) Agroforestry Opportunities for Enhancing Resilience to Climate Change in Rainfed Areas, ICAR-CRIDA, Hyderabad.

V. Reference Books:

1. Nair P.K.R., M.R. Rai and L.E.Buck, (2004). New Vistas in Agroforestry. Kluwer Academic
2. Publishers, Dordrecht, Netherlands
3. Young, A. (1997). Agroforestry for Soil Management. CABI
4. Shibu Jose, Anu Rangarajan, and Catherine L. Bevier (2008) Agroforestry for Natural Resource Management, Springer, Dordrecht, Netherlands.
5. Andrew Gordon and Tony J. Marshall (2015) Agroforestry in Sustainable Agricultural Systems, CRC Press, Boca Raton, Florida, USA

VI. Suggested activities and evaluation methods:

Unit-1: Activity: A case study report on agroforestry practices in India and abroad.
Evaluation method: Assessing the appropriateness of the data collection methods, sampling techniques, and analysis procedures.
Unit-2: Activity: Group discussion on various systems of agroforestry.
Evaluation method: Evaluating the capacity to analyze complex issues, propose creative solutions, and engage in effective decision-making processes as a team as per a grading scale.
Unit-3: Activity: A critical assignment on various agroforestry plants cultivated in India and abroad.
Evaluation method: Evaluating the overall clarity, coherence, and effectiveness of the writing style based on a rubric.
Unit-4: Activity: A study report on diverse waste lands in their locality and suitable plants for cultivation.
Evaluation method: Assessing the clarity and logical coherence of the study's conclusion based on a rubric.
Unit-5: Activity: Hands on practice on tree measurements in agroforestry.
Evaluation method: Assessing the trainee's development and improvement of job-specific skills during the training period.

Practical syllabus of Botany Major Course: Semester – IV
5.4 (D): Agroforestry

(Total hours of laboratory exercises 30 Hrs. @ 02 Hrs./Week)

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

1. Identify suitable tree species for agroforestry and their products.
2. Demonstrate skills on raising tree species from seeds and by vegetative propagation.
3. Perform skills on measurements related to wood-based products.
4. Estimate biomass in an energy plantation.

II. Laboratory/field exercises:

1. Identification of agroforestry tree-species.
2. Identification of important major and minor agroforest products.
3. Collection and maintenance of agroforest products and herbarium
4. Nursery lay out seed sowing and pre-sowing seed treatments.
5. Vegetative propagation techniques – hard wood cuttings and air layering.
6. Diameter measurements using callipers and tape; diameter measurements of forked, buttressed, fluted and leaning trees.
7. Height measurement of standing trees by shadow method, single pole method and hypsometer.
8. Volume measurement of logs using various formulae.
9. Biomass estimation in energy plantations.

Suggested Model Paper for Theory Question Papers

Common pattern for Question Paper for Theory Examination(s) at Semester end

Max. Time: 3 Hrs. **Max. Marks: 75 M**

Section – A

Answer all the following questions. **5 x 2 = 10 M**

- ✓ One question should be given from each Unit in the syllabus.

Section – B

Answer any three of the following questions. Draw a labelled diagram wherever necessary.

3 x 5 = 15 M

- ✓ One question should be given from each Unit in the syllabus.

Section – C

Answer any five of the following questions. Draw a labelled diagram wherever necessary.

5 x 10 = 50 M

- ✓ Two questions (a & b) are to be given from each Unit in the syllabus (internal choice in each unit). Student has to answer 5 questions by choosing one from a set of questions given from a Unit.

Note: Questions should be framed in such a way to test the understanding, analytical and creative skills of the students. All the questions should be given within the frame work of the syllabus prescribed.

Suggested Model Paper for Practical Examination

Common pattern for Question Paper for Practical Examination(s) at Semester end

Max Time: 3 Hrs. **Max. Marks: 50**

1. Experiment-1 (Major Experiment)	15 M
2. Experiment-2 (Minor Experiment)	10 M
3. Spotters	3 x 5 = 15 M
4. Record + Viva-voce	7 + 3 = 10 M