

BOTANY

Semester-I

Paper: Basics of Botany – I

Course Code: BO-1501

No. of Credits: 04

Learning Hours: 60 hrs

Learning Objectives: The students will be able to:

1. Understand the morphology, structure and importance of the organisms
2. State the meaning of scientific terms
3. Differentiate between various groups of Algae, Fungi, Bryophytes and Pteridophytes.
4. Understand the morphology, structure and functions of various parts of plants.
5. Learn the taxonomical terminology and understand the meaning of the same.
6. Learn anatomical structure and function of various tissues.
7. Acquainted with basic concepts of Ecology and Environment.
8. Able to understand the interactions taking place in the Ecosystems and the flow of energy.
9. Able to appreciate the diversity of Ecosystems.
10. The students will be able to understand:
11. The structure, composition and role of DNA and RNA.
12. The mechanism, role and importance of fundamental processes of replication and protein synthesis.

Unit-1: Plant diversity: Study of lower plants

Algae

1. Occurrence and thallus organization.
2. Modes of reproduction.
3. General account of Chlorophyta.
4. Type studies: Distribution, life cycle and systematic position of Spirogyra.
5. Economic importance of Algae (as food, fodder and fertilizer).

Fungi

1. Thallus organization in Fungi.
2. Mode of nutrition in Fungi.
3. Modes of reproduction.
4. Type studies: Distribution, life cycle and systematic position of Mucor.
5. Economic importance of Fungi (as food and medicine).

Bryophyta

1. General characters of Bryophytes.
2. Type studies: Distribution, life cycle and systematic position of Riccia.

Pteridophyta

1. General characters of Pteridophytes.
2. Type studies: Distribution, life cycle and systematic position of Nephrolepis.

Unit-2: Morphology of angiosperms

Morphology and anatomy of angiosperms

1. Leaf.

2. Simple and Compound leaves.
3. Types of Leaf incisions. Leaf margin. Leaf tip.
4. Phyllotaxy.
5. Bracts- Scaly, Involucral, Foliaceous, Petaloid and Spathe.
6. Flower- Complete, incomplete, actinomorphic, zygomorphic, irregular.
7. Inflorescence- Racemose, Cymose and special kinds.
8. General characters and functions of various kinds of plant tissues:
 - a. Meristematic tissues.
 - b. Simple tissues.
 - c. Complex tissues.

Unit-3: Plants and environment

1. Introduction, Scope and Branches of Ecology
2. Ecosystems:
 - Kinds of Ecosystem: Natural, Artificial
 - Structure and Functions of Ecosystems
 - Ecological Pyramids, Productivity of an Ecosystem, Energy flow in an Ecosystem
 - Biogeochemical Cycles-Carbon, Nitrogen, Phosphorus, Sulfur, Components of Freshwater Ecosystem (Pond) Components of Terrestrial Ecosystem (Grassland) Food chain and food web.
3. Biotic Factors:
 - Symbiosis: Mutualism, Proto-cooperation, Commensalism
 - Antagonism: Predation, Parasitism, Antibiosis, Competition, Saprophytism
4. Concept of Sustainable Biodiversity:
 - Case study: The Messenger Pigeon gone forever

Unit-4: Genetics and Molecular biology

1. DNA and RNA Composition and Structure
2. Watson and Crick's model of DNA
3. Types of RNA
4. DNA Replication
5. Genetic code
6. Protein Synthesis
7. Regulation of gene expression in prokaryotes – Operon concept

Reference Books:

1. Smith, Gilbert M; Cryptogamic Botany Algae & Fungi Volume 1; 2nd edition; McGraw-hill Book Comp. Tokyo, 1955.
2. Vasishtha B.R. And Sinha A. K. - Botany for degree students Part 1 ALGAE; S. Chand & Company Ltd, 1st edition, revised 2005.
3. Vasishtha B.R. And Sinha A. K. - Botany for degree students Part 2 FUNGI; S. Chand & Company Ltd, 1st edition, revised 2005.
4. Alexopoulos, Constantine J.; Mims, Charles W; Introductory Mycology; 3rd edition; New Delhi: Wiley Eastern Limited, 1983.
5. Webster, J.1985. *Introduction to Fungi*. Cambridge University Press.

6. Smith, Gilbert M; Cryptogamic Botany Bryophyta&Pteridophyta Volume 2; 2nd edition; McGraw-hill book Comp. Tokyo, 1955.
7. Parihar, N.S.; Pteridophytes: An introduction to Embryophyta, Vol.II; 4th edition; Allahabad: Central Book Depot, 1962.
8. Kar, Ashok Kumar;Gangulee, Hirendra Chandra; College botany: Volume II; 2nd edition; Kolkata: New Central Book Agency (P) Ltd, 1989, 2006.
9. Sporne, K.K. 1991. *The Morphology of Pteridophytes*.B.I. Publishing Pvt. Ltd. Bombay.
10. Singh V., Pande P.C., Jain D.K.; A Textbook of Botany, 4th Edition; Rastogi publications, 2013.
11. Dutta, A.C.; A Class-book of Botany; 15th edition; Calcutta: Oxford University Press, 1976.
12. Sivarajan, V.V.; Introduction to the principles of plant taxonomy; 2nd edition; Cambridge: Cambridge University Press, 1991.
13. Subramanian, N.S.; Modern plant taxonomy; New Delhi: 1st edition; Vikas Publishing House Pvt. Ltd., 1995.
14. Lawrence, George H.M.; Taxonomy of Vascular Plants; 1st edition; New Delhi: Oxford & IBH Publishing Co., 1967.
15. Sharma, O.P.; Plant Taxonomy; 1st edition, reprint; New Delhi: Tata McGraw-Hill Publishing Co. Ltd., 1993(2002)
16. Esau, Katherine; Anatomy of seed plants; 2nd edition; New York: John Wiley & Sons, 1977.
17. Gangulee, H.C.,Das, K.S., Dutta C.T.; College Botany Vol I; Kolkatta: New Central Book Agency, 2002.
18. 8.Naik, V.N. 1984. *Taxonomy of Angiosperms*; New Delhi:Tata McGraw - Hill Publishing Co. Ltd., 1984.
19. Fahn, A; Plant anatomy; 4th edition. Indian reprint; New Delhi: Aditya Books (P) Ltd., 1990(1997).
20. Eames, Arthur J.;MacDaniels, Laurence H.; An introduction to plant anatomy; 2nd edition. Reprint; New Delhi: Tata McGraw-Hill Publishing Company Limited, (1978, 2004).
21. Tayal M.S.; Plant Anatomy; Rastogi publications, 1983.
22. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick; Molecular Biology of the Gene, 5th Edition; Pearson Education, 2004.
23. Lewin, B..Genes VIII;NewYork:Oxford University Press, 2000.
24. Alberts, B., Bray,D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D.; Molecular Biology of the Cell.NewYork:Garland Publishing, Inc..
25. Wolfe, S.L.;Molecular and Cellular Biology. California, USA: Wadsworth Publishing Co., 1993.
26. Kleinsmith, L.J. and Kish, V.M.;Principles of Cell and Molecular Biology,2nd Ed.,New York, USA:Harper Collins College Publishers, 1995.
27. Subrahmanyam, N.S.;Sambamurty, A.V.S.S.; Ecology; 1st edition; New Delhi: Narosa Publishing House, 2000.
28. Sharma, P.D.; Ecology and Environment; 7th edition; Meerut:Rastogi Publishers, 1998.
29. Odum, E.; Barrick M.; Barrett G.; Fundamentals of Ecology, 5th edition; New Delhi: Cengage Learning India, Pvt. Ltd., 1971.
30. Miller, G. Tyler; Textbook of Ecology, New Delhi: Cengage Learning India,2009.

BOTANY

Semester-I

Paper: Basics Practicals - I

Course Code: BO-1502L

No. of Credits: 04

Learning Hours: 60 hrs

1. Study of Algae- *Spirogyra*
 - a. Mounting- Thallus, conjugation types.
 - b. Permanent slides - Thallus and conjugations.

2. Study of Fungi- *Mucor*
 - a. Specimen- Bread/ Roti with Mucor.
 - b. Mounting- Reproductive structure- spores, sporangia.
 - c. Permanent slides- Mucor sporangia, Zygosporangia.

3. Study of Bryophytes-*Riccia*
 - a. Specimen - Thallus with Sporophyte.
 - b. Permanent slides – Thallus, sporophyte, thallus with Antheridia and Archegonia.

4. Study of Pteridophytes- *Nephrolepis*
 - a. Specimen- Sporophytic plant.
 - b. Mounting- Ramenta, Hydathode, Sporangia.
 - c. Permanent slides- Prothallus with Antheridia and Archegonia; T.S. leaflet passing through sorus.

5. Study of morphological characters of Leaf, bracts, flower and inflorescence (as per theory syllabus).

6. Study of various types of Simple tissues from Sunflower and Cucurbita stems (T.S. and L.S.) through fresh material and permanent slides. Study of complex tissues through maceration.

7. Study of Biotic Factors- examples of Symbiosis and Antagonism (through charts / models / specimens)
 - a. Ecological Pyramids (Number, Biomass and Energy).
 - b. Ecosystems: Pond and Grassland.
 - b. Symbiosis- Root nodules, Lichen
 - c. Protocooperation- Hermit crab and Fierasfer fish
 - d. Antagonism- Cuscuta, Loranthes, Viscum, Utricularia, Nepenthes, Drosera

8. Detailed study of Genetic Codes.

9. Study of structure of Nucleic acids (DNA, RNA) through charts or models- Watson & Crick Model.

10. DNA Replication and Protein Synthesis through charts or models.

Basics of Botany Practicals - I (BO-1502L)

Semester-I

Total Marks: 35

Time: 3 Hours

- Q.1 Identify whether specimen A is an algae, fungi, bryophyte or pteridophyte, giving general characters. 03
- Q.2 Identify and describe Specimen B. 03
- Q.3 Mount the _____ from the Specimen C. 03
- Q.4 Mention the Amino Acids for the _____, _____, _____, Genetic Codes 02
- Q.5 Take T.S./ L.S./or maceration of the given specimen D, and make a temporary preparation. Stain if needed and show _____ to the examiner. 04
- Q.6 Identify and Describe the specimens 12
Specimen E (Algae or Fungi or Bryophyte or Pteridophyte)
Specimen F (Morphology)
Specimen G (Morphology)
Specimen H (Anatomy)
Specimen I (Ecology) m
Specimen I (Genetics)
- Q.7 Project & Viva 06
- Q.8 Journal 02
Guidance for arrangement of specimens in the examination.
Specimen A: Algae or Fung or Bryophyte or Pteridophyte.
Specimen B: Algae or Fung or Bryophyte or Pteridophyte.
Specimen C: Reproductive structure of Algae, Fungi, Bryophytes or Pteridophytes or Ramenta or Hydathode may be asked.

Project

The PROJECT will be on Plant Morphology. Students will study the morphological characters present in living plant specimens from the field. These are to be presented as an individual project which may contain pressed plant materials/original photographs/original drawings presented in a creative manner.

Semester – II

Botany: Basics of Botany-II

Course Code: BO-2501

No. of Credits: 04

Learning Hours: 60 hrs

Learning Objectives: The students will learn

1. The life cycle of individuals belonging to Gymnosperms, Dicotyledons and Monocotyledons.
2. The taxonomical terminology and understand the meaning of the same.
3. To differentiate between Gymnosperms, Dicotyledons and Monocotyledons.
4. Understand the morphology, structure and functions of various parts of plants.
5. Learn the taxonomical terminology and understand the meaning of the same.
6. Learn about various classification systems and the basis of classification of these systems.
7. Learn various plant families and their economic importance.
8. And differentiate between the physiological processes and their importance.
9. The factors which affecting flowering in plants.
10. The respiratory process in the presence of light.
11. Able to understand use of plant resources for food and medicine.
12. Able to understand basic concepts of gardening, including types of gardens and garden plants.
13. Acquainted with the latest technological developments in the field of Biotechnology and plant tissue culture.

Unit-1: Gymnosperms

1. General characters of Gymnosperms: occurrence, morphology and reproduction.
2. Cycas: Occurrence, distribution, taxonomic position, morphology, reproduction and life history of the genus (excluding anatomy),

Angiosperms

1. General characters of Dicotyledons and Monocotyledons.
2. Sunflower and Maize: Occurrence, distribution, taxonomic position, morphology, reproduction and life history of the genus (excluding anatomy).

Unit-2: Morphology and taxonomy of angiosperms

Morphology of angiosperms

1. Stipules: types and modifications.
2. Types of placentation.
3. Types of aestivation.

Taxonomy of angiosperms

1. Introduction to systems of classification—Artificial, Natural and Phyllogenetic.
2. Bentham and Hooker's system of classification.
3. Study of the following families.
 - a. Dicotyledons- Polypetalae – *Malvaceae*
 - b. Dicotyledons- Gamopetalae- *Convolvulaceae*
 - c. Dicotyledons- Apetalae- *Nyctaginaceae*
 - d. Monocotyledons- *Amaryllidaceae*

Unit-3: Plant physiology

1. Plant-Water Relations:
 - a. Water Potential
 - b. Diffusion,
 - c. Imbibition,
 - d. Osmosis,
 - e. Plasmolysis
2. Physiology of Flowering:
 - a. Role of temperature in flowering (Vernalization)
 - b. Role of light in flowering (Photoperiodism)
3. Respiration
 - a. Outline of Respiratory metabolism.
 - b. Glycolytic pathway.
 - c. Oxidative Pentose Phosphate Pathway.
 - d. Anaerobic respiration.
 - e. Tricarboxylic Acid Cycle.
 - f. Respiratory Chain.
 - g. Significance of ATP.
 - h. Chemiosmotic theory.

Unit-4: Plant resources, Gardening and Biotechnology

1. **Plant resources:** Botanical name, common name, family, useful part, brief description, important chemical constituents if any, climate and cultivation (only for cereals, pulses and oil seeds) and uses of the following plants:
 - a. Cereals- Wheat, Rice
 - b. Pulses- Gram
 - c. Medicinal plants- Ginger, Aloe, Neem and Ashwagandha
2. **Gardening:**
 - a. Introduction, Uses of gardens.
 - b. Types of gardens (Kitchen garden, water garden, rock garden and terrace garden)
 - c. Garden Operations- digging, planting
 - d. Identification of common plants for different garden location. (Minimum 5 plants for each location): paths, avenue, hedges and flower beds.
3. **Biotechnology:**
 - a. Introduction, Brief History, Scope and Types of Plant Biotechnology.
 - b. Plant Tissue Culture – Tools & Technique; Applications

Reference Books:

1. Chamberlain, Charles Joseph; Coulter, John Merle; Morphology of Gymnosperms; 2nd edition; Allahabad: Central Book Depot, 1964.
2. Chamberlain, Charles Joseph; Gymnosperms: structure and evolution; 2nd edition; New York: Dover Publications, Inc., 1966.
3. Bhatnagar, S.P.; Moitra, A.; Gymnosperms. ., New Delhi: New Age International Pvt. Ltd., 1996.

4. Raghavan, V.; *Developmental Biology of Flowering plants*; New York: Springer - Verlag, 1999.
5. Vasishta P.C.; *Botany for degree students- Vol. V, Gymnosperm*; Delhi: S. Chand, 1983.
6. Chopra G.L., Nagin S.; *Gymnosperm*; Jullundhar: S. Nagin & Co., 1978.
7. Dutta, A.C.; *A Class-book of Botany*; 15th edition; Calcutta: Oxford University Press, 1976.
8. Sivarajan, V.V.; *Introduction to the principles of plant taxonomy*; 2nd edition; Cambridge: Cambridge University Press, 1991.
9. Subramanian, N.S.; *Modern plant taxonomy*; New Delhi: 1st edition; Vikas Publishing House Pvt. Ltd., 1995.
10. Lawrence, George H.M.; *Taxonomy of Vascular Plants*; 1st edition; New Delhi: Oxford & IBH Publishing Co., 1967.
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14. Naik, V.N. 1984. *Taxonomy of Angiosperms*; New Delhi: Tata McGraw - Hill Publishing Co. Ltd., 1984.
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22. Salisbury, Frank B.; Parke, Robert V.; *Vascular plants: form and function*; London: Macmillan & Co Ltd, 1964.
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24. Ganguly A.K., Kumar N.C.; *General Botany, Vol II, Part II: Introduction to plant physiology*; 7th Edition; Emkay Publications, 1990.
25. Verma V.; *Text Book of Economic Botany*; Delhi: Ane Books, 2009.
26. Kochhar S.L., Elbaum L., Einstein E.; *Economic Botany in the Tropics*; Pan MacMillan, 2012.
27. Hill A.F.; *Economic Botany*, 2nd Edition; New York: McGraw -Hill, 1992.
28. Samba Murty A.V.S.S., Subramanyam N.S.; *Economic Botany of Crop Plants*; Asia tech Publishers, 2000.

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30. Futehally Laeeq; Gardens, 2nd Edition; New Delhi: National Book Trust, 1990.
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34. Bhojwani, S.S.; Plant Tissue Culture: Theory and Practical (a revised edition). New York, USA: Elsevier Science Publishers, 1990.
35. Ignacimuthu S.; Basic Biotechnology; Tata McGraw Hill, 1995.
36. Dubey, R.C.; Text Book of Biotechnology; S.Chand Ltd, 2001.

Semester – II

Botany: Basics of Botany Practicals – II

Course Code: BO-2502L

No. of Credits: 04

Learning Hours: 60 hrs

1. Study of Gymnosperms- Life-History of **Cycas**
 - a. Specimen- Cycas whole plant, coralloid roots, compound leaf, male cone, Megasporophyll and ovules
 - b. Mounting – Cycas microspores
 - c. Permanent slides- TS Microsporophyll, LS Ovule
2. Study of Angiosperm: Life-History of **Sunflower**
 - a. Specimens – Whole plant, Inflorescence, Ray floret and Disc floret.
Life-History of **Maize**
 - b. Specimen – Whole plant, Inflorescence, Seed.
 - c. Slides – LS of Seed
3. Study of Plant Morphology:
 - a. Types of placentation.
 - b. Types of aestivation.
 - c. Types of Stipules.

Study of Plant families- *Malvaceae*, *Convolvulaceae*, *Nyctaginaceae* and *Amaryllidaceae*- Classification with reasons, identifying characters, floral formula and floral diagrams, habit, sketch, androecium, gynoecium and TS of ovary; 3-4 botanical and common names of examples.

4. Plant Physiology: Experiments (to be individually performed) for-
 - a. Diffusion-experiment to show diffusion of gases.
 - b. Imbibition- Demonstration of Endosmosis, exosmosis in grapes
 - c. Osmosis- Potato osmoscope
 - d. Plasmolysis- Tradescantia leaf

Demonstration experiments-

- a. Anaerobic respiration.

- b. Kuhne's tube.
 - c. Release of CO₂ in anaerobic respiration.
5. Economic Botany- Study of plants as per theory syllabus.
 6. Study of Garden tools as per theory syllabus through charts- Scissors, Hoe, Hose, Clippers, Watering can, Sprinkler.
 7. Study of any five Avenue trees, five ornamentals and five foliage plants of your area through fresh specimen and herbaria.
 8. Plant Tissue Culture:
 - a. Laboratory design
 - b. Laminar Air Flow, Autoclave, pH meter, oven, digital balance

Basics of Botany Practicals – II

Course Code: BO-2502L

Semester-II

Total Marks: 35

Time: 3 Hours

Q.1 Identify and describe Specimen A.	04
Q.2 Mount the _____ from the Specimen B.	04
Q.3 Identify the Family of the Specimen C, classify it, give general characters and draw labeled diagrams.	04
Q.4 Perform the physiological experiment as per the chit.	04
Q.5 Identify and describe the specimens	10
Specimen D (Morphology)	
Specimen E (Physiology)	
Specimen F (Economicbotany)	
Specimen G (Gardening)	
Specimen H (Ptc)	
Q.6 Journal	03
Q.7 Project & Viva	06
Guidence for arrangement of specimens in the examination.	
Specimen A: Gymnosperm or Angiosperm.	
Specimen B: Gymnosperm or Angiosperm.	

Project:

Study the Career opportunities available in any of the branches of Biology which you have studied in Semesters I and II. Local, State, National and International level.

Semester - III

Paper: Algae, Fungi, Bryophytes, Plant Pathology

Course Code: BO-3501

No. of Credit: 4

Total Hours: 60 hrs

Unit-1: Algae

Learning Objectives: The students will be able to:

1. Differentiate between various groups of Algae.
2. Learn the life cycles of individuals belonging to Algae.

Algae

1. General Account of:-
 - a. Cyanophyta
 - b. Phaeophyta
 - c. Rhodophyta
2. Life history of following genera including morphology and excluding development:-
 - a. Oscillatoria
 - b. Ectocarpus
 - c. Batrachospermum

Unit-2: Fungi

Learning Objectives: The students will be able to:

1. Understand the ultra structure of a fungal cell.
2. Learn the life cycles of individuals belonging to Fungi and Lichens.

Fungi

1. Ultra structure of fungal cell.
2. Life histories of following genera including morphology excluding development (Classification according to Ainsworth)
 - a. Peziza
 - b. Puccinia
3. Types of Lichens

Unit-3: Bryophyta

Learning Objectives: The students will be able to:

1. Learn the life cycles of individuals belonging to Bryophytes.
2. Understand the importance of Bryophytes.

Bryophyta

1. Life histories of the following with external and internal structure excluding Development.
 - a. Hepaticopsida: Plagiochasma
 - b. Bryopsida : Funaria.
2. Economic importance of Bryophyta.

Unit-4: Plant Pathology

Learning Objectives: The students will be able to:

1. Understand the basic concepts of Plant Pathology.
2. Learn about the causal organisms of plant diseases.

Plant Pathology

1. Plant Pathology: Introduction. Classification of Plant Diseases.
2. Symptoms of Plant Diseases.
3. Casual agents of Plant diseases (Virus, Bacteria and Fungi).
4. Selected Plant Diseases:
 - a. White Rust of Crucifier (*Albugo candida*).
 - b. Loose smut of wheat (*Ustilago tritici*)

Reference Books:

1. Smith, Gilbert M; *Cryptogamic Botany Algae & Fungi* Volume 1; 2nd edition; McGraw-hill Book Comp. Tokyo, 1955.
2. Vasishtha B.R. And Sinha A. K. - *Botany for degree students Part 1 ALGAE*; S. Chand & Company Ltd, 1st edition, revised 2005.
3. Vasishtha B.R. And Sinha A. K. - *Botany for degree students Part 2 FUNGI*; S. Chand & Company Ltd, 1st edition, revised 2005.
4. Ainsworth, G.C.; Bisby, G.R.; Kirk, P.M. (ed.); *Ainsworth & Bisby's Dictionary of the Fungi*, 10th edition; CABI Publishing: 2008.
5. Alexopoulos, Constantine J.; Mims, Charles W; *Introductory Mycology*; 3rd edition; New Delhi: Wiley Eastern Limited, 1983.
6. Webster, J.1985. *Introduction to Fungi*. Cambridge University Press.
7. Smith, Gilbert M; *Cryptogamic Botany Bryophyta & Pteridophyta* Volume 2; 2nd edition; McGraw-hill book Comp. Tokyo, 1955.
8. Parihar, N.S.; *Pteridophytes: An introduction to Embryophyta*, Vol.II; 4th edition; Allahabad: Central Book Depot, 1962.
9. Kar, Ashok Kumar; Gangulee, Hirendra Chandra; *College botany: Volume II*; 2nd edition; Kolkata: New Central Book Agency (P) Ltd, 1989, 2006.
10. Singh V., Pande P.C., Jain D.K.; *A Textbook of Botany*, 4th Edition; Rastogi publications, 2013.
11. Sambamurthy A.V.S.S; *A Text Book of Plant Pathology*; New Delhi: I.K.International, 2005.
12. Sharma P.D.; *Plant Pathology*; 4th edition; Meerut: Rastogi Publication, 2004.
13. Singh R.S; *Introduction to Principles of Plant Pathology*; 4th edition; New Delhi: Oxford and IBH, 2009.

Semester - III

Paper: Anatomy, Ecology, Embryology And Cytology

Course Code: BO-3502

No. of Credit: 4

Total Hours: 60 hrs

Unit-1: Anatomy

Learning Objectives: The students will be able to:

1. Differentiate between the normal and anomalous secondary growth.
2. Learn anatomical structure and functions of various mechanical tissues.
3. Differentiate between different types of stele and various types of vascular bundles.

Anatomy

1. Classification and theories of root and shoot apex.
2. Cambium: types and functions
3. Types of Vascular Bundles
4. Stellar evolution and Types of Stele.
5. Mechanical Tissue System (e.g. Sunflower root, Nyctanthes Stem and Maize Leaf)
6. Normal Secondary Growth (Sunflower root, Sunflower Stem/ Capparis Stem)
7. Anomalous Secondary Growth (Salvadora Stem).

Unit-2: Ecology

Learning Objectives: The students will be able to understand:

1. The basics of soil science.
2. The ecological adaptations of various plants.

Ecology

1. Edaphic factors:
 - a. Composition of soil,
 - b. Origin and development of soil,
 - c. Soil moisture,
 - d. Soil profile,
 - e. Soil erosion
 - f. Soil conservation.
2. Biological clocks.
3. Remote sensing
4. Heterotrophic nutrition in plants.
5. Ecological adaptation in Hydrophytes and Xerophytes.

Unit-3: Embryology

Learning Objectives: The students will be able to:

1. Learn the developmental stages of micro and megasporangium.
2. Understand the process of Pollination.
3. Learn about fertilization and embryo development.

Embryology

1. Structure of microsporangium and male gametophyte.
2. Structure of ovule and its types.
3. Structure of megasporangium and female gametophyte. Monosporic, Bisporic, Tetrasporic (Fritillaria type).
4. Pollination: Definition, Types and Agents.
5. Pollination in Salvia and Calotropis.
6. Fertilization and Dicot and Monocot Embryo Development.

Unit-4: Cytology

Learning Objectives: The students will be able to understand:

1. The structure and functions of various plant cell organelles.

Cytology

1. Plant cell: Ultra structure.
2. Structure and functions of the following:
 - a. Cell wall
 - b. Plasma Membrane
 - c. Mitochondria and chloroplast
 - d. Nucleus
 - e. Endoplasmic reticulum
 - f. Ribosomes
 - g. Lysosome and Dictyosome.

Reference books:-

1. Eames, Arthur J.; MacDaniels, Laurence H.; *An introduction to plant anatomy*; 2nd edition. Reprint; New Delhi: Tata Mcgraw-Hill Publishing Company Limited, (1978, 2004).
2. Esau, Katherine; *Anatomy of seed plants*; 2nd edition; New York: John Wiley & Sons, 1977.
3. Gangulee, Das, and Dutta – College Botany Vol I.
4. Fahn, A; *Plant anatomy*; 4th edition. Indian reprint; New Delhi: Aditya Books (P) Ltd., 1990(1997).
5. Tayal M.S.; *Plant Anatomy*; Rastogi publications, 1983.
6. Sharma, P.D.; *Ecology and Environment*; 7th edition; Meerut: Rastogi Publishers, 1998.
7. Subrahmanyam, N.S.; Sambamurty, A.V.S.S.; *Ecology*; 1st edition; New Delhi: Narosa Publishing House, 2000.
8. Sharma, P.D.; *Ecology and Environment*; 7th edition; Meerut: Rastogi Publishers, 1998.
9. Odum, E.; Barrick M.; Barrett G.; *Fundamentals of Ecology*, 5th edition; New Delhi: Cengage Learning India, Pvt. Ltd., 1971.
10. Miller, G. Tyler; *Textbook of Ecology*, New Delhi: Cengage Learning India, 2009.
11. Maheshwari, P.; *Introduction to the embryology of angiosperms*; 2nd edition, reprint; New Delhi: Tata Mcgraw-Hill Publishing Company Limited, 1971.
12. Bhojwani, S.S.; Bhatnagar, S.P.; *The embryology of angiosperms*; revised edition; Delhi: Vikas Publishing House Pvt. Ltd., 1996.
13. Gupta, P.K.; *Cytogenetics*; 1st edition, reprint; Meerut: Rastogi Publications, 2004.
14. De Robertis, E.D.P.; Nowinski, Wiktor W.; Saez, Francisco A.; *Cell Biology*; Philadelphia: W.B. Saunders Company, 1970.

Semester - III

Paper: LOWER PLANT DIVERSITY - I

Course Code: BO-3503L

No. of Credit: 3

Total Hours: 60 hrs

1. **Study of Algae**
 - a. Oscillatoria: Specimen of Thallus.
 - b. Ectocarpus: Mounting of vegetative thallus, Unilocular and Plurilocular sporangium. Permanent slides of Unilocular and Plurilocular sporangium.
 - c. Batrachospermum: Mounting of vegetative thallus, Cystocarp. Permanent slides of antheridia, archegonia and cystocarp.

2. **Study of Fungi**
 - a. Peziza: Structure and Reproductive organs.
 - b. Puccinia: Mounting of Uredospore and Telutospore. Permanent slides of Uredospore, Telutospore, Pycneospore and aciospore.

3. **Study of Bryophytes-**
 - a. Plagiochasma: Specimen of Thallus, Reproductive organs. Permanent slides or charts of V.S. of thallus, Reproductive organs.
 - b. Funaria: Mounting of Antheridia, Archegonia, Peristomial teeth. Specimen Funaria gametophyte with sporophyte. Permanent slides of Antheridia, Archegonia, Sporophyte.

4. **Study of plant diseases as per theory syllabus.**
 - a. White rust of Crucifer.
 - b. Loose Smut of Wheat.

Students will prepare a PROJECT on any one of the following: Algae/Fungi/Bryophytes/ Plant Pathology. This will be presented as a hand-written report, or a chart/series of charts, or through a PP presentation. The evaluation will include a Viva.

Suggested Readings:

1. Bendre Ashok M.; Ashok Kumar: *A Text Book of Practical Botany*; Vol 1; Meerut: Rastogi Publications, 2010.

Semester - III

Paper: LOWER PLANT DIVERSITY - II

Course Code: BO-3503L

No. of Credit: 3

Total Hours: 60 hrs

Unit-1: Anatomy

1. Permanent slides of shoot apex (Dictyota and Chara) and root apex.
2. Permanent slides of cambium and cork cambium.
3. Mounting of shoot apex from Hydrilla shoot.
4. Permanent slides of Sunflower stem, root and Salvadora stem secondary growth.
5. Double stain temporary preparation of Salvadora stem secondary growth.
6. Distribution of Mechanical tissue from the following: Sunflower root, Nyctanthes stem, Maize leaf.
7. Types of Vascular bundles.

Unit-2: Ecology

1. Water holding capacity of soil.
2. Heterotrophic nutrition in plant specimens
3. Hydrophytes- Hydrilla, Nymphaea, Eichornea, Trapa.
4. Xerophytes- Nerium, Agave, Opuntia, Euphorbia

Unit-3: Embryology

1. Pollen germination
2. Permanent slide of T.S. of Anther, Pollen grain on stigma
3. Permanent slide or charts of Ovules.
4. Permanent slide of female gametophyte.
5. Permanent slides of Embryo sac with MMC; 2/4/8-nucleate Embryo sac,

Unit-4: Cytology

1. Plant cell: Ultra structure model or chart
2. Cell wall chart
3. Micrograph or chart of Plasma membrane, Chloroplast. Endoplasmic reticulum, Ribosome, Nucleus, Lysosome, Dictyosome, Mitochondria.

Students will prepare a PROJECT on any one of the following: Anatomy/Ecology/ Embryology/ Cytology. This will be presented as a hand-written report, or a chart/series of charts, or through a PP presentation. The evaluation will include a Viva.

Reference:

1. Practical Botany vol. I & II By Bendre and Kumar, Rastogi Publication
2. Practical Botany by S. C. Santra, Chettarjee and Das, New Central Book Agency.
3. Experimental Plant Ecology by Pratima Kapur and Sudha Rani, CBS Publication

Semester - IV

Paper BO-4501

No. of Credits: 04

Learning Hours: 60 hrs

(Pteridophytes, Gymnosperms, Plant Physiology)

Unit-1: Pteridophytes

Learning Objectives: The students will be able to:

1. Learn about the life histories of *Selaginella* and *Adiantum*.
2. Learn about heterospory.
3. Learn about process of fossil formation.

Pteridophytes

1. Life histories of the following with morphology and anatomy excluding development.
 - a. Lycopsida: *Selaginella*
 - b. Pteropsida: *Adiantum*
2. Heterospory and seed habitat.
3. Condition and formation of fossils.

Unit-2: Gymnosperm

Learning Objectives: The students will be able to:

1. Learn the classification of Gymnosperms.
2. Study the life history of *Pinus*.
3. appreciate the economic importance of Gymnosperms.

Gymnosperms

1. Classification of Gymnosperms by **Chamberlain** (1934).
2. Life history of *Pinus* including Morphology, Anatomy (Secondary structure of stem, R.L. S., T.L.S.), Reproduction, Embryogeny.
3. Economic Importance of Gymnosperms.

Unit-3: Plant Physiology - I

Learning Objectives: The students will be able to understand:

1. The catabolic process and synthesis of chemical energy in plants.
2. The anabolic process in plants.
3. Differentiation between light and dark reactions of photosynthesis.
4. The respiratory process in presence of light.
5. Differentiate between C₃, C₄ and CAM plants.

Plant Physiology-1

1. Chloroplast as the unit of photosynthesis.
2. Light phase of photosynthesis.
3. Reaction scheme for ATP and NADPH formation.
4. Role of ATP and NADPH in CO₂ fixation.
5. Path of carbon in photosynthesis – C₃, C₄ and CAM plants.
6. Factors influencing photosynthesis.

Unit-4: Plant Physiology-2

Learning Objectives: The students will be able to understand:

1. The importance of minerals to plants.
2. The transport mechanism in plants.
3. The physiological processes and their importance.

Plant Physiology-2

1. Absorption of water:-
 - a. Properties of water.
 - b. Mechanism of water absorption.
 - c. Transportation of water: Dixon's theory of cohesion force.
2. Growth and development: Definition and Phases of Growth.
3. Mineral nutrition in plants:-
 - a. Macro and Micronutrients-C, H, O, N, S, P, K, Ca, Fe, Mg, Mn, Zn, B, Cu, Mo
Source and Functions.
 - b. Nutritional Disorders of Plants.
 - c. Mycorrhiza.

Reference Books:

1. Pandey, S.N., Trivedi, P.S. and Misra S.P; *A Textbook of Botany Vol. I and II*, Vikas Publishing House Pvt. Ltd, 2005.
2. Parihar, N.S.; *Pteridophytes: An introduction to Embryophyta*, Vol.II; 4th edition; Allahabad: Central Book Depot, 1962.
3. Kar, Ashok Kumar; Gangulee, Hirendra Chandra; *College botany: Volume II*; 2nd edition; Kolkata: New Central Book Agency (P) Ltd, 1989, 2006.
4. Sporne, K.K. 1991. *The Morphology of Pteridophytes*. B.I. Publishing Pvt. Ltd. Bombay, 1991.
5. Vashishta, B.R. 1983. *Botany for degree student- Pteridophyta*, S. Chand Pub, New Delhi, 1983.
6. Bhatnagar, S.P. and Moitra, A; *Gymnosperms*; New Delhi: New Age International Pvt. Ltd.,1996.
7. Chopra, G.L; *Gymnosperms*; Jullundhar: S. Nagin & Co.
8. Coulter, J.M. & Chamberlain, C.J; *Morphology of Gymnosperms*; Allahabad: Central Book Depot, 1978.
9. Vashishta, P.C; *Botany for degree student- Gymnosperms*; New Delhi: S. Chand Publications, 1983.
10. Vashishta, P.C.; *Gymnosperms*; New Delhi: S. Chand Publications, 1983.
11. Noggle, Ray G.;Fritz, George J.; *Introductory plant physiology*; 2nd edition; New Delhi: Prentice-Hall Of India Private Limited, 1991.
12. Sinha, B.K.;Pandey, S.N.; *Plant Physiology*; 1st edition; New Delhi: Vikas Publishing House Pvt. Ltd., 1981.
13. Verma, V.; *Textbook of Plant Physiology*; New Delhi: Ane Books India, 2007.
14. Salisbury, Frank B.;Ross, Cleon W.; *Plant Physiology*; 3rd edition, Reprint; New Delhi: CBS Publishers & Distributors, 1986 (2001).
15. Devlin, Robert M.;Witham, Francis H.; *Plant Physiology*; 4th edition, Indian reprint; Delhi: CBS Publishers & Distributors, 1986 (2001).
16. Kochhar, P.L.; *A textbook of Plant Physiology*; 7th edition; Delhi: Atma Ram & Sons, 1964.
17. Verma S. K. *Textbook of Plant Physiology and Biochemistry*; 4th edition; S. Chand & Company Ltd, 2003.
18. Witham, F.H., Delvin, R.M; *Plant Physiology*; Boston, MA:Willard Grant, 1983.

Semester - IV

Morphology, Taxonomy & Economic Botany, Palynology, Genetics, Biochemistry

Course Code:BO- 4502

No. of Credits: 04

Learning Hours: 60 hrs

Unit-1: Morphology, Taxonomy & Economic Botany

Learning Objectives: The students will be able to:

1. The taxonomical terminology and understand the meaning of the same.
2. The classification system along with the reason behind the same.
3. Learn various plant families and their economic importance.

4. Learn the economic importance of timber and firewood plant species.
5. Learn about the commercialized essential oil producing plants.

Morphology

1. Morphology of fruits.

Taxonomy

Classification of the following families as per Bentham and Hooker's system of classification including examples of economic importance.

1. Dicotyledons:
 - a. Polypetalae: *Cesalpiniaceae*
 - b. Gamopetalae: *Rubiaceae*, *Apocynaceae*
 - c. Apetalae: *Euphorbiaceae*
2. Monocotyledons: *Palmae* and *Gramineae*.

Economic Botany

Timber Species:

1. *Tectona grandis*
2. *Gmelina arborea*
3. *Madhuca indica*

Firewood Species:

1. *Zizyphus jujuba*
2. *Acacia nilotic*
3. *Salvadora persica*

Essential Oils:

Habit, Habitat, Family, Botanical name, Useful parts and uses of the following Essential oils- Sandalwood, Eucalyptus, Jasmine and Kewra

Unit-2: Palynology

Learning objectives: The students will be able to understand:

1. Pollen morphology.
2. The applications of palynology.
3. Pollen storage and its viability.
4. Phenomena of pollen germination.

Palynology

1. Pollen and spore morphology- size and shape, polarity, apertures, exine stratification, construction of palynogram.
2. Application of palynology in honey industry, coal and oil exploration, forensic sciences, pollen allergy.
3. Pollen viability and storage- Causes for loss of pollen viability, tests for pollen viability, pollen storage.
4. Germination and growth of the pollen tube, factors affecting pollen tube growth.

Unit-3: Genetics

Learning Objectives: The students will be able to understand:

1. The phenomenon of inheritance.

Genetics

1. Mendelian genetics (Monohybrid, Dihybrid ratio).
2. Gene interactions (Complementary and Supplementary genes).
3. Cytoplasmic inheritance: (Mirabilis, male sterility in maize)
4. Sex determination in plants.

Unit-4: Biochemistry

Learning Objectives: The students will be able to understand:

1. The mechanism of enzyme actions
2. The major classes of organic compounds, their synthesis and breakdown in plants.

Biochemistry

1. pH and Buffer.
2. Protoplasm as a colloidal system.
3. Classification & types of Carbohydrates and Lipids.
4. Enzymes:
 - a. Definition.
 - b. Nomenclature and classification of enzymes.
 - c. Chemical nature of enzymes.
 - d. Properties of enzymes.
 - e. Mechanism of enzyme action.
 - f. Factors affecting enzyme activity.

Reference Books:-

1. Dutta, A.C.; *A Class-book of Botany*; 15th edition; Calcutta: Oxford University Press, 1976.
2. Gangulee, H.C., Das, K.S., Dutta C.T.; *College Botany Vol I*; Kolkatta: New Central Book Agency, 2002.
3. Lawrence, George H.M.; *Taxonomy of Vascular Plants*; 1st edition; New Delhi: Oxford & IBH Publishing Co., 1967.
4. Naik, V.N. 1984. *Taxonomy of Angiosperms*; New Delhi:Tata McGraw - Hill Publishing Co. Ltd., 1984.
5. Sharma, O.P.; *Plant Taxonomy*; 1st edition, reprint; New Delhi: Tata McGraw-Hill Publishing Co. Ltd., 1993(2002)
6. Sivarajan, V.V.; *Introduction to the principles of plant taxonomy*; 2nd edition; Cambridge: Cambridge University Press, 1991.
7. Subramanian, N.S.; *Modern plant taxonomy*; New Delhi: 1st edition; Vikas Publishing House Pvt. Ltd., 1995.
8. Singh, G.; *Plant Systematics- Theory and Practice*; New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd, 1999.
9. Verma B.K. *Introduction to Taxonomy of angiosperms*. New Delhi:PHI Learning Pvt. Ltd., 2011.

10. Verma V.; *Text Book of Economic Botany*; Delhi: Ane Books, 2009.
11. Kochhar S.L., Elbaum L., Einstein E.; *Economic Botany in the Tropics*; Pan MacMillan, 2012.
12. Hill A.F.; *Economic Botany*, 2nd Edition; New York: McGraw -Hill, 1992.
13. Samba Murty A.V.S.S., Subramanyam N.S.; *Economic Botany of Crop Plants*; Asia tech Publishers, 2000.
14. Nair, P.K.K.; *Essentials of palynology*; Bombay: Asia Publishing House, 1966.
15. Nair, P.K.K.; *Advances in palynology*; 1st edition; Lucknow: National Botanic Gardens, 1964.
16. Bhattacharya, Kashinath; Majumdar, Manas Ranjan; Bhattacharya, Swati Gupta; *A textbook of palynology: Basic and applied*; 1st edition; Kolkata: New Central Book Agency (P) Ltd, 2006.
17. Powar, C.B; *Genetics*; Vol 1 & 2; Himalaya Publishing House, 2003.
18. Strickberger, M.W.; *Genetics*. New Delhi: PHI Learning Pvt. Ltd., 2008.
19. Arumugon, N.; *Cell Biology, Genetics, Evolution*. Kanyakumari: Saras Publication.
20. Stent, G.S.; *Molecular Genetics*; San Francisco: W.H. Freeman, 1971.
21. Russel, P.J; *Genetic*; Harper Collins College, 1992.
22. Noggle, Ray G.; Fritz, George J.; *Introductory Plant Physiology*; 2nd edition; New Delhi: Prentice-Hall Of India Private Limited, 1991.
23. Sinha, B.K.; Pandey, S.N.; *Plant Physiology*; 1st edition; New Delhi: Vikas Publishing House Pvt. Ltd., 1981.
24. Verma, V.; *Textbook of plant physiology*; New Delhi: Ane Books India, 2007.
25. Salisbury, Frank B.; Ross, Cleon W.; *Plant physiology*; 3rd edition, Reprint; New Delhi: CBS Publishers & Distributors, 1986(2001).
26. Devlin, Robert M.; Witham, Francis H.; *Plant Physiology*; 4th edition, Indian reprint; Delhi: CBS Publishers & Distributors, 1986(2001).
27. Kochhar, P.L.; *A textbook of Plant Physiology*; 7th edition; Delhi: Atma Ram & Sons, 1964.
28. Verma S. K. *Textbook of Plant physiology and Biochemistry* ; 4th edition; S. Chand & Company Ltd, 2003.

Semester - IV

BO -4503L: Plant Diversity And Physiology

No. of Credits: 04

Learning Hours: 60 hrs

Unit-1: Pteridophytes:

1. **Selaginella:** Specimen
 - a. Selaginella cone L.S. & T.S. Permanent slides.
 - b. Mounting of Selaginella spores from cone.
2. **Adiantum:** Specimen
 - a. Permanent slide of T.S. Passing through sori of Adiantum leaflet.
 - b. Mounting of sporangia of Adiantum

Unit-2: Gymnosperms

Pinus:

1. Mounting of Pollen grain
2. T.S. of Pinus needle.
3. Specimens: Male cone, Female cone, Needle
4. Permanent slides: Ovule, Needle, male cone L.S.

Unit-3: Plant Physiology-I

1. Demonstration that oxygen is evolved in photosynthesis.
2. To study the Kranz anatomy.
3. Isolation of chloroplasts and study of Hill Reaction (Demonstration only).

Unit-4: Plant Physiology-II

1. Conduction of water through xylem (Demonstration only).
2. Estimation of Ca²⁺ and Mg²⁺ in plant sample.
3. Estimation of phosphorous in plants.

Project

Students will prepare a PROJECT on any one of the following: Pteridophytes/Gymnosperms/ Plant Physiology. This will be presented as a hand-written report, or a chart/series of charts, or through a PP presentation. The evaluation will include a Viva.

Semester-IV: (Practical)

Course Code: BO -4503L

No. of Credits: 04

Learning Hours: 60 hrs

Unit-1: Morphology and Taxonomy

1. Morphology specimens as per theory syllabus.
2. Study of Families as per theory syllabus.
3. Economic botany as per syllabus.

Unit-2: Palynology

1. Study of pollen morphology of *Hibiscus*, *Canna*, *Pancreatium* and *Ocimum*.
2. Determination of pollen viability.
3. Study of pollen tube growth using different concentrations of sucrose.
4. Pollen analysis from honey samples.

Unit-3: Genetics

1. Genetics problems (as per appendix)

Unit-4: Biochemistry

1. Determination of pH of various solutions.
2. Agar-agar (Sol & Gel).
3. Histochemical tests of Carbohydrate (starch, glucose and Lignin) & Lipid.
4. Enzyme activity- amylase and Catalase.

Project

Students will prepare a PROJECT on any one of the following: Morphology/ Taxonomy/Economic Botany/ Palynology/ Genetics/Biochemistry. This will be presented as a hand-written report, or a chart/series of charts, or through a PP presentation. The evaluation will include a Viva.

Semester – V

Botany

LOWER PLANT DIVERSITY - I (ALGAE, FUNGI, BRYOPHYTES, PTERIDOPHYTES)

Course Code: BO- 5501

Total Credits: 4

Total teaching hours: 60

Unit: I:- ALGAE

LEARNING OBJECTIVES:

The students will be able to:

- a. Differentiate between various groups of Algae.
- b. Learn the life cycles of individuals belonging to Algae.
- c. Role of Algae in human welfare.

ALGAE

1. Structure, Reproduction (excluding development) and life history:

- a. CYANOPHYTA: Rivularia, Scytonema
- b. CHLOROPHYTA: Coleochaete, Chara
- c. PHAEOPHYTA: Sargassum,
- d. RHODOPHYTA: Polysiphonia
- e. CHRYSOPHYTA: Diatoms (Bacillariophyceae)
- f. **Use of Algae in space research; in medicine, in biofuels.**

Unit II:- FUNGI

LEARNING OBJECTIVES:

The students will be able to:

- a. Study the life history of selected fungi belonging to Mastigomycotina Ascomycotina and Basidiomycotina.
- b. Learn about Mixomycotina.
- c. Understand the method of cultivation of mushrooms.

FUNGI

1. Occurrence, Distribution, Structure, Reproduction, utilization and life history (excluding development):

- a. MASTIGOMYCOTINA: Phytophthora

- b. ASCOMYCOTINA: Aspergillus (Eurotium)
 - c. BASIDIOMYCOTINA: **Agaricus**
 - d. MIXOMYCOTINA: **General account**
3. General Account of Mushroom cultivation

Unit III:- BRYOPHYTA

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn the life cycles of individuals belonging to Bryophytes.
- b. Understand evolution of sporophytes in Bryophytes.
- c. Study the comparative account on various Bryophytes.
- d. Learn about the adaptive features of Bryophytes as in land plants.

BRYOPHYTA

- 1. Adaptation in Bryophytes and land plants
- 2. Comparative account of morphology, anatomy, reproduction and adaptation in Riccia, Marchantia, **Anthoceros**, Polytricum and Funaria.
- 3. Evolution of Sporophyte.
- 4. Structure, Reproduction and life history (excluding development):
 - a. HEPATICOSPODIA: **Marchantia**
 - b. ANTHOCEROTOPSIDA: **Anthoceros**
 - c. BRYOPSIDA: **Polytrichum**.

Unit IV:- PTERIDOPHYTES

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn the classification of Pteridophytes by Reimer.
- b. Study the life cycle of Pteridophytes belonging to Psilotopsida and Sphenopsida.
- c. Study **Telome theory in Pteridophytes**.

PTERIDOPHYTES

- 1. Classification of Pteridophytes by Reimer (1954).
- 2. Structure, Reproduction and life history (excluding development):
 - a. PSILOTOPSIDA: Psilotum
 - b. SPHENOPSIDA: Equisetum
- 3. **Telome Theory**.

Reference Books:

- 1. Smith, Gilbert M; *Cryptogamic Botany Algae & Fungi* Volume 1; 2nd edition; McGraw-hill Book Comp. Tokyo, 1955.

2. Vasishtha B.R. And Sinha A. K. - *Botany for degree students Part 1 ALGAE*; S. Chand & Company Ltd, 1st edition, revised 2005.
3. Vasishtha B.R. And Sinha A. K. - *Botany for degree students Part 2 FUNGI*; S. Chand & Company Ltd, 1st edition, revised 2005.
4. Ainsworth, G.C.; Bisby, G.R.; Kirk, P.M. (ed.); *Ainsworth & Bisby's Dictionary of the Fungi*, 10th edition; CABI Publishing: 2008.
5. Alexopoulos, Constantine J.; Mims, Charles W; *Introductory Mycology*; 3rd edition; New Delhi : Wiley Eastern Limited , 1983.
6. Webster, J; *Introduction to Fungi*; Cambridge University Press, 1985.
7. Smith, Gilbert M; *Cryptogamic Botany Bryophyta & Pteridophyta* Volume 2; 2nd edition; McGraw-hill book Comp. Tokyo, 1955.
8. Parihar, N.S.; *Pteridophytes : An introduction to Embryophyta*, Vol.II; 4th edition; Allahabad : Central Book Depot , 1962.
9. Kar, Ashok Kumar; Gangulee, Hirendra Chandra; *College botany : Volume II*; 2nd edition; Kolkata : New Central Book Agency (P) Ltd , 1989, 2006.
10. Singh V., Pande P.C., Jain D.K.; *A Textbook of Botany*, 4th Edition; Rastogi publications, 2013.
11. Sporne, K.K. 1991. *The Morphology of Pteridophytes*. B.I. Publishing Pvt. Ltd. Bombay.

Semester – V

BASICS OF BOTANY-III (SYSTEMATIC BOTANY, ANGIOSPERMS, EMBRYOLOGY and ANATOMY)

Course Code: BO- 5502

Total Credits: 4

Total teaching hours: 60

Unit I:- SYSTEMATIC BOTANY

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn about system of classification.
- b. Understand the principles and rules of ICBN.
- c. Learn about the concept Typification, Priority and rules of publication of the research work.
- d. Understand the preparation and importance of Herbarium.
- e. Study the role of Herbaria and Botanical Gardens.
- f. Construct dichotomous keys.

SYSTEMATIC BOTANY

1. Principles of taxonomy, merits and demerits of systems of classification of Engler and Prantle.

- 2. Plant nomenclature: ICBN. Principles and Rules. Effective and Valid publication, Rule of Priority and its typification, author citation, rejection and retention of names.**
- 3. Herbarium techniques: Plant collection and preparation of Herbarium.**
- 4. Role of Herbaria and Botanical Gardens.**
- 5. Botanical keys: Construction of dichotomous keys – Indented and bracketed keys.**

Unit II:- ANGIOSPERMS

LEARNING OBJECTIVES:

The students will be able to understand:

- a. Study various plant families and their economic importance based on classification system of Bentham and Hooker.**

Classification as per Bentham and Hooker with economic importance

1. DICOTYLEDONS:

- a. Polypetalae: Capparidaceae, Sterculiaceae, Rhamnaceae, Combretaceae.**
- b. Gamopetalae: Asclepiadaceae, Boraginaceae, Bignoniaceae**
- c. Apetalae: Amaranthaceae**

2. MONOCOTYLEDONS: Commelinaceae, Cyperaceae

Unit III:- EMBRYOLOGY

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn the different types of endosperms and their functions.**
- b. Understand the concepts of Apomixis, Polyembryony and Sexual incompatibility.**

EMBRYOLOGY

- 1. Sexual incompatibility: Causes, Types and Significance.**
- 2. Endosperm: Types: free nuclear, cellular, helobial, ruminant; functions of endosperm.**
- 3. Polyembryony: causes, types and significance.**
- 4. Apomixis: definition, types and significance.**
- 5. Role of Embryology in Taxonomy.**

Unit IV:- ANATOMY

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn about secretory and absorbing tissue system.**
- b. Learn about the mineral crystals deposited in plant cells.**
- c. Understand the phenomenon of leaf fall.**
- d. Study the Root Stem transition.**
- e. Understand the role of anatomical characters in Taxonomy.**

ANATOMY

1. Secretory tissue system (excluding Laticiferous)
2. Absorbing tissue system.
3. **Waste Material: Mineral crystals-**
 - a. Calcium oxalate- prismatic raphides, spheraphides
 - b. Calcium carbonate- Cystolith.
4. Leaf – fall.
5. Root – stem transition.
6. **Applied Plant Anatomy: Anatomy related to Taxonomy.**

Reference Books:

1. Lawrence, George H.M.; *Taxonomy of Vascular Plants*; 1st edition; New Delhi : Oxford & IBH Publishing Co., 1967.
2. .Naik, V.N. 1984. *Taxonomy of Angiosperms*; New Delhi:Tata McGraw - Hill Publishing Co. Ltd., 1984.
3. Sharma, O.P.; *Plant Taxonomy*; 1st edition, reprint; New Delhi : Tata McGraw-Hill Publishing Co. Ltd. , 1993(2002)
4. Sivarajan, V.V.; *Introduction to the principles of plant taxonomy*; 2nd edition; Cambridge : Cambridge University Press , 1991.
5. Subramanian, N.S.; *Modern plant taxonomy*; New Delhi : 1st edition; Vikas Publishing House Pvt. Ltd. , 1995.
6. Singh, G.; *Plant Systematics- Theory and Practice*; New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd, 1999.
7. Verma B.K. *Introduction to Taxonomy of angiosperms*. New Delhi:PHI Learning Pvt. Ltd., 2011.
8. Bhojwani, S.S.;Bhatnagar, S.P.; *The embryology of angiosperms*; revised edition; Delhi : Vikas Publishing House Pvt. Ltd. , 1996.
9. Maheshwari, P.; *Introduction to the embryology of angiosperms*; 2nd edition, reprint; New Delhi : Tata Mcgraw-Hill Publishing Company Limited , 1971.
10. Eames, Arthur J.;MacDaniels, Laurence H.; *An introduction to plant anatomy*; 2nd edition. Reprint; New Delhi : Tata Mcgraw-Hill Publishing Company Limited, (1978, 2004).
11. Esau, Katherine; *Anatomy of seed plants*; 2nd edition; New York : John Wiley & Sons, 1977.
12. Fahn, A; *Plant anatomy*; 4th edition. Indian reprint; New Delhi : Aditya Books (P) Ltd. , 1990(1997).
13. Gangulee, Das, and Dutta – College Botany Vol I.
14. Tayal M.S.; *Plant Anatomy*; Rastogi publications, 1983.
15. Dutta, A.C.; *A Class-book of Botany*; 15th edition; Calcutta: Oxford University Press, 1976.

Semester – V

LOWER PLANT DIVERSITY - I (PLANT PHYSIOLOGY, BIOCHEMISTRY, CELL BIOLOGY, GENETICS)

Course Code: BO- 5503

Total Credits: 4

Total teaching hours: 60

Unit I:- PLANT PHYSIOLOGY

LEARNING OBJECTIVES:

The students will be able to:

- a. learn about seed dormancy.
- b. Study the physiological changes during seed germination.
- c. Understand the various growth correlations.
- d. Understand the concept of R.Q. and the factors affecting respiration.
- e. Understand the basics of the process of senescence.

PLANT PHYSIOLOGY

1. Dormancy: Causes of dormancy. Methods of breaking dormancy.
2. Germination: Different phases of germination and Factors affecting germination.
3. Growth correlations.
4. Respiration:
 - a. R.Q.
 - b. Factors affecting respiration.
5. Senescence and aging: Introduction, types of senescence, mechanism, factors affecting senescence.

Unit II:- BIOCHEMISTRY

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn in detail classification, structure and types of amino acids.
- b. Study classification and structures of various proteins.
- c. Understand the process of synthesis of lipids.
- d. Learn about nitrogen metabolism and nitrogen fixation.
- e. Learn about structure and function of vitamins.

BIOCHEMISTRY

1. Amino acids: Classification, structure, protein and non-protein amino acids
2. Protein: Classification of protein on the basis of structure
3. Lipids: Synthesis, alpha & Beta -oxidation
4. Nitrogen metabolism and Nitrogen fixation

5. General account of structure and functions of vitamins

Unit III:- CELL BIOLOGY

LEARNING OBJECTIVES:

The students will be able to:

- a. Understand the ultra structure of chromatin.
- b. Learn the morphology and structure of Polytene chromosome and Lampbrush chromosomes.
- c. Study the interactions between two cells and the phenomenon of cell differentiation.
- d. Learn the various phases of the cell cycles (mitosis and meiosis) in detail.
- e. Understand the phenomenon of Programmed Cell Death in plants.

CELL BIOLOGY

1. Ultra structure of Chromatin.
2. Chromosomes:
 - i. Morphology and structure of Polytene chromosome.
 - ii. Morphology and structure of Lampbrush chromosome.
3. Cell differentiation
4. Cell-cell interaction
5. Cell Cycle:- Interphase, Mitosis, Meiosis
6. Programmed Cell Death (PCD) in plants.

Unit IV:- GENETICS

LEARNING OBJECTIVES:

The students will be able to:

- a. to understand the basics of DNA fingerprinting alongwith its importance.
- b. Learn about the phenomenon of linkage and crossing over.
- c. Study about the concept of gene mutation and the genomic organization in Eukaryotes.
- d. Learn about introns and their significance.

GENETICS

1. DNA finger printing and its importance DNA damage and repair
2. Linkage: Coupling & Repulsion hypothesis; Linkage groups
3. Crossing over: Chromosome mapping, three point test cross; interference and coincidence.
4. Introns and their significance.
5. **Gene mutations- Types- somatic/germ line, spontaneous/induced, substitutions-transversion, transition; effect of substitution mutation on phenotype- Missense, Nonsense, Neutral, Silent mutations.**
6. **Coding and noncoding sequences and satellite DNA.**

Reference Books:

1. Devlin, Robert M.; Witham, Francis H.; Plant Physiology; 4th edition, Indian reprint; Delhi: CBS Publishers & Distributors, 1986(2001).
2. Ganguly A.K., Kumar N.C.; General Botany, Vol II, Part II: Introduction to plant physiology; 7th Edition; Emkay Publications, 1990.
3. Hans-Walter Heldt., *Plant Biochemistry* – Academic Press. 2004
4. Kochhar, P.L.; A textbook of Plant Physiology; 7th edition; Delhi: Atma Ram & Sons, 1964.
5. Noggle, Ray G.; Fritz, George J.; Introductory plant physiology; 2nd edition; New Delhi : Prentice-Hall Of India Private Limited , 1991.
6. Salisbury, Frank B.; Parke, Robert V.; Vascular plants: form and function; London: Macmillan & Co Ltd, 1964.
7. Salisbury, Frank B.; Ross, Cleon W.; Plant physiology; 3rd edition, Reprint; New Delhi : CBS Publishers & Distributors , 1986(2001).
8. Sinha, B.K.; Pandey, S.N.; Plant Physiology; 1st edition; New Delhi : Vikas Publishing House Pvt. Ltd. , 1981.
9. Sinha, R.K.; Modern plant physiology; 2nd edition; New Delhi: Narosa Publishing House, 2004.
10. Verma S. K. Textbook of Plant physiology and Biochemistry; 4th editon; S. Chand & Company Ltd, 2003.
11. Verma, V.; Textbook of plant physiology; New Delhi :Ane Books India , 2007.
12. Alberts, B., Bray,D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D.; Molecular Biology of the Cell.New York:Garland Publishing, Inc..
13. Arumugon, N.; *Cell Biology, Genetics, Evolution*. Kanyakumari: Saras Publication.
14. De Robertis, E.D.P.; Nowinski, Wiktor W.; Saez, Francisco A.; *Cell Biology*; Philadelphia : W.B. Saunders Company , 1970.
15. Gupta, P.K.; *Cytogenetics*; 1st edition, reprint; Meerut : Rastogi Publications , 2004.
16. Kleinsmith, L.J. and Kish, V.M.; Principles of Cell and Molecular Biology, 2nd Ed., New York, USA: Harper Collins College Publishers, 1995.
17. Lewin, B. Genes VIII; New York: Oxford University Press, 2000.
18. Powar, C.B; *Genetics*; Vol 1 & 2; Himalaya Publishing House, 2003.
19. Russel, P.J; *Genetic*; Harper Collins College, 1992.
20. Stent, G.S.; *Molecular Genetics*; San Francisco: W.H. Freeman, 1971.
18. Strickberger, M.W.; *Genetics*. New Delhi: PHI Learning Pvt. Ltd., 2008.
19. Watson, J.D; T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick; Molecular Biology of the Gene, 5th Edition; Pearson Education, 2004.
20. Wolfe, S.L.; Molecular and Cellular Biology. California, USA: Wadsworth Publishing Co., 1993.

Semester – V

LOWER PLANT DIVERSITY - II (ECOLOGY, PLANT GEOGRAPHY, ECONOMIC BOTANY, BIostatistics)

Course Code: BO- 5504

Total Credits: 4

Total teaching hours: 60

Unit I:- ECOLOGY

LEARNING OBJECTIVES:

The students will be able to:

- a. understand the development of vegetation alongwith the mechanism, causes and types of succession and formation of hydrosere and xerosere.
- b. Learn about the various methods of study of a plant community.
- c. Study the plant community as plant indicators.
- d. Understand the principles of limiting factors.

ECOLOGY

1. Vegetation development: Causes and types of succession: Mechanism of ecological succession; Changes in ecosystem properties during succession; Hydrosere, Xerosere.
2. Structure of Plant Communities; Methods of studying plant communities: Analytical and Synthetic characters of plant community; Raunkiaer's life forms, Biological Spectrum.
3. Plant community as Plant indicators.
4. Principles of limiting factors.

Unit II:- PLANT GEOGRAPHY

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn about the concept of phytogeography and its relations with other disciplines.
- b. Learn about major and minor biomes of the world.
- c. Learn about the soil and climates of India.
- d. Learn about the botanical regions of India.
- e. Study of vegetation types of Gujarat.
- f. Understand the term endemism.
- g. Learn about the origin of life forms based continental drift theory and centres of origin.

PLANT GEOGRAPHY

1. Phytogeography: definition, **concept, scope and significance of Phytogeography.**
2. Major and minor biomes of the world.
3. **Patterns of Plant Distribution: Continuous distribution and Discontinuous distribution, Migration.**
4. Botanical regions of India.
5. Vegetation of Gujarat.
6. Endemism: **Definition, causes, types, characteristics and theories.**
7. **Continental drift- Evidences, impacts, glaciations, theory of Land bridges.**

Unit III:- ECONOMIC BOTANY

LEARNING OBJECTIVES:

The students will be able to:

- a. Study about the economic use, the botanical names, family, morphology, products and uses of several economically important plants.
- b. Learn about domestic preservation methods for pulses and cereals.

ECONOMIC BOTANY

1. Classification based on the economic use of the following plants. Study the binomial, family, morphology of useful part, products and uses.

- a. **FRUITS: Papaya, Banana, Mango**
- b. **VEGETABLES: (i) Root:-Carrot
(ii) Stem:-Potato
(iii) Leaves:-Cabbage
(iv) Fruit:-Cucumber**
- c. **BEVERAGES: Tea, Coffee.**
- d. **FATS and OILS: Sunflower oil**
- e. **GUMS and RESINS: Gum Arabic, Asafoetida**
- f. **INSECTICIDES: Neem, Tobacco**
- g. **FUEL: Jatropha, Pongamia pinnata**

2. Domestic Preservation methods for Pulses and Cereals.

Unit IV:- BIOSTATISTICS

LEARNING OBJECTIVES:

The students will be able to:

- a. Understand use of biometrics in biological sciences.
- b. Learn procedure of collecting data and representation of the same.
- c. Study methods of measuring the central tendency and dispersion in collected data.

BIOSTATISTICS

1. Biometrics: Aims and objectives as applicable to biological science. Methods of data collection and its graphical representation.

2. Measures of central tendency: Mean, median and mode

3. Measures of Dispersion: Range, mean deviation, standard deviation, standard error and 't' test. Chisquare and goodness of fit. Simple Linear regression. Frequency of distribution; Normal, binomial, Poisson distribution.

Reference Books:

1. Miller, G; Tyler; *Textbook of Ecology*, New Delhi: Cengage Learning India, 2009.
2. Odum, E.; Barrick M.; Barrett G.; *Fundamentals of Ecology*, 5th edition; New Delhi: Cengage Learning India, Pvt. Ltd., 1971.
3. Sharma, P.D.; *Ecology and Environment*; 7th edition; Meerut: Rastogi Publishers, 1998.
4. Subrahmanyam, N.S.; Sambamurty, A.V.S.S.; *Ecology*; 1st edition; New Delhi: Narosa Publishing House, 2000.
5. MacDonald, G; *Biogeography: Introduction to Space, Time and Life*. John Wiley & Sons, Inc. 2003.

6. Simmons, I. G; *Biogeography: Natural and Cultural*. Edward Arnold Ltd. 1979.
7. Hill A.F.; *Economic Botany*, 2nd Edition; New York: McGraw -Hill, 1992.
8. Kochhar S.L., Elbaum L., Einstein E.; *Economic Botany in the Tropics*; Pan MacMillan, 2012.
9. Samba Murty A.V.S.S., Subramanyam N.S.; *Economic Botany of Crop Plants*; Asia tech Publishers, 2000.
10. Verma V.; *Text Book of Economic Botany*; Delhi: Ane Books, 2009.
11. Mahajan, B.K.; *Methods in biostatistics*; 6th edition; New Delhi : Jaypee Brothers, 1997.
12. Rastogi, Veer Bala.; *Fundamentals of Biostatistics*; 2nd edition, reprint; New Delhi : Ane Books India , 2006(2008).

Semester – V

LOWER PLANT DIVERSITY - I Elective Paper: Production Horticulture

Course Code: BO- 5401

Total Credits: 4

Total teaching hours: 60

Unit-I: Fundamentals of Horticulture

Definition, branches, importance and scope, classification of horticultural crops, Special horticultural practices

Floriculture: Introduction, Cultivation and Flower arrangement.

Unit-II: Soil and water considerations

1. Formation of soil, classification, physical and chemical properties.
2. Soil nutrients and symptoms of excesses and deficiencies of nutrients.
3. Soil fertilizers: chemical, organic and biofertilizers.
4. Water: physical and chemical properties; Irrigation- surface, sprinklers, drip and gravity irrigation.

Unit-III: Plant Propagation and Plant Protection

1. Seed Propagation: Seed viability, seed longevity, essential condition for successful seed germination, raising of seed beds, transplanting techniques.
2. Micropropagation: General account and significance.
3. Pest management: Precautions to avoid pests, Pest Control Methods (Natural, Biological and Chemical)
4. Weed management.

Unit-IV: Production, Packaging, Marketing and Conservation

Greenhouse cultivation, Root and tuber crops, Vegetable production, Organic gardening, Containers and packaging techniques, Local and international demand, export standards and potential.

Suggested readings:

1. Text book of horticulture – K. Manibhushan Rao , MACMILLAN India Ltd.
2. Basic Horticulture – Victor R. Gardner, The MACMILLAN Company, New York 1.

Semester – V

LOWER PLANT DIVERSITY - I (Algae, Fungi, Bryophytes, Pteridophytes)

Practical I: Session 1

Course Code: BO- 5505L

Total Credits: 4

Total teaching hours: 60

Study of types through fresh, preserved material and permanent slides.

(a) Identify and classify following types:

ALGAE: Rivularia, Scytonema, Coleochaete, Polysiphonia.

FUNGI: Aspergillus.

BRYOPHYTA: Riccia, Anthoceros, Marchantia.

PTERIDOPHYTA: Psilotum (Stem), Equisetum (Stem).

(b) Structure and Reproductive organs:

ALGAE: Chara, Sargassum.

FUNGI: Phytophthora, Agaricus.

BRYOPHYTA: Funaria & Polytrichum: Sex organs & Capsule, Marchantia sex organs.

PTERIDOPHYTA: Equisetum: Cones; Psilotum synangium

(c) Charts of Telome theory, algae in biofuels, medicine, space research.

(d) Submissions. Students are expected to submit Cryptogamic specimens.

Semester – V

Botany

LOWER PLANT DIVERSITY - I (Algae, Fungi, Bryophytes, Pteridophytes)

Practical I: Session II

Course Code: BO- 5506L

Total Credits: 4

Total teaching hours: 60

ANGIOSPERMS: Study of families as per theory syllabus including floral formula and floral diagram. A minimum of ten herbarium sheets should be submitted,

Students must be taken on a Botanical excursion for studying vegetation in natural state. The Excursion report, and submission of specimens during the practical examination will be given due weightage.

EMBRYOLOGY:

(a) Exposition and mountings of

a. Endosperm haustoria : *Cucumis*.

b. Developing embryo : *Cyamopsis tetragonoloba* (Guvar)

(b) Study of Pollen germination on stigma in *Hibiscus*, *Datura*.

ANATOMY:

1. To study secretory tissue system through fresh material or permanent slides:
 - (1) Orange rind
 - (2) Lemon leaf
 - (3) Fern leaf (Hydathodes).
 - (4) Cycas rachis (Mucilage Duct)

2. Study of Tracheary elements by maceration technique:
 - (1) Nephrolepis rachis
 - (2) Cycas rachis
 - (3) Cucurbita Stem
 - (4) Maize Stem

3. Study of leaf fall (Abscission layer) through permanent slide.

4. Study of Waste materials:
 - (a) Calcium oxalate
 - a) Raphides [*Colocasia*].
 - b) Spheraphides [*Opuntia*].
 - (b) Calcium carbonate
 - a) Cystolith [Banyan leaf].

5. Study of Absorbing tissue system through fresh / preserved material or permanent slides.
 - (1) Absorbing tissue: Orchid root
 - (2) Haustorial organ: Scutellum maize grain.
 - (3) Haustoria in *Cuscuta*.

PLANT PHYSIOLOGY & BIOCHEMISTRY:

1. Major experiments:

The following physiological experiments to be performed by the students and results are expected:

- (i) To determine the water potential of given tissue (Any tuber)
- (ii) Separation of amino acids in a mixture by paper chromatography & their identification by comparison with standard R_f value.
- (iii) Determine R.Q. of the given plant material of bud and or seedling.

2. Minor experiments:

The following experiments to be performed by the students:

- (i) Qualitative tests for proteins from plant material.
- (ii) Test for the presence of fats from oil seeds.
- (iii) To detect the seed viability.

Biochemistry charts as per theory syllabus.

CELL BIOLOGY:

1. To study mitosis in onion root tip by squash method
2. Histochemical localization of DNA, RNA and total protein
3. Electron micro photographs of following cell organelles:
 - a. Ultra structure of Chromatin
 - b. Chromosome: Lampbrush, Polytene
 - c. Cell-Cell interaction

GENETICS:

1. Genetics problems.
2. Charts on Gene mutations.

(Ecology, Plant Geography, Economic Botany, Biostatistics)

ECOLOGY:

1. Determination of Frequency (%), Density and Abundance.
2. Study of Biological Spectrum and prediction of vegetation of a given area by comparing it's biological spectrum to the normal .
3. To study following ecological instruments:
 - i. Anemometer
 - ii. Psychrometer
 - iii. Hygrometer

PLANT GEOGRAPHY:

1. To prepare map showing vegetation of Gujarat and to comment on it.
2. To prepare map of India with respect to – Major Climatic Zones, Biogeographical regions of India and to comment on it.

ECONOMIC BOTANY: Students are expected to identify plants or plant products (raw or processed) studied in theory and to know the binomial, family and morphology of the useful parts of source plants.

BIOSTATISTICS: Statistical Problems.

Semester – VI

PLANT DIVERSITY AND PHYSIOLOGY (PTERIDOPHYTES, GYMNOSPERMS, PALEOBOTANY, HISTOCHEMICAL METHODS AND TECHNIQUES)

Course Code: BO- 6501

Total Credits: 4

Total teaching hours: 60

SEMESTER-VI

Detailed Curriculum has been designed as per semester system. There shall be one theory paper having four units.

Contact Hours per week: 4

Exam Duration: 3hours

Unit I:- PTERIDOPHYTES

LEARNING OBJECTIVES:

The students will be able to:

1. Learn about the life histories of *Isoetes* and *Marselia*.
2. Learn about Apospory and Apogamy.
3. Do a comparative study of some selected Pteridophytes.

PTERIDOPHYTES

1. Comparative account of morphology and reproduction in Psilotum, Isoetes, Selaginella, Equisetum, Marsilea and Adiantum.
2. Structure, Reproduction and life history (excluding development):
 - a. LYCOPSIDA: Isoetes
 - b. PTEROPSIDA: Marsilea
3. Apospory and Apogamy

Unit II:- GYMNOSPERMS

LEARNING OBJECTIVES:

The students will be able to understand:

- a. Learn about the structure of microspores and male gametophytes
- b. The morphology, anatomy, reproduction and life history of Ginkgo.
- c. The morphology, anatomy, reproduction and life history of Ephedra.
- d. Learn about Indian Contribution to Gymnosperms.

GYMNOSPERMS

1. Structure of microspores and male gametophytes
2. Morphology, anatomy, reproduction and life history:
 - a. GINKGOALES: Ginkgo
 - b. GNETALES: Ephedra
3. Indian contribution to Gymnosperms.

Unit III:- PALEOBOTANY (Fossils of Pteridophytes and Gymnosperms)

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn about evolution of Pteridophytes.
- b. Study of general characters of fossil Pteridophytes belonging to Psilophytales, Lepidodendrales and Calamitales.

PALEOBOTANY

1. Geological Time-Scale
2. Psilophytales: General Characters: Rhynia

3. Lepidodendrales: General Characters: Lepidodendron and Lepidocarpon
4. BENNETTITALES : Spore bearing organs
5. CORDAITALES: Cordaites, Cordaitanthus
6. PENTOXYLALES (general account)

Unit IV:- HISTOCHEMICAL METHODS AND TECHNIQUES

LEARNING OBJECTIVES:

The students will be able to understand:

- a. Have a general account of killing and fixing.
- b. Learn about various histochemical methods and techniques.

HISTOCHEMICAL METHODS AND TECHNIQUES

1. General account of killing and fixing, Agents used for killing and fixing. Common fixatives-Formalin-Acetic-Alcohol, Chromic acid-Acetic acid mixture.
2. Dehydration and infiltration-General account of dehydration (Ethanol, Isopropyl alcohol, Acetone, Glycerine). Ethanol- Xylene series and Tertiary Butyl Alcohol Series.
3. Infiltration- Paraffin Wax method, Embedding.
4. Staining: Histochemical Staining and Vital Staining.
5. Mounting: Whole mount, Maceration (of conducting tissues) and Smears (Mitosis).
6. Adhesive for Section, Sealing for medium.

Reference Books:

1. Kar, Ashok Kumar; Gangulee, Hirendra Chandra; *College botany* : Volume II; 2nd edition; Kolkata : New Central Book Agency (P) Ltd , 1989, 2006.
2. Pandey, S.N. , Trivedi, P.S. and Misra S.P; *A Textbook of Botany Vol. I and II*, Vikas Publishing House Pvt. Ltd, 2005.
3. Parihar, N.S.; *Pteridophytes : An introduction to Embryophyta*, Vol.II; 4th edition; Allahabad : Central Book Depot , 1962.
4. Sporne, K.K. 1991. *The Morphology of Pteridophytes*. B.I. Publishing Pvt. Ltd. Bombay, 1991.
5. Vashishta, B.R. 1983. *Botany for degree student- Pteridophyta*, S. Chand Pub, New Delhi, 1983.
6. Bhatnagar, S.P. and Moitra, A; *Gymnosperms*; New Delhi: New Age International Pvt. Ltd.,1996.
7. Chamberlain, Charles Joseph;Coulter, John Merle; *Morphology of Gymnosperms*; 2nd edition; Allahabad : Central Book Depot , 1964.
8. Chamberlain, Charles Joseph; *Gymnosperms : structure and evolution*; 2nd edition; New York : Dover Publications, Inc. , 1966.
9. Chopra G.L., Nagin S.; *Gymnosperms*; Jullundhar:S. Nagin& Co., 1978.
10. Coulter, J.M. & Chamberlain, C.J; *Morphology of Gymnosperms*; Allahabad: Central Book Depot, 1978.
11. Vashishta, P.C; *Botany for degree student- Gymnosperms*; New Delhi: S. Chand Publications, 1983.
12. Vashishta, P.C.; *Gymnosperms*; New Delhi: S. Chand Publications, 1983.

13. Johansen, D.A.; *Plant Microtechnique*. Mc Graw – Hill Book Company, Inc. New York, 1940.
14. Kanika, S.; *Manual of Microbiology – Tools and Techniques*; Ane's student edition, 2007.
15. Khasim, S.K., *Botanical Microtechnique; principles and Practice*, Capital Publishing Company, New Delhi., 2002.
16. Toji, T., *Essentials of botanical microtechnique*; Chennai: Apex Infotec Publ., 2004.

Semester – VI

BASICS OF BOTANY-VI (SYSTEMATIC BOTANY, ANGIOSPERMS, ANATOMY, MICROBIOLOGY)

Course Code: BO- 6502

Total Credits: 4

Total teaching hours: 60

Unit I:- SYSTEMATIC BOTANY

LEARNING OBJECTIVES:

The students will be able to:

- a. The taxonomical principles and understand the meaning of the same.
- b. The study of classification system along with their merits and demerits given by Hutchinson and Takhtajan.
- c. Learn the various ways of classifying plants.
- d. Learn about the role of BSI in conservation of biodiversity.

SYSTEMATIC BOTANY

1. Principles of taxonomy, merits and demerits of system of classification of Hutchinson
2. Outline, merits and demerits of system of classification of Takhtajan
3. General account: Chemotaxonomy, Numerical taxonomy, Cytotaxonomy, Molecular taxonomy
4. BSI: its role in conservation of biodiversity.

Unit II:- ANGIOSPERMS

LEARNING OBJECTIVES:

The students will be able to understand:

- a. Study plants families belonging to dicots and monocots along with their economic importance and classification based on Bentham and Hooker system of classification.

ANGIOSPERMS

Classification as per Bentham and Hooker with economic importance

1. DICOTYLEDONS:

- a. Polypetalae: **Menispermaceae**, Meliaceae, Anacardiaceae, Umbelliferae.
- b. Gamopetalae: Sapotaceae, Verbenaceae, **Asteraceae**

- c. Apetalae: Urticaceae, Polygonaceae
2. MONOCOTYLEDONS: Cannaceae

Unit III:- ANATOMY

LEARNING OBJECTIVES:

The students will be able to understand:

- a. Study anomalous secondary growth and abnormal behavior of normal cambium.
- b. Study of accessory cambium formation and its activity in Bougainvillea, Mirabilis and Boerhaavia stem.
- c. Study of abnormal secondary growth in fleshy roots of Carrot, Raphanus and Beet root.
- d. Study of nodal anatomy.

ANATOMY

1. Anomalous secondary growth: Abnormal behavior of normal cambium Eg. Achyranthes and Mirabilis stem.
2. Accessory cambium formation and its activity. Eg. Bougainvillea and Boerhaavia stem
3. Abnormal secondary growth in fleshy roots. Eg. Carrot, Raphanus and Beet root
4. Nodal Anatomy:-
 - (a) Unilacunar, Trilacunar, Multilacunar.
 - (b) Leaf Trace and Leaf Gaps
 - (c) Branch trace and Branch gaps

Unit IV:- MICROBIOLOGY

LEARNING OBJECTIVES:

The students will be able to understand:

- a. Learn about the nomenclature, classification, properties of viruses.
- b. learn about the morphology and ultra structure of bacteriophages.
- c. learn about the ultra structure and types of bacteria alongwith staining principles of bacteria.
- d. Study the industrial application of microorganisms.
- e. learn about role of microbes in Agriculture.

MICROBIOLOGY

1. Brief outline; Nomenclature and classification of viruses, Properties of viruses, morphology and ultra structures (Bacteriophage).
2. Types of bacteria; ultrastructure of bacteria.
3. Industrial application of microorganisms, Alcohol, Food Processing, Milk products, Antibiotics and Biopesticides, Biofertilizers.
4. Roles of microbes in agriculture- role in Nitrogen fixation.
5. Biodegradation of cellulose, lignin and petroleum wastes and heavy metal waste.

Reference Books:

1. Lawrence, George H.M.; Taxonomy of Vascular Plants; 1st edition; New Delhi : Oxford & IBH Publishing Co., 1967.
2. Raghavan, V.; Developmental Biology of Flowering plants; New York: Springer - Verlag, 1999.
3. Sharma, O.P.; Plant Taxonomy; 1st edition, reprint; New Delhi : Tata McGraw-Hill Publishing Co. Ltd. , 1993(2002).
4. Sivarajan, V.V.; Introduction to the principles of plant taxonomy; 2nd edition; Cambridge : Cambridge University Press , 1991.
5. Subramanian, N.S.; *Modern plant taxonomy*; New Delhi : 1st edition; Vikas Publishing House Pvt. Ltd. , 1995.
6. Eames, Arthur J.; MacDaniels, Laurence H.; *An introduction to plant anatomy*; 2nd edition. Reprint; New Delhi : Tata McGraw-Hill Publishing Company Limited, (1978, 2004).
7. Esau, Katherine; *Anatomy of seed plants*; 2nd edition; New York: John Wiley & Sons, 1977.
8. Fahn, A; *Plant anatomy*; 4th edition. Indian reprint; New Delhi : Aditya Books (P) Ltd. , 1990(1997).
9. Tayal M.S.; *Plant Anatomy*; Rastogi publications, 1983.
10. Dubey, H. C.; *Bacteria, Viruses and Fungi*, New Delhi: 6th edition; Vikas Publishing House Pvt Ltd , 2004.
11. Patel R. J. and Patel K. R.; *Experimental Microbiology Vol. -I*; Ahmedabad: Aditya, 2000.
12. Pelczar M. J., Chan E. C. S. and Krieg N. R.; *Microbiology* ; 27th Reprint Edition; New Delhi: Tata McGraw -Hall Publishing Company Ltd., 2004.
13. Powar and Dagainawala; *General Microbiology Vol.I & II*; Mumbai: Himalaya Publishing House, 1977.
14. Prescott, Harley and Klein; *Microbiology* , 6th edition; ; New Delhi: Tata McGraw -Hall Publishing Company Ltd., 2004,
15. Sharma, P. D.; *Microbiology* , 6th edition; Delhi: Rajpal and Sons Publishing, 2010.

Semester – VI

LOWER PLANT DIVERSITY - I (PLANT PHYSIOLOGY, BIOINFORMATICS, PLANT BREEDING, MOLECULAR BIOLOGY, BIOTECHNOLOGY)

Course Code: BO- 6503

Total Credits: 4

Total teaching hours: 60

Unit I:- PLANT PHYSIOLOGY AND BIOINFORMATICS

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn about the plant movements.
- b. Study about the different plant growth regulators.
- c. Understand the physiological changes in plants during stress conditions.

PLANT PHYSIOLOGY

1. Plant movements: Hydrotropism, Geotropism, Phototropism, Thigmotropism. **Nastic movements.**
2. Plant Growth Regulators (Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene): biosynthesis, mode of action and physiological functions
3. Stress Physiology: Light stress and Temperature stress- Injury and resistance.

BIOINFORMATICS

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn about the basic concepts of bioinformatics-basic.
- b. Learn how to use internet and its uses.
- c. Understand about World Wide Web.
- d. Learn about the tools used in bioinformatics.
- e. Understand the use of various databases in bioinformatics.

BIOINFORMATICS

1. Introduction to bioinformatics, internet and its uses, World Wide Web,
2. Tools used in bioinformatics related to biotechnology; NCBI data models and other data bases, services offered by NCBI and EBI.

Unit II:- PLANT BREEDING

LEARNING OBJECTIVES:

The students will be able to:

- a. Understand the aims, objectives and impacts of plant breeding.
- b. Learn about the selection and procedure followed to introduce a new plant variety alongwith merit and demerits.
- c. Study the various techniques followed for hybridization.
- d. Learn about the methods of pollination used in-order to produce a new plant variety.
- e. Learn about vegetatively propagated crops.

PLANT BREEDING

1. Aims, objectives and impacts of plant breeding.
2. Procedure of plant introduction; merits and demerits of plant introduction
3. Selection methods: Mass selection, Pure line selection, Progeny selection.
4. Techniques of hybridization: emasculation, bagging, tagging, pollination and procedure of selfing. Hybridisation methods of plant breeding.
5. Self pollinated plants: Pedigree method, Bulk method of breeding, Back cross method.
6. Cross pollinated crops: Steps in producing hybrid maize, simple and reciprocal recurrent selection and synthetic varieties.
7. Vegetatively propagated crops.

Unit III:- MOLECULAR BIOLOGY

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn the concept of gene mapping.
- b. Study about DNA Sequencing.
- c. Study about Molecular markers.
- d. Understand the hazards of Recombinant DNA technology.
- e. Learn about Mitochondrial and chloroplast genomes.

MOLECULAR BIOLOGY

1. General account and techniques of gene mapping
2. DNA sequencing
3. **Molecular markers and their applications.**
4. **Biohazards of Recombinant DNA Technology.**
5. Mitochondria and Chloroplast genome

Unit IV:- BIOTECHNOLOGY

LEARNING OBJECTIVES:

The students will be able to:

- a. understand the applications of biotechnology in health and agriculture.
- b. Learn about Human insulin and Vaccine production
- c. Understand the concept of Gene therapy.
- d. Learn about the production of artificial seeds, edible vaccines and transgenic plants.
- e. Learn the methods of gene transfer methods.
- f. Understand about the cryopreservation and germplasm conservation.

BIOTECHNOLOGY

1. Application of Biotechnology in health and agriculture: Human insulin and vaccine production, gene therapy; **Pollution Control.**
2. Artificial Seeds from plants samples.
3. Edible Vaccines from plants.
4. Methods of gene transfer in plants: 1) Micro injection, 2) Electroporation, 3) particle gun and 4) Agrobacterium-mediated gene transfer.
5. **Transgenic Plants with Improved: Protein Storage, Attractive flowers, High rate photosynthesis, Engineering for Preservation of Fruits, Bioreactors and advantages.**
6. Cryopreservation and Germplasm storage.

Reference Books:

1. Devlin, Robert M.; Witham, Francis H.; *Plant Physiology*; 4th edition, Indian reprint; Delhi : CBS Publishers & Distributors , 1986(2001).
2. Kochhar, P.L.; *A textbook of Plant Physiology*; 7th edition; Delhi : Atma Ram & Sons , 1964.

3. Noggle, Ray G.;Fritz, George J.; *Introductory plant physiology*; 2nd edition; New Delhi : Prentice-Hall Of India Private Limited , 1991.
4. Salisbury, Frank B.;Ross, Cleon W.; *Plant Physiology*; 3rd edition, Reprint; New Delhi : CBS Publishers & Distributors , 1986(2001).
5. Salisbury, Frank B.;Parke, Robert V.; *Vascular plants : form and function*; London : Macmillan & Co Ltd , 1964.
6. Sinha, B.K.;Pandey, S.N.; *Plant Physiology*; 1st edition; New Delhi : Vikas Publishing House Pvt. Ltd. , 1981.
- 7.Sinha, R.K.; *Modern plant physiology*; 2nd edition; New Delhi : Narosa Publishing House , 2004.
8. Verma S. K. *Textbook of Plant Physiology and Biochemistry* ; 4th editon; S. Chand & Company Ltd, 2003.
9. Verma, V.; *Textbook of Plant Physiology*; New Delhi : Ane Books India , 2007.
10. Witham, F.H., Delvin , R.M; *Plant Physiology*; Boston, MA:Willard Grant, 1983.
11. Ignacimuthu, S.; *Basic bioinformatics*; 4th editon; New Delhi : Narosa Publishing House , 2005.
12. Kar Dipak Kumar; Halder Soma; *Plant Breeding and Biometry*; 1st edition; Kolkatta: New Central Book Agenc y (P) Ltd., 2006.
13. Singh B.D; *Plant Breeding Principles and Methods*; 1st edition; Ludhiana: Kalyani Publishers, 2001.
14. Satyanarayana U.; *Biotechnology*; Kolkatta: Books and Allied (P) Ltd, 2005.
15. Gupta P.K.;*Elements of Biotechnology*; Meerut: Rastogi Publications, 2009.
- 16 Arumugam, N.; Narayanan L. M.and Mani, A.; *Molecular Biology and Genetic Engineering*, 1st Reprint; Nagercoil: Saras Publication, 2008.

Semester – VI

LOWER PLANT DIVERSITY - I (ENVIRONMENTAL BIOLOGY, GARDENING, ETHNOBOTANY, FORESTRY)

Course Code: BO- 6504

Total Credits: 4

Total teaching hours: 60

Unit I:- ENVIRONMENTAL BIOLOGY

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn concept, levels, plants in IUCN categories of threat, red data book and biodiversity hot spots.
- b. Understand about EIA, International Biological Program; Man and Biosphere Program (MAB)
- c. Learn about climate change, green house gases, Green house effect, global warming and ozone depletion.
- d. Effect of pollution on Air, Soil and Water.
- e. Understand concept of carbon footprint.

ENVIRONMENTAL BIOLOGY

1. Plant Biodiversity: Concepts and levels, IUCN categories of threat, Red data books, Hot spots.
2. Brief account: EIA, International Biological Program; Man and Biosphere Program (MAB).
3. Climate change: Greenhouse Gases (CO₂, CH₄, N₂), CFCs: Sources, Trends and Role, Consequences of Climate Change (CO₂, Global warming, Sea level Rise,)Greenhouse effect and global warning; Ozone depletion.
4. Effect of Air, Water and Soil pollution on vegetation.
5. Carbon footprint.

Unit II:- GARDENING

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn about principles of garden design.
- b. Learn about some garden features.
- c. Understand the methods of Pruning.
- d. Learn the ways to take care of garden plants.
- e. Learn about landscape designing in India.
- f. Learn how to manage a good nursery.
- g. Understand about Bonsai.

GARDENING

1. Principles and Materials of Garden Design.
2. Garden features: Paths, walkways and avenues, arches, lawns, floral beds, hedges, edges. **Topiary.**
3. Garden operations: Pruning- principles & kinds.
4. Plant care: Manuring. Daily care & maintenance, repotting.
5. Landscape designs in India- Buddhist, Mughals, etc.
6. **Dry landscape gardens. Water efficient plants.**
7. Nursery management
8. **Bonsai**

Unit III:- ETHNOBOTANY

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn about the history and development of Ethnobotany.
- b. Learn about the ethnobotanical studies in India.
- c. Understand the ways to do ethnobotanical research.
- d. Learn about plants in mythology and their role in conservation.
- e. Learn about some selected plants used by tribes of Gujarat.

ETHNOBOTANY

1. History and development of Ethnobotany.
2. Ethnobotany in India.
3. Methods of Ethnobotanical research.
4. **Mythology and conservation of ecosystems, sacred groves.**
5. Plants used by tribes of Gujarat:
 - a. *Achyranthes aspera*
 - b. *Asparagus racemosus*
 - c. *Butea monosperma*
 - d. *Calotropis procera*
 - e. *Ficus religiosa*
 - f. *Jatropha gossypifolia*
 - g. *Tamarindus indica*
 - h. *Vitex negundo*

Unit IV:- FORESTRY

LEARNING OBJECTIVES:

The students will be able to:

- a. Learn about forest types of India.
- b. Understand the physical properties of wood including structural features and identification of wood.
- c. Learn about wood and paper industries.
- d. Learn about Lac culture.
- e. Learn about social and agricultural forestry.
- f. Learn about wildlife and biosphere reserves.
- g. Learn about forest education and training institutes.
- h. Learn and understand the about the various Acts and Amendments related to forest and wildlife conservation.

FORESTRY

1. Forest types of India.
2. Physical properties, structural features and identification of wood.
3. Wood and Paper industries.
4. Lac Culture.
5. Social forestry and Agricultural Forestry.
6. Wild life and biosphere reserves.
7. Forest research education and training Institutes.
8. Forest Conservation Act (1980-1982); the Indian Wildlife (Protection) Act 1972 – Amended 1991.

Reference Books:

1. Miller, G. Tyler; *Textbook of Ecology*, New Delhi: Cengage Learning India, 2009.
2. Odum, E.; Barrick M.; Barrett G.; *Fundamentals of Ecology*, 5th edition; New Delhi: Cengage Learning India, Pvt. Ltd., 1971.
3. Saha, T.K; *Ecology and Environmental Biology*; Kolkata: Books and Allied Pvt. Ltd.

4. Sharma, P.D.; *Ecology and Environment*; 7th edition; Meerut : Rastogi Publishers , 1998.
5. Subrahmanyam, N.S.; Sambamurty, A.V.S.S.; *Ecology*; 1st edition; New Delhi : Narosa Publishing House , 2000.
6. Bhattacharjee, S.K; *Landscape Gardening and Design with Plants*; Jaipur: Aavishkar Publishers, 2012.
7. De, L.C.; *Handbook of Gardening*; Jaipur: Sheetal Printers, 2012.
8. Laeeq Futehally; *Gardens: National Book Trust: 1978*.
9. Percy Lancaster; *Gardening in India*; New Delhi: Mohan Makhijani and Rekha Printers, 1979.
10. Trivedi, P.C; *Ethnobotany*; Jaipur: Aavishkar Publishers.
11. Jain, S.K; *Manual of Ethnobotany*; Jodhpur: Scientific Publication.

Semester – VI

LOWER PLANT DIVERSITY - I Elective Paper: Plant Tissue Culture

Course Code: BO- 6401

Total Credits: 4

Total teaching hours: 60

Unit-I: Introduction and laboratory organization

Definition, Origin and History of plant tissue culture, Laboratory organization (washing area, transfer area, culture area, green house) and instruments (autoclave, laminar air flow, pH meter, oven, distillation unit).

Unit-II: Techniques in plant tissue culture

Sterilization techniques (media sterilization, glassware sterilization, plant material sterilization, culture room sterilization and small instrument sterilization). Media composition and preparation, roles of various plant growth regulators (PGR's), Inoculation of the explants and maintenance of culture.

Unit-III: Types of cultures

Seed culture, embryo culture, callus culture, cell culture, protoplast culture, **Micropropagation.**

Unit-IV: Applications of plant tissue culture:

Applications of plant tissue culture in industries, forestry, horticulture, plant breeding and agriculture.

Reference Books:

1. Chawla, H.S.; *Introduction to Plant Biotechnology*; New Delhi: Oxford and IBH publishing Co. Pvt. Ltd.
2. Dube, R.C; *A Text Book of Biotechnology*, 4th edition; New Delhi: S. Chand and Company Ltd., 2012.
3. Gupta P.K.; *Elements of Biotechnology*; Meerut: Rastogi Publications, 2009.

4. Razdan, M.K.; *Introduction to plant tissue culture*; New Delhi: Oxford and IBH publishing Co. Pvt. Ltd..
5. Satyanarayana U.; *Biotechnology*; Kolkatta: Books and Allied (P) Ltd, 2005.

Semester – VI

LOWER PLANT DIVERSITY - I Session I

(Pteridophytes, Gymnosperms, Paleobotany, Histochemical methods and Techniques) Course Code: BO- 6505L

Total Credits: 4

Total teaching hours: 60

1. Study of types through fresh preserved material and permanent slides.

(a) Identify and classify following types:

PTERIDOPHYTA: Isoetes, Marsilea.

GYMNOSPERMS: Ginkgo, Ephedra

(b) Structure and Reproductive organs:

PTERIDOPHYTA: Isoetes: Sporophyll

Selaginella: Cones

Adiantum: Sporophyll

Marsilea: Sporocarp

GYMNOSPERMS: Ginkgo, Ephedra

2. The following Fossil Specimens and / or slides should be studied.

Pteridophytes

PSILOPHYTALES: Rhynia: Stem T.S

LEPIDODENDRALES: Lepidodendron: Stem T.S.

Lepidocarpon: V.S.Slide

Gymnosperms:

BENNETTITALES: Spore bearing organ

CORDAITALES: Cordaites: Stem T.S

Cordianthus – L.S of Cone.

Submission of photographs of at least 10 different Pteridophytes and Gymnosperms.

Session II: (Systematic Botany, Angiosperms, Anatomy, Microbiology)

ANGIOSPERMS: Study of families as per theory syllabus including floral formula and floral diagram.

ANATOMY: Study of different types of stele through charts and permanent slides.

(a.) Study of abnormal secondary growth:

- (1) Achyranthes stem
- (2) **Draceana stem**
- (3) Bougainvillea stem
- (4) Mirabilis stem
- (5) Boerhavia stem
- (6) Carrot root
- (7) Raphanus root
- (8) Beet root

(b.) Study of nodal anatomy as per syllabus.

MICROBIOLOGY:

(a.) Staining of bacteria through gram staining.

(b.) Electron micrograph: Bacteriophage virus & Bacteria.

Submissions: Herbarium sheets and Permanent Slides.

PRACTICAL II: Session I: (Plant Physiology, Plant Breeding, Molecular Biology, Biotechnology)

PLANT PHYSIOLOGY

1. Major experiments:

The following physiological experiments to be performed by the students and results are expected:

- (i) To study the rate of photosynthesis under different concentration of CO₂.
- (ii) To study of the rate of photosynthesis under different wavelength of light
- (iii) To study of the rate of photosynthesis under different light intensities.

2. Minor experiments:

The following experiments to be performed by the students:

- (i) Hill reactions
- (ii) C₃ & C₄ plants demonstration by anatomical features.
- (iii) Demonstration of respiratory enzymes in plant tissues.
 - (a) Polyphenol Oxidase
 - (b) Dehydrogenase
- (iv) Preparation of solutions: Molar, Molal, Normal, Percent Concentrations

3. Demonstration Experiments:

- (i) To demonstrate the phenomenon of geotropism.
- (ii) To demonstrate the phenomenon of hydrotropism.
- (iii) To demonstrate the phenomenon of phototropism.
- (iv) To demonstrate the phenomenon of thigmotropism.

PLANT BREEDING: Charts as per theory syllabus.

MOLECULAR BIOLOGY: Charts as per theory syllabus.

BIOTECHNOLOGY: Charts as per theory syllabus.

PROJECT WORK: Students will carry out a research project under the guidance of a Faculty. The findings will be presented at a Seminar. Project report is to be submitted and will be given due weightage.

PRACTICAL II: Session II: (ECOLOGY, GARDENING, ETHNOBOTANY, FORESTRY)

ECOLOGY

1. Determination of Chloride content in water sample
2. Determination of Carbonate and Bicarbonate in water sample
3. Determination of Calcium content in water sample
4. Determination of Total hardness of water sample
5. Determination of Carbonate/Nitrate deficiency from the given soil sample. (Quantitative)

GARDENING

1. Visit to a garden to study the principles and materials used in landscape design. Report to be submitted during practical exam.
2. Visit to a Nursery to study its management. Report to be submitted during practical exam.

ETHNOBOTANY: Ethnobotanical specimens as prescribed in theory syllabus.

FORESTRY

Identification and characteristics of following wood samples:

- a. Eucalyptus sp.
- b. Acacia arabica
- c. Mangifera indica
- d. Tectona grandis
- e. Shorea robusta (Sal)

Submissions: Garden and Nursery visit Report, Wood samples, Herbarium of Ethnobotanical plants.