BO 2.1 Diversity of Pteridophytes, Gymnosperms, and Fossil Plants

Credits: 4 **Lectures: 60**

Objectives:

1. To provide training in scientific and transferable skills through modular lecture course, research projects, written work, and seminars.
2. To know earlier plants, their vegetative and reproductive structures and their importance.
3. To acquaint the students about the morphology, biology and importance of Pteridophytes& gymnosperms.
4. To demonstrate sufficient knowledge of the concept of the fossil plants.
5. To apply biological principle and concept to everyday life, especially to matters affecting living things, the environment and economy.
6. Student should be able to differentiate between the characteristics of Pteridophytes & Gymnosperms.
7. Student should be able to differentiate between male and female reproductive organs and relate their structure and function to the production of new plants.
8. Student should be able to trace the evolution from fossil plants.

Credit: I Pteridophytes-I (15)

1. Introduction and characteristic features.

   Diversity of Pteridophytes in India and their migration to land. Affinities of pteridophyte with Bryophyte and Algae.

2. Recent systems of classification of Pteridophytes.
3. Comparative morphology, reproduction and phylogeny of following orders with reference to the forms mentioned against each**:** Psilotales (Tmesipteris), Lycopodiales (Lycopodium), Filicales (Adiantum), Equisitales (Equisetum), Salviniales (Salvinia)

Credit: II Pteridophytes-II (15)

1. Apogamy and Apospory.
2. Telome concept .
3. Stelar evolution .
4. Soral evolution .
5. Gamatophyte evolution.
6. Heterospory and seed habit .
7. Economic importance of Pteridophytes .

Credit: III Gymnosperms (15)

1. Characteristic features of Gymnosperms.
2. Recent system of classification (S.P. Bhatnagar and Alok Moitra).
3. Study of morphology and reproduction Cycadales(Zamia),Coniferales(Pinus), Gnetales(Gnetum), Ephedrales (Ephedra),
4. Gymnosperms as prospective ancestor of Angiosperms.
5. Economic importance of gymnosperms.

Credit: IV Paleobotany (15)

1. Introduction ,Evolution time scale
2. Principles of Paleobotany : Petrification , Impression and Compression.
3. Indian fossil flora –Glossopteris flora , Rajmahal hill flora and Deccan Intertrappean flora.
4. Paleopalynological techniques- Coal maceration and Lignite maceration
5. Study of morphology and evolutionary trends of:
    - Bennettitales
    - Cycadales
    - Coniferales
6. Economic importance.

Reference Books:

1. Trivedi, A. N. (2002) - Advances in Pteridology
2. Bierhorst, D.W. (1971) - Morphology of Vascular plants
3. Eames, A. J. and E. M. Giffard (1950) - Comparative morphology of vascular plants
4. Rashid, A. (1978) - An introduction otPeridophytes
5. Spome, K.R. (1966) - Morphology of Ptseridophytes
6. Bower, F. O. (1963) - The Ferns
7. Jermy, A. G. (1973) - The Phylogeny and Classification of ferns.
8. Vashishta, B.R. (1996) - Botany for degree students – Pteridophytes
9. Parihar, N.S. (1959) - An Introduction to Pteridophyta
10. Arnold, C.A. (1972) - An introduction to paleobotany
11. Darroh, W.C. (1968) - Principles of paleobotany
12. Surange, K.R. (1968) - Indian Fossil Pteridophytes

Journals

1. American Fern Journal
2. International Journal of plant sciences.
3. Bierhorst, D.W. (1971) – Morphology of vascular plants

4. Chamberlein, C.J. (1966) - Gymnosperms, Structure and Evolution
5. Coulter and Chumberlein, J. M. - Morphology of Gymnosperms
6. Foster, A. S. and Gifford, E. M. (1959)- Comparative morphology of vascular plants
7. Ramanujan, C.G.K. (1979) - Indian Gymnosperms in Time and Space
8. Spome, K.R. (1967) - Morphology of Gymosperms
9. Vashistha, P.C. (1976) - The Gymnosperms
10. Bhatnagar, S.P. and MoitraAlok (1996)- The Gymnosperms.
11. Arnold, C. A. (1972) - An Introduction to Pateobotany
12. Andrews, H.N. (1961) - Studies in Pateobotany
13. Darroh, W.C. (1960) - Principles of Paleobotany
14. Surange, K. R. (1968) - Indian Fossil Pteridophyles
15. Shukla, A.C. and Mishra, S.D. (1975)- Essentiales of Paleobotany
16. Bhatnagar, S.P. and MoitraAlok (1975) - The Gymnosperms
17. Stewart, W. N. (1983) - Paleobotany and the evolution of plants,Cambridge U.S.

BO 2.2 Cell Biology **Credits: 4**

Lectures: 60

Objectives

1. Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
2. Students will understand how these cellular components are used to generate and utilize energy in cells
3. Students will understand the cellular components underlying mitotic cell division.
4. Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.
5. All cell biology sections will cover the following topics.

Credit I: Cell organelles (I)

1. **Introduction**
2. Cell wall- biogenesis, ultra structure and function. Growth- primary and secondary wall.
3. **Cell membranes:** molecular organization, Fluid mosaic model, membrane protein diffusion, electrical properties of membranes, transport across membranes -facilitated diffusion, carrier & channel proteins, transporters, active transport, transport of ions and solutes
4. Biogenesis of chloroplasts and mitochondria.
5. .Molecular organization of chloroplast and mitochondrial membranes.
6. Plasmodesmata –Structure and role in movement of molecules.
7. Vacuoles –Tonoplast membrane biogenesis, transporters, role as storage organelle, transport across vacuolar membrane

Credit II: Cell organelles (II)

1. Nucleus –Structure, organization and regulation of nuclear pore complex. Transport across nuclear membrane.
2. Endoplasmic reticulum-Role in synthesis and transport of secretory proteins
3. Golgi complex –Role in sorting , storage and secretion,
4. .Lysosomes, membraneintegrity and roleGlyoxysomes and Peroxisomesstructure and functions.
5. Ribosomes –Structure, assembly and dissociation of subunits, function
6. Structure and function of Cytoskeleton**:** composition and organization of microtubules, microfilaments. Treadmilling , role in cell division, signaling and intracellular traffic. Role in motility. Flagella-Structure and organization.

Credit III: Cell signaling and communication.

A) **Cell signaling :**

1. Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors.
2. Signal transduction pathways, secondary Messengers.
3. Regulation of signaling pathways,
4. Bacterial and plant two component systems.
5. Light signaling in plants.

B) Cellular communication:

1. Regulation of hematopoiesis.
2. General principles of cell communication,
3. Cell adhesion and roles of different adhesion molecules
4. Gap junctions
5. Extracellular matrix and integrins,

6. Neurotransmission and its regulation.

Credit IV: Cell cycle

Cell Cycle

1. Phases of Cell Cycle,
2. Functional importance of each phase
3. Molecular events during cell cycle
4. Regulation of cell cycle.
5. Cyclins and protein kinases,
6. MPF (maturation promoting factor)

Cell aging and cell senescence:

1. Programmed cell death and its molecular aspects.
2. Regulation of cell death
3. PCD in response to stress

Apoptosis:

1. Role of different genes.
2. Cell organelles during apoptosis
3. Genetic control of apoptosis.

Cancer:

1. Cancer and the cell cycle
2. Interaction of cancer cell with normal cell
3. Metastasis

Reference Books:

1. Alberts B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. 1989
2. Molecular biology of the Cell (2ndedition). Garland Pub. Inc., New York.

3. Karp, G. 1999. Cells and Molecular Biology: Concepts & Experiments. John Wiley andSons,Inc., USA.
4. Lodish S, Baltimore B , Berk, C and Lawrence K, 1995 , Molecular Cell Biology ,3rd edn, Scientific American Books, N.Y
5. De Robertis and De Robertis, 1988, Cell and Molecular Biology, 8thedn, Info-Med, Hongkong.
6. Buchanan, Grissem and Jones, 2000, Biochemistry and Molecular Biologyof Plants, American Soc. Plant Biologists, Waldorf
7. Lewin, B. 2000. GENE VII. Oxford University Press, New York, USACooper G M and Hausman R E,2007 , The Cell: MolecularApproach 4thEdn, SinauerAssociates,USA. Johnson Lewys – 2004 : Cell Biology ; sarup and sons, New Delhi
8. E.J. Dupraw – 1970 : Cell and Molecular Biology; Academic Press, London
9. De Robertis and De Robertis – 1997: Cell and Molecular Biology (VIII); B.I. WaverlyPvt. Ltd., New Delhi
10. C. P. Swanson, T. Merz, and W.J. Young – 1982 : Cytogenetics ; Prentice – Hall ofIndia Pvt. Ltd., New DelhiIndia
11. C. B. Powar – 1992: Cell Biology; Himalaya Publishing House.

BO 2.3 Plant Physiology and Metabolism

Credits: 4 **Lectures: 60**

Objectives

1. To increase awareness and appreciation for plants in your environment, as well as to understand their diverse physiological functions.
2. To help you understand the role of plant physiology in the botanical sciences.
3. To introduce you to some methods and techniques used in plant physiological research.
4. To give you the opportunity to develop useful research skills and to improve your scientific writing skills.
5. To help you develop the knowledge and confidence to pursue advanced courses in plant biology, and to conduct your own plant physiology research.
6. Demonstrate ways to measure environmental services accomplished by plants.
7. Propose ways of using plants to preserve and improve urban, agricultural, rural, and wilderness environments.
8. Explain and provide examples of how plants interact with light, water, soil and
9. Other organisms and how humans can optimize those interactions.
10. Evaluate the idea that plants such as wheat, corn, tea and tomato have exploited
11. Humans to become widely successful far beyond their native ranges.
12. To help to demonstrate and explain research equipment and measures (data) used to document and compare plant response to a changing environment.
13. Able to understand how to increase food autonomy through productive food gardens in countries.
14. Position themselves to join a research group investigating plant function

---

Credit: I Transport and translocation mechanism:

1. Solute transport and photoassimilate translocation

1. Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem.
2. Transpiration, mechanisms of loading and unloading of photoassimilates, nutrient uptake through root microbe interaction; membrane transport proteins.

2. Nitrogen metabolism:,

1. Root nodulation and nitrogen fixation.
2. Nitrogen uptake
3. NOD factor

Credit: II Stress physiology and Senescence

1. **Stress physiology**: – **Stress physiology** – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.
2. **Senescence: Mechanism**, physiology of senescence; role of hormones, biochemical aspects, significance in fruit ripening.

Credit: III Photosynthesis

1. **Photosynthesis**: Evolution of photosynthetic apparatus, photoxidation of water, Hills reaction, two-pigment system, mechanism of electron and proton H+ transport.
2. **Carbon assimilation pathways** in C3, C4 and CAM plants. Photosynthetic productivity in these plants, and significance.
3. **Photorespiration:** Glycolate pathway, Glyoxylate pathway, biochemical basis of photorespiration, significance.

Credit: IV Plant Metabolism

1. **Secondary metabolites** - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.
2. **Phytohormones:** Biosynthesis and mechanism of action of Phytohormones auxin, gibberellin, cytokinin,ethylene and ABA. Brassinosteriods, Jasmonic acids, Polyamines, salicylic acid.

Suggested Reading:

1. Buchanan B.B., Gruissem, W. and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
2. Galston, A.W. 1989. Life Processes in Plants. Scientific American Libray, Springer-Verlag, New York,USA.
3. Hooykaas, P.J.J., Hall, M.A. and Libbenga, K.R. (eds) 1999.Biochemistry and Molecular Biology of Plant Hormones, Elsevier, Amesterdam, The Netherilands.
4. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley& Sons, Inc., New York, USA.
5. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D.,and Darnell, J. 2000. Molecular Cell Biology (fourth edition).W.H. Freeman and Company, New York, USA.
6. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones(second edition). Springer-Verlag, New York, USA.
7. Nobel, P.S., 1999. Physiochemical and Environmental PlantPhysiology (second edition), Academic Press, San Diego, USA.
8. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4th edition).Wadsworth Publishing Co., California, USA.
9. Singhal, G.S., Renger, G., Sopory. S.K., Irrgang, K.D. and Govindejee 1999. Concepts in Photobiology. Photosynthesis andPhotomorphogenesis, Narosa Publishing House, New Delhi.
10. Taiz, L. and Zeiger, E. 1998. Plant Physiology (2nd edition). Academic Press, San Diego, U.S.A. Westhoff, P. (1998) Molecular Plant Development: from Gene to Plant. Oxford University Press, Oxford, UK.

11. Plummer, D.T. 1988. An Introduction to practical Biochemistry. TataMcGraw Hill Publishing Co.Ltd.New Delhi.
12. Wilson,K. and Goulding, K.H. (Eds), 1992. A Biologist Guide to Principles and Techniques
13. Practical Biochemistry (3rd Edition). ManasSaikia for Foundation Books, New Delhi.
14. Sadasivam, S. and Manickam A., 1996. Biochemical methods (2ndEdition). New Age International Publishers New Delhi

BO 2.4 Plant Structure, Development & Reproduction in Angiosperms

Credits: 4 **Lectures: 60**

Objectives:

1. Student should able to describe reproductive structure of a plant and compare male and female gametophytes and explain how they form in Angiosperms.
2. To describe the components of a complete flower.
3. To compare and contrast life cycles of angiosperms, gymnosperms.
4. To describe the structure and function of the flower within the angiosperm life cycle.
5. To list and explain significance of steps in angiosperm gametogenesis and fertilization, including double fertilization.
6. To explain significance of features or steps of seed maturation, dormancy, and germination.
7. To predict mechanisms of pollination or dispersal based on flower or fruit characteristics.
8. To study structure and development of angiosperms.

Credit: I: Process of Plant Development (15L)

1. Plant development- concept, definitions and unique features.
2. Processes of development, cell growth, organization of cells, tissues and tissue system to whole plant. Cell- cell interaction.
3. Factors for development- intrinsic and extrinsic.
4. Vegetative development – structure and organization of seed embryo.
5. Seed formation and germination – Embryonal axis- meristems, establishment of seedling organ.
6. Phenomenon of development, meristems as dynamic centers of cell regeneration, organ development, primordium to organ, juvenility – characteristics, transition to adult phase.Coordinated development.

Credit: II: Embryological Aspects of Development (15L)

1. Transition - vegetative to reproductive phase, morphological and histochemical changes in vegetative plant body.
2. Gametophyte development, microsporogenesis and male gametophyte megasporogenesis and female gametophyte
3. Fertilization – process and its significance abnormalities in fertilization .
4. Embryo development - Development of embryo in dicots and monocot, unclassified or abnormal embryos, unorganized or reduced embryo.
5. Polyembryony – concept and classification of polyembryony, special cases and causes of polyembryony, apomixis- concept, categories- agamospermy and vegetative reproduction apospory, parthenogenesis .

Credit III: Molecular basis of plant development

1. Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.
2. Organization of shoot and root apical meristem , shoot and root development , leaf development and phylotaxi

Credit IV: Palynology

[15L]

1. Palynology**:** Scope and branches with special suggested readings
2. Palynotaxonomy**:** Pollen morphology and plant taxonomy with suggested readings: to Gymnosperms and Angiosperms.
3. Paleopalynology: Principles, microfossil recovery theory and techniques, microfossilgroups and oil exploration.
4. Aeropalynology**:** Principles, techniques, pollen analysis, pollen and spore allergy,
5. allergicproperties of pollen, pollen calendar and importance.
6. Agropalynology**:** Pollen viability, pollen germination, pollen storage and their
7. Significance.
8. 6.Melittopalynology**:** Bee colony, foraging behavior of bees unifloral multifloral honey,aplication in crop productivity.

References:

1. Bhojwani S. S. and Bhatnagar S. P. (1999). The embryology of angiosperms. VikasPub.House.
2. Bhojwani S.S. and Soh W.Y. (2001). Current Trends in Embryology of Angiosperms.
3. Kluwer Academic Publishers.
4. Fahn A (1989) plant anatomy (Third edn) Pergamon Press.
5. Gilbert (2006). Developmental biology (8thEdition). Sinauer Associates, Inc., Publishers,Sunderland, Massachusetts, USA.
6. Graham C.F. and Wareing P.F. (1984). Developmental Controls in Animals and Plants.
7. Blackwell Scientific Publications.
8. Jermy Burgess (1985) An Introduction to Plant Cell Development. Cambridge University Press.
9. Johri B. M. and Srivastava P. S. (2001). Reproductive biology of plants. Narosa Pub. House,New Delhi.
10. KrishnamurthyK.V. (1988) Methods in Plant Histochemistry.

11. Lewis Wolpert(2002), Principles of Development (2ndedition). Oxford University Press.
12. Lyndon R.F. (1990) Plant Development The Cellular Basis. UNWIN HYMAN.
13. Raghavan V. (2000) Developmental Biology of Flowering Plants.SpringerVerlag.
14. Razdan M.K. (2003) Plant Tissue Culture, Oxford IBH

Botany Lab. Course-III (4C) (Based on Theory paper BO – 2.1 and BO – 2.2)

Practical's based on (BO 2.1) Diversity of Pteridophytes, Gymnosperms, and Fossil Plants

1-5 Morphological, anatomical and reproductive studies of the following members (available specimens / slides)

- Psilotales: Tmesipteris
- Lycopodiales: Lycopodium /Selaginella /Isoetes
- Filicales :Adianntum
- Equisitales: :Equisetum
- Salviniales :Salvinia
- Prepration of double stained slidepermnant slide of above mentioned plant material.

6-10 Study of the morphology and anatomy of the vegetative and reproductive parts of Zamia., pinu, Podocarpus, and Ephedra from availablespecimens / slides.

11-12 Study of following specimens (Any two as per available material)

Any Ten Practicals

Practicals based on Cell Biology (BO 2.2)

1 Isolation of chloroplast.

2. Demonstration of SEM and TEM.(photocopy)
3. Isolation of mitochondria. .
4. Comparative study of normal and banded karyotype.
5. Determination of mitotic index in any plant species

7. Differential centrifugation for isolation of cell fractions –Nuclear fraction

8. Determination of permeability of living cells to acids and bases

9-10.Identification of different stages of mitosis from Onion root meristem

11-12. Identification of different stages of meiosis from suitable plant material.

13.To study cell diversity.

Botany Lab. Course-IV (4C) (Based on Theory paper BO – 2.3 and BO – 2.4)

Practicals based on Plant physiology and metabolism (BO 2. 3)

1. Estimation of soluble proteins in germinating and non-germinating seeds by Lowry /Bradford'smethod
2. Estimation of total amino acids in germinating and non germinating seeds
3. The identification of sugar in Fruit juices by TLC.
4. Isolation of Chloroplast from spinach leaves.
5. To study biochemical changes during leaf senescence.
6. Effect of time and enzyme concentration on the rate of enzyme action(Any one)
7. Estimation of stress induced amino acid (Proline)
8. Estimation of total fats in fatty seeds.
9. Separation of Alkaloids/Phenols by TLC.
10. Estimation of Phenols by chemical method.
11. Qualitative analysis of secondary metabolites.
12. Sugar/ amino acids analysis with paper chromatography.
13. Estimation of Chlorophylls

Any Ten Practicals

Practicals Based on BO 2.4 Plant Structure, Development & Reproduction in Angiosperms

1. Isolation of vegetative and reproductive apical meristems.
2. Tracing the course of stomatal development and observations on stomatal types.
3. Anatomical studies on secondary growth (wood).
4. Origin and development of epidermal structures (trichomes, glands and lenticels) and study of secretory structures (nectaries and laticifers).
5. Histochemical comparison between vegetative SA and reproductively induced SA.
6. Observations on Microsporogenesis and development of male gametophyte (pollen).
7. Observations on.Megasporogenesis and development of female gametophyte.

8. Observations on types of endosperm, dissection and isolation of endosperm.
9. Observations on stages of embryo development, dissection and isolation of developing embryo (3 stages) .
10. In vitro germination of spore/pollen, Correlation between fertility (stainability), viability (TTC and FDA staining) and germinability (in vitro) of pollen grains.
11. Histological analysis of secondary growth (Primary or secondary axis).
12. Dissection of haustorial endosperm.
13. Dissection of an embryo of dicot and monocot.

LAB COURSE OUTCOMES LABORATORY COURSE III (Based on Bo 2.1&2.2)

1. To introduce concept about plant physiology and biochemistry at an advanced level.
2. To enable a practical understanding of the cardinal importance of plant metabolism in biosphere and how it may be manipulated through genetic engineering.
3. To understand the functions of their cells and biological molecules.
4. To understand how plants grow and develop throughout their lives.
5. To understand the fundamental importance of water relations to plant growth, development and function.
6. To recognize environmental stimuli that affect plant growth and development
7. To understand the orientation i.e. how did the root and shoot respond to gravity.
8. To understand the role of plant hormones in plant growth and developed.
9. To teach observation and interpretation of biological phenomena.
10. To describe the relationship between carbon dioxide & photosynthesis.

LAB COURSE OUTCOMES LABORATORY COURSE IV (Based on Bo 2.3&2.4)

1. To understand the general systematic relationships of gymnosperms and angiosperms.
2. To describe the general feature of gymnosperms and angiosperms.
3. To understand the life cycle of vascular plants.
4. To compare the significant features of life cycle for various pteridophyte, gymnosperm and angiosperm and state the particular evolutionary importance.

5. To be able to differentiate between representative organisms in each group i.e. cycad, ginkgo, welwitschia etc.
6. To compare and contrast the properties and functions of channels and carriers.
7. To design an experiment that demonstrates membrane fluidity changes in response to the environment.
8. To identify the different cellular compartments in a eukaryotic cell and their main function in the cell.
9. To compare and contrast the structure and function of different cell types.

BOTANY PROGRAMME SPECIFIC OUTCOME

1. A botany degree is applicable to many types of careers.
2. Some plant biologists work primarily outdoors, in forests, parklands, or fields.
3. Others work in laboratories, museums, in botanical gardens, or in industry. Graduates go into fields as diverse as biotechnology, environmental monitoring and protection, and agriculture. More than half of Botany students go on to graduate studies in natural science, agriculture, environmental sciences, and education.
4. Plant Pathologists specialize in diagnosis
5. Treatment and management of plant diseases in forests, crops, and landscape plants. They are employed by the agricultural industry, international institutes, state and federal agencies, colleges and universities, or as private consultants.
6. Plant Ecologists
7. They conduct field surveys and technical work researching ecological issues, such measuring the environmental impact of human activities and climate change. They develop and carry out management plans to mitigate environmental problems and conserve species and ecosystems. They educate students and the general public on how to preserve diversity and create sustainable communities.
8. They are employed by private industry, ecological consulting companies, state and federal agencies that oversee public lands and resources, and educational institutions.
9. Plant Evolutionary Biologists and Taxonomists

10. Explore the diversity and origin of plant species across the globe. They are employed by museums, botanical gardens, pharmaceutical companies, state and federal agencies, international institutions, and colleges and universities.
11. Plant Physiologists and Molecular Biologists
12. Work in laboratories in the agriculture and biotechnology industry, in colleges and universities, and in government agencies, like the USDA, EPA and DOE.
13. They do research on many aspects of plant function, and how plant genetic diversity contributes to improve crop performance, nutrition, and disease resistance.
14. Biological Sciences (Conservation Biology and Ecology)
    i. Master Gardener Series: Basic Botany
    ii. Soils and Compost
    iii. Vegetable Gardening
    iv. Introduction to Entomology
15. Plant Pathology ,Pesticide Safety
16. Herbaceous Ornamental Plants
    i. Sustainable Landscape Design
    ii. Sustainable Landscape Maintenance
17. State agencies need botanists in many different fields.
18. Plant biologists work in various branches of Agriculture, including the Medical Plant Resources Laboratory,
19. TheGermplasm Resources Laboratory,
20. The Animal and Plant Health Inspection Service,
21. Plant scientists also work in several other federal agencies, including the Public Health Service, State Department, National Aeronautics and Space Administration, Smithsonian Institution, and Environmental Protection Agency.
22. In addition, each of the 50 state governments employs plant scientists in agencies similar to those of the federal government. Environmental organizations, like the Nature Conservancy, also hire botanists.
23. Industry is the third major employer of plant biologists. Drug companies, the oil industry, the chemical industry, lumber and paper companies, seed and nursery companies, fruit growers, food companies, fermentation industries (including

breweries), biological supply houses and biotechnology firms all hire men and women trained in botany.

24. Recently the first genetically altered food crop, the FlavrSavr(tm) tomato, reached store shelves. This opens a new career field for botanists.

BOTANY COURSE OUTCOME

Diversity of pteridophytes, gymnosperm and fossil plants. BO-2.1

1. Students are expected to familiarize with the morphological and systematic knowledge the about different plant groups.
2. They will be able to make use of this knowledge for detailed study in other disciplines.
3. The course is designed to provide an adequate knowledge about basic concept of different plant groups and their phylogenetic relationship.
4. They will able to comparative study of life form, structure, reproduction and economic significance of pteridopyte, Gymnosperm etc.
5. The course is designed to provide an insight to the basic concept of plant systematic and its role in classification.
6. Students are expected to learn about the history of plant systematic and its role in classification.

Cell biology BO-2.2

1. To introduce the students to basic aspects of cell biology, Genetics and evolution.
2. Students will be able to describe apply and integrate the basic concepts of cell biology including structure and functions of organisms.
3. They will able to study of cell structure using compound microscope and
4. elucidation of ultra structure from electron microphotographs.
5. Students will able to study of mitosis and meiosis by smear/ squash method and from prepared slides.
6. Students will be able to understand scientific methods for implementation in applied courses of cell biology.

Plant physiology BO- 2.3.

1. The Aim is to give the students increased knowledge of metabolism
2. physiology and structure of plants.
3. Students will able to understand regulation of growth and development and influence of environment.
4. The course will be to understand the soil plant relationship with reference to environmental factors and plant physiology.

plant structure, development & reproduction in angiosperms. BO 2.4

1. Students will able to study anatomy in relation to basic structure of plants and their developmental biology.
2. They are able to make use of this knowledge for the identification and grouping of different plants based on the anatomy.
3. The students will acquire knowledge about leaf, shoot root development.
4. Students will understand basic anatomical concept of primary structure of root ,stem and flower.
5. They will be able to discuss the idea of secondary growth.