

**Module-I**

**Meristem:** Primary and secondary cell wall, ultrastructure and chemistry of cell wall; Meristem- Classification and types, organisation of shoots, root apical meristem, simple and complex tissues- ultrastructure of xylem and phloem. Structure and development of epidermal and Ground tissue system- Stomata, Trichome, Laticifer, Lenticells, Periderm and cambium.

**Module-II**

**Primary and Secondary structure:** Nodal anatomy- types of nodes, origin of buds' traces; stem anatomy- dicot (*Nyctanthes*, *Boerhaavia*, *Aristolochia*, *Tinospora*), Monocot (*Dracaena*, *Agave*) with special references to primary anatomy structure. Wood- annual rings, heart and sap wood, heart and soft wood and ring and diffuse porous wood, wood anatomy- *Tectona*, *Michelea*, *Shorea*.

**Module-III**

**Introduction to plant reproduction:** Modes of reproduction in plants- Vegetative (artificial and natural) and significances of Sexual reproduction. History- Contribution of P. Maheshwari, B.M. Johri, G.B. Amici, W. Hof Strasburger to the development of Embryology. Structural organisation of flower in angiosperms. Floral development in model plants- ABC model. Male gametophyte- Microsporogenesis, Anther development, Anther wall layers and functions. Tapetum- types and function. Female gametophyte- Megasporogenesis, ovules structure and types, development and ultrastructure of female gametophyte (embryo sac).

**Module-IV**

**Gametogenesis, Pollination and fertilization:** Microgametogenesis: Pollen wall structure, MGU (male germ unit) structure, classification of pollen and spore based on NPC system; Pollen wall proteins; Sporopollinin, Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia. Megagametogenesis: Ovule Special structures—endothelium, obturator, aril, caruncle. Pollination: types, agents. Pollination syndrome. Fertilization- path of entry of pollen tube, site of pollen discharges, pollen tube growth, double fertilization and polyspermy, barriers of fertilization.

**Module-V**

**Endosperm and Embryo-endosperm relationship:** Endosperm: Development, types, haustoria and function. Embryogenesis- Monocot and dicot embryo development, embryonal suspensors. Experimental embryology: Scope and application, *In vitro* pollination and fertilization. Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Polyembryony and apomixis- Introduction, Classification, causes and applications.

**References:**

1. Bhojwani S. S. and Bhavnagar S. P. 2000. The embryology of Angiosperms (4th revised and enlarged edition) Vikas Publishing house, New Delhi.
2. Esau, K. 1965. Vascular differentiation. Hort, Rinehart and Winston, New York.
3. Fahn, A. 1974. Plant Anatomy 2nd Edition, Pregmon.
4. Roy, K. 2006. Plant Anatomy, New Central Book Agency (P) Limited, Calcutta.  
Embryology:
5. S.S. Bhojavani, S.P. Bhatnagar & P.K. Dantu. 2015. Embryology of Angiosperms. 6<sup>th</sup> edition Vikas Publication.

**Module-I**

**Water relations and Mineral nutrition:** Translocation of solutes and macromolecules from soil to membrane. Importance of nutrients, deficiency, disorders and treatment. Active and Passive transport. Transpiration mechanism of loading and unloading of photoassimilates. Factors affecting transpiration, transpiration control and anti-transpiration, photo oxidation of water, mechanism of electron transport.

**Module-II**

**Photosynthesis:** Concept of photosynthesis, photosynthetic apparatus, photosynthetic pigments, LHC's composition and characterization of PS-I and PS-II, Photo protective mechanism, Photophosphorylation, C3, C4 and CAM Pathway. Photorespiration- biosynthesis of glycolate and regulation of photorespiration. Chlorophyll fluorescence as a tool in research, agriculture and new challenges in photosynthetic research.

**Module-III**

**Respiration:** Overview of plant respiration, glycolysis and TCA cycle, electron transport and ATP synthesis, oxidative phosphorylation, chemiosmosis hypothesis, PP Pathway and its significance, Glyoxylate cycle, functional organisation and control of plant respiration, respiratory metabolism in relation to physiological function in higher plants. The functional organization and control of plant respiration.

**Module-IV**

**Plant development-1:** Evolution of developmental complexity from algae to angiosperm. Role of cell division and expansion in plant development, Plant cell cycle endoreduplication and control of plant cell size. Regulation of Plant Architecture, Shoot apical meristem, Root apical meristem and positional control of root development. Lateral organ development- Leaf primordia initiation, leaf development, Generation of regulation of stomatal patterning in plants. Vernalization of plants.

**Module-V**

**Plant development-2** Seed germination and dormancy, Plant Senescence, Reproductive development of Plants, Inflorescence initiation, Flower development in plants, Embryogenesis in higher plants. **Plant growth regulators** - Biosynthesis and mode of action of phytohormones- Auxin, Gibberellins, Cytokinins, Ethylene, Abscissic acid, Brassinosteroids, Salicylic and Jasmonic acid and karrikins. Environmental regulation of Plant Development, Photoperiodism and circadian rhythms and biological clock.

**References**

1. Barkla, B.J., and Pantajo, O. 1996. Physiology of ion transport across the tonoplast of higher plants. Ann. Rev. Plant Physiol. 47: 159-184.

2. Devline and Witham, 1986. Plant Physiology. CBS Publs. and Distributors, New Delhi.
3. S. Sadasivam and A, Manickam Biochemical methods. New age international publishers
4. S.K. Varma & Mohit Varma. 2008. A text book plant physiology, biochemistry and biotechnology. S. Chand Publication.
5. S.N. Pandey & B.K. Sinha. Plant physiology, 4<sup>th</sup> Edi. Vikas Publication. 2005.
6. Singhal. 1999. Concepts in Photobiology, Photosynthesis and Phytomorphogenesis, Narosa Pub. House, New Delhi.
7. Sinha R.K. 2014. Modern Plant Physiology 2<sup>nd</sup> Edition. Narosa Publication.
- Spanswick, R.M. 1981. Electrogenic ion pumps. Ann. Rev. Plant Physiol. 32: 267-289.
8. V.K. Jain. Fundamentals of plant physiology, 19<sup>th</sup> Edi. S.Chand Publication. 2017.

**Module-I**

**Media and sources:** Discoveries and contributions in PTC, Principles of plant tissue culture, media composition and preparation. Carbon source- Reducing and non-reducing sugars, aseptic manipulation. Role of plant growth regulators. Growth determination and medium analysis. microenvironmentation in micropropagation. Methodology of micropropagation, technical problems in micropropagation.

**Module-II**

**Concepts and strategies:** Concept of cellular totipotency, culturing techniques- Meristem culture, Callus culture, Root, Shoot and Leaf culture, flower culture (ovary, anther and pollen). Suspension culture- methods and cell population dynamics, Embryo culture. Somatic embryogenesis and Factors affecting somatic embryogenesis. Germplasm conservation and synthetic seed technology. Current and future status of PTC, advantages and applications of PTC. Strategies to overcome explant recalcitrance.

**Module-III**

**Somatic hybridization and *in vitro* secondary metabolites:** Somatic hybridization: Isolation, purification and culture of protoplast, protoplast fusion. Soma-clonal variation: feature, mechanism, advantages and disadvantages. Tissue culture in agriculture and crop improvement programme. Tissue culture in pharmaceuticals, production of secondary metabolites and biosynthesis of active molecules through PTC, Hairy root cultures, immobilization, elicitors.

**Module-IV**

**Case studies in PTC:** Tissue culture techniques, salient features and commercial importance in relation to orchids, medicinal plants, Crop plant, Industrial crop plant, industrial non-edible plant, tress species (Strategies and scope of above-mentioned group of plants). Transgenics through *in vitro* techniques- Insect resistance, virus resistance and disease resistance.

**Module-V**

**Advanced techniques in PTC:** Single cell culture (Bergmann cell plating technique), determination of cell viability test- TTC method of staining and Evans blue staining. Protein separation and identification techniques- Agarose gel electrophoresis, Polyacrylamide gel electrophoresis, Microarray. Blotting techniques: nucleic acid, southern, western blotting.

**Selected References:**

1. Bhojwani, S.S. and Dantu, P.K., 2013. Plant tissue culture: an introductory text (Vol. 318). India: Springer.
2. Smith, R.H., 2012. Plant tissue culture: techniques and experiments. academic press.
3. Jha, T.B., 2005. Plant tissue culture: basic and applied. Universities press.

4. Anis, M. and Ahmad, N. eds., 2016. Plant tissue culture: propagation, conservation and crop improvement. Springer Singapore.
5. Neumann, K.H., Kumar, A. and Imani, J., 2009. Plant cell and tissue culture: a tool in biotechnology (Vol. 12). Berlin: Springer.
6. Dodds, J.H. and Roberts, L.W., 1995. Experiments in Plant Tissue Culture. Cambridge University Press.
7. Bhojwani, S.S. and Razdan, M.K., 1986. Plant tissue culture: theory and practice. Elsevier.
8. Smith, R.H., 2012. Plant tissue culture: techniques and experiments. academic press.

# SEED TECHNOLOGY

22BOT232

52Hrs

## MODULE-1

**Seed Technology:** Introduction, development of Seed Technology in India and importance in Agriculture. Morphology and Anatomy of Seed- Seed Structure in Angiosperms; Types of Seeds- apomictic seeds, polyembryonic seeds; parthenocarpy, somatic embryos, synthetic seeds; heirloom varieties, orthodox and recalcitrant seeds; seed treatments; seed protectants, priming, coating, pelleting, germination enhancers. Seed quality, health and vigour, significance and tests; physical and genetic purity tests.

## MODULE-2

**Seed germination viability and Seed production:** Factors, Types affecting germination and viability tests, different media for germination, *In vitro* seed germination. Seed Viability – Concept, seed viability testing methods. Seed production: Types of soils, seed sowing methods for vegetable, fruit, flower and field crops; natural and synthetic fertilizers, biofertilizers.

## MODULE-3

**Principles of Seed processing:** Harvesting, drying, thrashing, stratification; Seed storage, cryopreservation; factors affecting seed storage; seed deterioration and methods of control; seed banks; seed borne pests and diseases and their control in seeds of vegetable, fruit, oil, fibre, millet, pulse and cereal crops; Seed sampling; Classes of seeds: breeders' seeds, nuclear seeds, certified seeds, founder seeds, cultivar seeds; Seed certification: submission procedure for seed certification; Seed Act, 1966 and The Seeds Bill, 2004.

## MODULE-4

**Seed testing and Certification:** National seed testing laboratories (Govt. of India) and international organisations (ISTA, ISF, UPOV, APSA, FAO). Plant quarantine and protection of new varieties, hybrids and genetically engineered varieties, significance of protection; Indian and UPOV (Union for protection of new varieties) regulations and patenting. Principles and Philosophy of Seed Certification, purpose and procedures.

## MODULE-5

**Seed borne diseases and management:** Seed borne and storage fungi; Seed borne bacteria and viruses; Seed borne diseases and their management; Diseases of locally important crop plants- Jawar, Bajra, Rice, Red gram and their management; Post harvest diseases and management of aforesaid crops.

## References

1. Agarawal P K 2006. Principles Of Seed Technology. Indian Council of Agri. Research, New Delhi.
2. Amarjit S Basra – 2006. Handbook of Seed Science and Technology, The Haworth Press, USA.

3. Bench. A.L.R. and Sanchez, R.A. 2004. Handbook of Seed Physiology: Applications to agriculture. Food Product Press and Hawthorn Press, Binghamtown, USA.
4. Black, M., Bewley, D. and Halmer, P. 2006. The Encyclopedia of Seeds: Science, Technology and Uses. CABI, Wallingford, UK.
5. Desai, B.B. 2004. Seeds Handbook: Processing and Storage, CRC Press.
6. ISTA. 2006. Seed Testing Manual. ISTA, Switzerland.
7. Karuna, V. 2007. Seed Health Testing. Kalyani Publishers, Ludhiana.
8. Lawrence O Copeland – 1995. Principles of Seed Science and Technology- Kluwer Academic Publishers, The Netherlands.
9. Paul Neergaard. 2005. Seed Pathology, Palgrave – Macmillan, Denmark.



**Module-I**

**Ecosystem:** Scope, concept and components, Homeostasis (Xenobiotic), diversity, characters, functions of major ecosystem (Aquatic and Terrestrial) and Agricultural ecosystem. Energy flow, primary production and decomposition. Population ecology: characteristics of a population, population growth curves, population regulations, concepts of metapopulation- Demes and Dispersals, interdemec extinctions, age structured populations.

**Module-II**

**Ecological Factors:** Biotic and abiotic factors; species interaction- types of interactions, interspecific competition, herbivore, carnivore, pollination, symbiosis; Restoration ecology, industrial ecology, ecosystem engineers; Biogeochemical cycles- Carbon, Nitrogen and Phosphorus; Water bodies and their classification, methods and importance of rain water harvesting.

**Module-III**

**Community Ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Genecology, synecology and autecology; Plant succession- views and types; concept of climax. Ecological niche- concept of niche; width and overlap, fundamentals and realised niche, resource portioning and character displacement. Environment and climate change (Karnataka and India).

**Module-IV**

**Principles of Phytogeography:** Static and Dynamic phytogeography, Phytogeography of Kalayana Karnataka Region. Origin of Islands and continents: Pangaea, Panthalassa, Laurasia and Gondwana land. Plate tectonics and Continental drift. Phytogeographical regions of the world and India. Soil, climate, flora, and vegetation of India. Native taxa; Naturalization of exotic taxa. Plant distribution and migration, barriers of plant migration.

**Module-V**

**Strategies for Conservation of Diversity:** *In situ* Conservation – Sanctuaries, National Parks, Biosphere Reserves, MPCA, MPDA, Mangroves, Coral Reefs, Sacred Groves. Ex-situ Conservation: Botanical Gardens. Arborata and Palmata; Herbaria, Gene Banks, Seed Banks, Traditional Role of National and International Organizations – WWF, IPGN, IUCN, NBPGR, BSI, ICAR, CSIR, DBT, DST, NGOs and Role of Indigenous people in Biodiversity conservation.

**References**

1. Ambast R.S. Ambast N.K. 1999. Text book of plant Ecology.
2. Chapman J.I. and Reiss, M.J. 1998. Ecology-Principles and applications. (Cambridge University Press, Cambridge).

3. DK Asthana & Meera Asthana. 2006. A text book of Environmental Studies. S Chand Publication.
4. Kormondy E.J. 1989. Concepts of Ecology.
5. N. Nandini, N Sunita, Sucharita Tondon. 2007. Environmental Studies. 6<sup>th</sup> Edi. Sapna Book House.
6. Odum,E.P. 1971. Fundamentals of Ecology.
7. Robert Leo, Smith. 1980. Elements of ecology and field biology;
8. Sharma P.D. 1999. Ecology and environment;
9. Sharma B D, Singh N P Raghaven S and Deshpande U R. 1984. Flora of India- Series
10. Flora of Karnataka- Analysis. Botanical Survey of India, Department of Environment.

**Module- I**

**Ethnobotany:** Introduction, concept, scope and principles, application and objectives. Ethnobotany as an interdisciplinary science, quantitative ethnobotany, ethnic group of India, Karnataka and their significance relationship with plants, Ethnomedicine, Importance in modern health care system. Current status of Ethnobotanical research- Constraints and Suggestion

**Module-II**

**Methodology of Ethnobotanical studies:** methods of documentation a) Field work b) Herbarium c) Ancient Literature d) Temples and sacred places. Plants used by the tribal: Food plants, intoxicants and beverages, Resins and oils and miscellaneous uses. Indigenous societies and interactions with plants- a global view. Relationship between human and plants- for benefit of both and developmental strategies of both.

**Module-III**

**Conservation and application:** Ethnobotany and conservation of plants with special reference to India- Mythology and conservation of ecosystems, conservation of selected medicinal plant species: sacred groves, forestry and unique ecosystems, and their ethnobiological values, plants and animals in art, tradition and ethnography. Ethnobotany as a source of drug

**Module-IV**

**Bioprospection:** Bio-piracy - Definition, introduction, current practices in bioprospecting for conservation and genetic resources- Bioprospecting Act- Phases of bioprospection, Exemption to act, fields of bioprospecting. IPR, types and its role in Ethnobotany. Classical examples of ethnomedicinal plants for their bioprospection.

**Module-V**

**Methods of Medicinal Plants Bioprospection:** Pharmaceutical bioprospecting for plant new drugs. Assays in bioprospection- Antioxidant assay (Free radical scavenging assay), antigenotoxicity assay (MTT Assay), Antiviral assay- SRB assay. Microbial bioprospecting- isolation of microbial metabolites and their bioactivity. Marine bio-prospectivity- isolation of bio actives from sea weeds and application.

**Selected References**

1. Jain, S.K., 2010. Manual of ethnobotany. Scientific publishers.
2. Pullaiah, T., Krishnamurthy, K.V. and Bahadur, B., 2017. Ethnobotany of India, Volume 3: North-East India and the Andaman and Nicobar Islands. Apple Academic Press.
3. Balick, M.J. and Cox, P.A., 2020. Plants, people, and culture: the science of ethnobotany. Garland Science.

4. Maheshwari, J.K., 2019. Ethnobotany and medicinal plants of Indian subcontinent. Scientific Publishers.
5. Applequist, W.L., 2004. Medicinal plants in folk tradition: An ethnobotany of Britain & Ireland by David E. Allen and Gabrielle Hatfield. Systematic Botany, 29(4), pp.1021-1021.

## **Practical: Anatomy & Reproductive Biology of Angiosperms- 23BOTL25**

1. Preparation of Fixatives and Stains for plant anatomical study.
2. Preparation of double stained permanent slides.
3. Preparation and Identification of transverse section of the plants: *Tridax procumbens*, *Boerhaavia diffusa*, *Bougainvillea spectabilis*, *Achyranthes aspera*, *Nyctanthus arbo-terrestris*, *Aristolochia* sp., *Tinospora cordifolia*.
4. Preparation and identification of the following wood based on T.S, T.L.S and RLS section *Michelia champaka*, *Dalbergia sissoo*, *Tectona grandis* (Teak), *Azadirachta indica* (Neem).
5. Anomalous primary structure and secondary growth with reference to the following *Achyranthes*, *Nyctanthus*, *Boerhaavia*.
6. Identification of different developmental stages of Embryo Sac.
7. Identification of different developmental stages of Anther.
8. Endosperm mounting.
9. Study of trichomes.
10. Anatomical study of seed during germination.
11. Submission- Slides/ samples (as per instructions of mentor)

## **Practical: Plant Physiology and Development- 23BOTL26**

1. Estimation of proteins in seeds by Lowry's method.
2. Estimation of total fat content in oil seeds.
3. Quantitative estimation of carbohydrates.
4. Study of Kranz anatomy in C4 plant leaves.
5. Determination of water potential of tissue by Plasmolytic/gravimetric method.
6. Quantitative estimation of Chl a, Chl b and total chlorophyll in plant tissues.
7. Study of absorption spectrum of plant chlorophylls.
8. Separation of plant pigments using paper Chromatography.
9. Estimation of phenols in germinating seedlings.
10. Study of PGR in Plants.

## **Practical: Plant Cell, Tissue and Organ Culture- 23BOTL271**

1. Setup of a Tissue Culture Laboratory.
2. Aseptic techniques.
3. Media Components and Preparation.
4. Isolation, preparation and surface sterilization of Explants.
5. Induction, establishment and maintenance of Callus.
6. Induction of organogenesis and whole plants.
7. Isolation of protoplasts and Culturing.
8. Induction of suspension cultures.
9. Culture of Anthers and the Establishment of Haploid Plants.

10. *In vitro* Propagation for Commercial Production of Ornamentals.
11. Experiments on cell viability tests

### **Practical: Seed Technology- 23BOTL272**

1. Determination of physical purity of seed samples of local field crops.
2. Determination of moisture content using oven, infrared moisture balance: OSAW universal moisture meter.
3. T.T.C Test for seed viability.
4. Germination Evaluation of various crops-top of paper method: between paper method and sand method.
5. Vigor Evaluation a) Conductivity test b) Hiltner's test c) Performance test d) Accelerated ageing test.
6. Identification of common seeds using seed photos, seed manuals, seed atlas.
7. Detection of mycoflora of stored seed samples by SMT/PDA method.
8. In vitro seed germination.
9. Seed quality- Viability, moisture, weight.
10. Propagation through seeds, methods to overcome the seed dormancy
  - a. Mechanical scarification.
  - b. Soaking the seeds in water.
  - c. Acid scarification.
  - d. Stratification
11. Isolation and Identification of seed borne pathogens (Fungi/ Bacteria).

**Note:** Every student has to submit 5 locally grown seeds and at the time of practical examination.

### **Practical: Plant Ecology and Phytogeography- 23BOTL273**

1. Determination of Leaf area by Planimeter method
2. Determination of Stomatal index.
3. Determination of organic content of soil and compost.
4. Determination of DO in water.
5. Determination of minimum size of the quadrat by species area curve method
6. Listing of endangered plants of Karnataka and India.
7. Floristic regions of India.
8. Drawing maps of continental drift.
9. Studying species distribution and its measurements.
10. Examples of exotic / invasive species
11. Study plant abundance and density by quadrant method.
12. Meteorological instruments and their working principles.
13. Study of Energy flow at different trophic level- Food web and Food Chain.

## **Practical: Methods in Plant Science Research-1-23BOTL28**

1. Basic instrumentation in plant science laboratory.
2. Working principle and application of below mentioned instruments  
Centrifuge, pH meter, Electrophoresis, Spectroscopy and spectrophotometer, Chromatography, Micrometry.
3. Thin layer chromatography and column chromatography of pigments and secondary metabolites.
4. Separation of DNA & Proteins using electrophoresis
5. Measurements of cells, spore, and chromosomes size using stage and ocular micrometry.
6. Estimation of primary and secondary metabolites using spectrophotometer.
7. Determination of pH of soil and water from different sources.
8. Computer basics- Word, excel and power point.