



## **DEPARTMENT OF BOTANY**

Ewing Christian College Prayagraj

*(An Autonomous Constituent College of University of Allahabad)*

Curriculum for Master of Science (M.Sc.)

Programme

in

**BOTANY**

For Academic Session 2024-2025

Under Choice Based Credit System

## **Aims and Objectives**

Plants are the only producers and providers of food, energy, lifesaving oxygen and other biological services on the earth. The study of Plant Sciences, deals with the structure, function, systematic, origin and evolution of plants has attracted and inspired many great Modern Plant Sciences includes fusion of knowledge from traditional botany along with frontier aspects of Biochemistry, Molecular Biology, Biotechnology Bioinformatics and other allied branches of Science and technology. Keeping recent advancements in view and to actively involve student and faculty facilitators in knowledge used activity without diluting the academic standards. Botany Department of EWn8 Christian College is proposing new Curriculum of Botany for two year Postgraduate program (M.Sc.) from academic session 2017-18 taking care of different aspects of Plant sciences (Diversity of Plants, Systematic, Anatomy, Physiology, Biochemistry, Cytogenetics, Molecular biology, Bioinformatics, Biostatistics, Palaeobotany, Ecology, Biodiversity and advanced botanical research techniques) and giving due weightage the entire curriculum has been divided into 14 core theory papers (each of 100 marks), one dissertation and one elective paper in semester IV from among the choice given ( each of 100 marks) and 08 Practicals ( two in each semester based on the theory paper with weightage of 100 marks each) over 04 semesters to ensure following aims and objectives.

- **To ensure a comprehensive curriculum in Botany at Post graduate level to meet national interest.**
- **To provide the curriculum such that it can inspire, attract, enthuse, sustain and promote the interest among students for opting Botany and allied disciplines as their career.**
- **To provide the opportunity to Postgraduate students in Botany of Ewing Christian College pursue their research programs in classical as well as modern branches of botany along with interdisciplinary approach.**
- **To update course contents in Botany by introducing recent development to ensure academic advantage to young botanists.**
- **To increase the awareness of students about the abuses to which plants have been subjected by human greed and train them in exploration, identification, evaluation and conservation of plant diversity.**

### **PATTERN OF QUESTION PAPER**

The question paper will consist of five units I, II, III, IV and V. Each unit will have two questions, out of that one question must be answered, and each question will carry 12 marks. Candidates are required to attempt FIVE questions; each question will carry 12 marks.

Sem	Course Code	Course Title/Paper Title	Credit
<b>I</b>	<b>BOT1TH01</b>	<b>Phycology&amp; Bryology</b>	<b>3</b>
	<b>BOT1TH02</b>	<b>Mycology</b>	<b>3</b>
	<b>BOT1TH03</b>	<b>Pteridology&amp; Paleobotany</b>	<b>3</b>
	<b>BOT1TH04</b>	<b>Gymnosperms</b>	<b>3</b>
	<b>BOT1PRA1</b>	<b>PRACTICALS BASED ON THEORY PAPER 1BOTTH1and 1BOTTH2</b>	<b>4</b>
	<b>BOT1PRA2</b>	<b>PRACTICALS BASED ON THEORY PAPER 1BOTTH3 and 1BOTTH4</b>	<b>4</b>
<b>II</b>	<b>BOT2TH01</b>	<b>Plant morphology, Economic botany&amp; Ethnobotany</b>	<b>3</b>
	<b>BOT2TH02</b>	<b>Anatomy&amp; reproductive biology of Angiosperms</b>	<b>3</b>
	<b>BOT2TH03</b>	<b>Plant Physiology</b>	<b>3</b>
	<b>BOT2TH04</b>	<b>Cytogenetics&amp; Plant breeding</b>	<b>3</b>
	<b>BOT2PRA01</b>	<b>PRACTICALS BASED ON THEORY PAPER 2BOTTH1 and 2BOTTH2</b>	<b>4</b>
	<b>BOT2PRA02</b>	<b>PRACTICALS BASED ON THEORY PAPER 2BOTTH3 and 2BOTTH4</b>	<b>4</b>
<b>III</b>	<b>BOT3TH01</b>	<b>Taxonomy of Angiosperms</b>	<b>3</b>
	<b>BOT3TH02</b>	<b>Plant Ecology</b>	<b>3</b>
	<b>BOT3TH03</b>	<b>Microbiology&amp; Phytopathology</b>	<b>3</b>
	<b>BOT3TH04</b>	<b>Biochemistry&amp; Molecular biology</b>	<b>3</b>
	<b>BOT3PRA01</b>	<b>PRACTICALS BASED ON THEORY PAPER 3BOTTH1 and 3BOTTH2</b>	<b>4</b>
	<b>BOT3PRA02</b>	<b>PRACTICALS BASED ON THEORY PAPER 3BOTTH3 and 3BOTTH4</b>	<b>4</b>
<b>IV</b>	<b>BOT4TH01</b>	<b>Plant Biotechnology</b>	<b>3</b>
	<b>BOT4TH02</b>	<b>Bioanalytical techniques, Bioinformatics, Bioethics&amp; Biostatistics</b>	<b>3</b>
	<b>BOT4TH03</b>	<b>Dissertation/Thesis</b>	<b>5</b>
	<b>BOT4TH04</b>	<b>A. Molecular Cytogenetics</b>	<b>3</b>
		<b>B. Applied Microbiology</b>	
		<b>C. Ecology&amp; Environment</b>	
		<b>D. Taxonomy of Angiosperms</b>	
		<b>E. Paleobotany</b>	
<b>F. Morphology of Seed plants</b>			
	<b>4BOTPRA1</b>	<b>PRACTICALS BASED ON THEORY PAPER 4BOTTH1 and 4BOTTH2</b>	<b>4</b>
	<b>4BOTPRA2</b>	<b>PRACTICALS BASED ON THEORY PAPER 4BOTTH4</b>	<b>2</b>
<b>TOTAL CREDITS</b>			<b>80</b>

## SEMESTER I

### Paper I PHYCOLOGY AND BRYOLOGY CODE: BOT1TH01

#### Unit I

Introduction to phycology, Principles and systems of classification of algae, Comparative account of algal pigments, food reserves, cell wall, flagellation, chloroplasts and eye spot, their phylogenetic and taxonomic importance.

Cell Structure and thallus organization, heterocyst and akinetes development and their role; chromatic adaptations and reproduction in Cyanopyta, distribution and ecology of cyanobacteria.

#### Unit II

Range of thalli and methods of reproduction in Chlorophyta, evolutionary tendencies in Chlorophyta. A brief account of Bacillariopyta, Pyrrophyta, Haplophyta, Crysophyta, Xanthophyta, Euglenophyta and Prochlorophyta, and other related and recent new groups. Thallus organization and reproduction in Phaeophyta and Rhodophyta.

#### Unit III

General introduction including broad outline of classification and evolutionary trends in bryophytes. Distribution of the group in India, general features and adaptation to land habit. Origin and evolution of gametophyte and sporophyte generation. Endemism and endemic liverwort genera of India. Bryophyte ecology, Moss protonema, protonemal differentiation and bud induction. Regeneration in bryophytes. Economic uses, chemistry of bryophytes, fossil history.

#### Unit IV

Hepaticopsida / Marchantiophyta: distribution: Global and Indian. General characteristics, morphology, anatomy and life history of **Marchantiales**: *Plagiochasma*, *Asterella*, *Cryptomitrium*, *Targionia*, *Cyathodium*; **Monocleales** (*Monoclea* **Sphaerocarpaceles** (*Sphaerocarpus*, *Riella*) **Calobryales** (*Calobryum*, *Haplomitrium*) **Metzgeriales** (*Riccardia*, *Metzgeria*, *Pallavicinia*) **Jungermanniales** (*Radula*, *Herberta*, *Porella*, *Frullania*); **Treubiales**: *Apotreubia*.

#### Unit V

**Anthocerotophyta**: distribution: Global and Indian, general features, Morphology, anatomy and life history of **Anthocerotales** (*Anthoceros*, *Notothylas*).

**Bryopsida/Musci**: distribution: Global and Indian, general features, morphology and anatomy, life history of **Sphagnales**: (*Sphagnum*) **Andreaeales** (*Andreaea*) **Andreaeobryales** (*Takakia*) **Polytrichales** (*Polytrichum*, *Pogonatum*) **Tetraphidales** (*Tetraphis*, *Georgia*), **Buxbaumiales**: (*Buxbaumia*) **Bryales** (*Bryum*, *Rhodobryum*, *Funaria*).

### **Suggested Readings:**

1. Bolt, C. and Wynne, MJ. 1985. Introduction to the Algae, 2nd Edition, Prentice-Hall Inc.
2. Dixon R. Biology of Rhodophyta, Koelt Science Publisher, West Germany.
3. Fritsch, F.E., Structure and Reproduction of Algae Vol. I & II, Cambridge University Press, Cambridge
4. Gangulee, H.C. and Kar, A.K., 2011, College Botany Vol. II. New Central Book Agency, Kolkata
5. Geissler P., Stanley W. G., Cramer, J, (1982) Bryophyte Taxonomy: methods, practices and floristic exploration.
6. Graham Robin South and Alan Whittick. 1998 Introduction to Phycology, Blackwell Scientific Publication
7. Janice. M. Glime, 2006, Bryophyte Ecology.
8. Kashyap S. R. 1972, Liverworts of the Western Himalayas & the Punjab Plains. Part 1&2.
9. Lee, Robert Edward, 2008, Phycology, Fourth edition, Cambridge University Press
10. Parihar N. S. 1965, An Introduction to Embryophyta- Bryophyta. Central Book Depot. Allahabad.
11. Richardson DHS (1981) The Biology of mosses. John Wiley & Sons, Inc New York.
12. Shaw AJ and B Goffinet (2000) Bryophyte Biology. Cambridge University Press.
13. Singh, Pande, Jain, 2010, A Text Book of Botany, Rastogi Publication, Meerut

**Paper II**  
**MYCOLOGY**  
**Code: BOT1TH2**

**Unit I**

**General Mycology:** Introduction to fungi and their significance to fungi, Fungal humans, General characteristics of cell and cell walls, Specialized fungal structures, Asexual reproduction and spores in fungi, Sexual reproduction, Fungal classification and molecular methods of fungal taxonomy; Heterothallism, Parasexual cycle and sex hormones in fungi.

**Protozoa:** General characteristics of Acrasiomycota, Dictyosteliomycota, Myxomycota, Plasmodiophormycota and life cycles of Plasmodiophora

**Unit II**

**Staminipila:** General characteristics of Hyphochytridiomycota, Labyrinthulomycota and Oomycota, Saprolegniales (*Saprolegnia*, *Achlya*), Pythiales and Peronosporales

**Chytridiomycota:** General characteristics and classification, Chytridiales (Synchytrium, Olpidium), Blastocladales (Allomyces)

**Unit III**

**Zygomycota:** General characteristics and classification of class Zygomycetes and Trichomycetes, Mucorales (special reference to evolutionary tendencies in asexual and sexual reproduction), Salient feature of order Zoopagales, Entomophthorales and Glomales

**Ascomycota:** General characteristics with special reference to development of ascus and ascospores, ascocarp, Taphrinales (*Protomyces*, *Taphrina*) Schizosaccharomycetales, Saccharomycetales, Eurotiales, Sordariales (*Neurospora*), Xylariales, Hypocreales, Claviceptales (*Claviceps*), Erysiphales, Pezizales, Helotiales, Dothidiales and Pleosporales.

**Unit IV**

**Basidiomycota:** General characteristics with special reference to dolipore septum, clamp connection, basidium and basidiospores, basidiocarp; Classification and general account of Uredinales, Ustilaginales, Auriculariales, Tremellales, Agaricales, Boletales, Lycoperdales, Nidulariales, Sclerodermatales,

**Deuteromycota:** General characteristics and classification of class Hyphomycetes and Coelomycetes.

**Unit V**

**Fungal Symbiosis:** Introduction to lichens, the symbiotic relationship and classification of lichens, methodology for lichens taxonomy, morphology and anatomy of thallus, reproduction, physiology, ecological aspects and chemistry, conservation, culture, bioprospection and economic importance of lichens, Mycorrhiza.

**Suggested Reading**

1. Webster, John, 1980, Introduction to Fungi, Cambridge University Press
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996, Introductory Mycology, Wiley
3. Carlile, M.J., Watkinson S.C. and Booday, G.W., 2001, The Fungi, Academic Press
4. Maheshwari, R. 2012, Fungi

5. Deacon, JW. Blackwell, M. Webster, John and Roland, W Hale, ME (1983), The biology of lichens(3rd cd.). Edward Arnold.
6. Webster, John and Roland, W.S. 2007. Introduction to fungi, Cambridge University Press.
7. Hale, ME (1983), The biology of lichens(3rd cd.). Edward Arnold.
8. Hawksworth, DL & Hill, DJ 1984: The Lichen-Foming Fungi. - Blackie, Glasgow and London. 158 pp
9. Galun, M. (ed.) (1988) CRC Handbook of Lichenology. Volume I. - CRC Press, Inc., Boca Raton.
10. Galun, M. (ed.) (1988) CRC Handbook of Lichenology. Volume II. -CRC Press Inc., Boca Raton.
11. Galun, M. (ed.) (1988) CRC Handbook of Lichenology. Volume I. -CRC Press, Inc., Boca Raton
12. Awasthi.D.D.2000. A hand book of Lichens: Bisben Singh Mahendra Pal Singh., Dehradun
13. Awasthi, D.D. 2000.Lichenology in Indian subcontinent: Bishen Singh Mahendra Pal Singh., Dehradun
14. Culberson, C.F. 1979.Chemical and Botanjcal Guide to Lichen Products,OttoKoeltz Sci Publishers, Germany
15. Singh G. P. and Singh K.P., 2005. Macrolichens of Sikkim, Botanical survey of India, Ministry of Environment & Forest
16. Brown D. H., Hawksworth D. L. & Bailey R.H. 1976. Lichenology: Progress & problems, Academic Press. London.
17. Smith A. L(1921) Lichens, Cambridge university Press
18. Orange A, James PW and White FJ (2001) Microchemical methods for identification of lichens. British Lichen Society.
19. Thomas H. N. (2001) Lichen Biology, Cambridge University Press.
20. Clair L and Seaward M. R. D, (2004) Biodeterioration of stone surfaces: Lichen and Biofilms as weathering agents of rock and cultural heritage, Kluwer academic publishers.
21. Kershaw K. A. (1985) Physiological Ecology of Lichens, Cambridge University Press
22. Longton R E. (1988) Biology of polar bryophytes and lichens, the press syndicate of the university of Cambridge.
23. Casselman D. K. (2001) Lichns dya: the new source book, Studio vista publication.
24. Nimis P.L. and Wolseley P.A. (2002), Monitoring with Lichen, Kluwer academic publishers
25. Karner I., Beckett R. and Varma A.(2002), Protocol in Lichenology, Springer-Verlag Berlin Heidelberg New York.
26. Baron G. (1999) Understanding Lichens, Richmond Publishing co.
27. Ahmadjian, V. 1993. The Lichens symbiosis. Jhon Wiley & Sons.
28. Nayaka, S and Upreti, DK. 2013. The Lichens of Uttar Pradesh. UP State Biodiversity Board.

**Paper III**  
**PTERIDOLOGY AND PALEOBOTANY**  
**CODE: BOT1TH03**

**Unit I**

General Introduction of pteridophytes, their peculiar features and similarities and dissimilarities with bryophytes and gymnosperms, pteridophytes classification based on molecular data by Smith et al. 2006. World distribution of pteridophytes with special reference to India, Economic importance of the pteridophytes, ecology of pteridophytes, Endangered pteridophytes their conservation.

**Unit II**

Early land plant and their evolution, Origin and evolution of pteridophytes with special reference to Telome theory and stelar theory, Stomatal structures in pteridophytes, Spores of pteridophytes. Apogamy, Apospory and parthenogenesis. Sex organs gametophytes and embryogeny in pteridophytes, Cytogenetics of pteridophytes., ecology of pteridophytes, Heterospory and origin of seed habits in Pteridophytes.

**Unit III**

Comparative morphology, anatomy, reproductive biology and evolutionary studies of the following group: Psilopsida, Lycopsida, Sphenopsida and monographic study of *Psilotum*, *Lycopodium*, *Isoetes* and *Equisetum*.

**Unit IV**

Filicopsida: Comparative morphology, anatomy, reproductive biology and evolutionary studies of the following orders. Coenopteridales, Ophioglossales, Marattiales and monographic studies of *Ophioglossum*, *Osmunda*, *Lygodium*, *Cyathea*, *Gleichenia*, *Adiantum*, *Pteris*, *Christella* and aquatic ferns.

**Unit V**

Paleobotany: Concept of Paleobotany, Scope and objectives of Paleobotanical studies Introduction to structure of earth, types of rocks and dating the past, Geological time scale. Types of fossils, Process of fossilization, Techniques of Fossil study, Reconstruction of plant fossils.

**Suggested Readings:**

1. Agashe S.N. 1995. Paleobotany. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Arnold A.C. 2005. An Introduction to Paleobotany. Agrobios (India). Jodhpur.
3. Eames E.J. 1983. Morphology of Vascular Plants. Standard University Press.
4. Eames, E.J. (1936) Morphology of Vascular plant-lower group. Tata Mc Graw Hill, New Delhi
5. Gifford., Ernest, M., Foster, Adriance. S., 1989, Morphology and Evolution of vascular plant. W. H. Freeman; Third Edition.
6. Ogura, Yuzuru., 1972, Comparative Anatomy of Vegetative Organs of the Pteridophytes. Gebr. Borntraeger; 2nd edition.
7. Parihar, N. S., 1977, The Biology and Morphology of the Pteridophyte. Central Book Depot.
8. Rashid, A, 2011, An Introduction to Pteridophyta, 2nd edition, (Reprint), Pub. Vikas Publishing House Pvt. Ltd., Noida.



9. Rashid, A. 1999, An Introduction to Pteridophyta, : Diversity, Development, Differentiation. Vikas Publishing House Pvt Ltd.
10. Sharma O.P. 1990, Textbook of Pteridophyta, MacMillan India Ltd. Dehl.
11. Smith G.M. (1955). Cryptogamic Botany Vol II. McGraw Hill.
12. Sporne K.R. 1986. The morphology of Pteridophytes. Hutchinson Unlversity Library, London.
13. Stewart W.N. and Rothwell G.W. (2005). Paleobotany and the Evolution of Plants. 2nd Edn. Cambridge University Press.
14. Sundar Rajan S. 1999. Introduction to Pteridophyta. New Age International Publishers, New Delhi.
15. Taylor. H Edith L. Tailor. Michaelkrings 2009. Palaeobotany: The biology and Evolution of Fossil Plants Amsterdam ; Boston, Mass. : Academic Press, c

**Paper IV**  
**GYMNOSPERMS**  
**CODE: BOT1TH04**

**Unit I**

General introduction of gymnosperms with special reference to its salient features, similarities and dissimilarities with other groups like pteridophytes and angiosperms. Classifications of gymnosperms Economic importance and biotechnology of gymnosperms

**Unit II**

Origin and Evolution of gymnosperms with special reference to Progymnosperms and origin of seed. Global distribution of gymnosperms with special reference to Indian plants. Endangered gymnosperms, their conservation and present status. Coniferopsida and Gnetopsida.

**Unit III**

Comparative morphology, anatomy, reproductive biology and phylogenetic studies of the following groups: Pteridospermopsida, Cycadopsida, Pentoxyllopsida, Bennettiopsida, Ginkgopsida

**Unit IV**

Comparative morphology, anatomy, reproductive biology and phylogenetic studies of the class Coniferopsida and Taxopsida

**Unit V**

Comparative morphology, anatomy, reproductive biology and phylogenetic studies of the class Ephedropsida and Gnetopsida

**Suggested Readings**

1. Bhatnagar, S.P. Moitra, Alok. 1996. Gymnosperms. New Age International.
2. Chamberlain, Charles Joseph, B.1863, Gymnosperm S;Structure and Evolution. Chicago, IL., The University of Chicago Press
3. Chhaya Biswas and B.M.Johri. The Gymnosperm. Springer; 1997 edition (16 April 2014)
4. Pant D. D. 2002, An Introduction to Gymnosperms, Cycas, and Cycadales, Birbal Sahni Institute of Palaeobotany.
5. Singh Hardev (1978) Embryology of Gymnosperms. Encyclopedia of Plant Anatomy. Vol X Gebruder Borntraeagl, Berlin, Stuttgart

## **SEMESTER II**

### **Paper I**

### **PLANT MORPHOLOGY, ECONOMIC BOTANY AND ETHNOBOTANY**

**CODE: BOT2TH01**

#### **Unit I**

Introduction of morphology and including brief historical account. External organization of higher plants; Morphology of root, stem, leaf and their morphological modifications and adaptations. Floral morphology and morphology of fruits and seeds. Morphological phenomenon: Symmetry, Polarity and differentiation.

#### **Unit II**

Food Plants: Cereal crops, legume or pulses, vegetables, fruit, oil and fats, spices, condiments, sugar yielding plant. Food adulterants and their adverse effect.

#### **Unit III**

Beverages and Mastication (Tobacco, Catechu, Areca nut, cannabis, coca, tea, coffee); timber, fibre, petro crops and biofuels; tannins, dye stuffs, rubber, gums and resin.

#### **Unit IV**

Pharmacognosy: Medicinal and Aromatic Plants: Medicinal plant, aromatic plants, insecticidal, herbicidal and sacred plants, active principles of medicinally important plants (Alkaloids, Flavonoids, Steroids, terpenoids, phenolics etc. Entrepreneurship exposure to botanical resources.

#### **Unit V**

Ethnobotany: Concept, scope and objective and medico-ethnobotanical significance of plants and their application in treatment of diseases by tribals and Vaidyas. Conservation and propagation of these plants. Concept of Indigenous (Ayurveda, Siddha and Unani) system of medicine.

#### **Suggested Readings**

1. Hill, Albert E, Economic Botany: A Textbook of Useful Plants and Plant Products. McGraw-Hill publications, New York
2. Jain S.K. 1989, Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow
3. Kocchar, S.L., Economic Botany in the Tropics. Macmillan Publisher,
4. Sambamurthy, A. V. S. S., A Textbook of Modern Economic Botany, CBS Publications.
5. Wickens GE ,2004, Economic Botany: Principles and Practices, Springer.

## **Paper II**

### **ANATOMY AND REPRODUCTIVE BIOLOGY OF ANGIOSPERMS**

**CODE: BOT2TH02**

#### **Unit I**

**Introduction of anatomy including brief historical account.** Internal organization of higher plants. Cell and its inclusion, cellular organization, Microscopic and sub-microscopic structure and organization of cell wall, Secretory and excretory structures; transfer cells. Meristems: organization of root apical meristem (RAM) and shoot apical meristem (SAM) and their differentiation. Xylem and phloem: Ontogeny and structure of components and phylogeny.

#### **Unit II**

**Primary and secondary structure of root and stem.** Origin of lateral roots, root-stem transition, nodal anatomy and its evolutionary significance. Anomalous secondary growth; Vascular cambium and its derivatives periderm, Leaf -structure and function with special reference to epidermis. Systematic significance of trichomes and stomata.

#### **Unit III**

**Introduction to life history of angiosperms,** brief history of plant embryology; Anther: Structure and development wall layers and their role: Microsporogenesis: Cytoplasmic reorganization during microsporogenesis, Pollen wall morphogenesis and anther dehiscence; Development of male gametophyte, ultrastructure, abnormal male gametophyte, Ovule: Ontogeny, structure, integuments and nucellus specialized structures, megasporogenesis; Development of embryo sac, subcellular details of constituent cells and their function, major types.

#### **Unit IV**

**Pollination and pollen germination, Pollen-pistil interaction:** Role of pollen wall proteins and stigma surface proteins, pollen tube growth in pistil, fertilization and apomixes; Endosperm: Major types, ultrastructure and histochemistry; Embryo: Polarity in embryo differentiation, major types, Polyembryony;

#### **Unit V**

**Experimental embryology:** Anther and pollen culture, ovary and (Pollen endosperm culture). Palynology morphology, wall stratification and NPC nomenclature) Embryology and palynology in relation to Taxonomy;

#### **Suggested Readings**

1. Arthur J.Eames; Laurence H.Mac Daniels (1951), An Introduction To Plant Anatomy, published by London; New York: Mc Graw Hill.
2. Bhojwani, S.S. and Bhatnagar, S.P., Embryology of Angiosperms, Vikash Publishing House, New Delhi
3. Carguist, S., 1961, Comparative Plant Anatomy Holt, Rinehart and Winston, published by New York Press.
4. Dickison, Willam C., 2000, Integrated Plant Anatomy, published by Academic Press. London.
5. Erdtman G, 1986. Pollen Morphology and Plant Taxonomy, published by Brill Archive,
6. Esau, 1965, Plant Anatomy, published by John Wiley and Sons. Inc, New York.
7. Fahn A. 1982, Plant Anatomy Vol I and Vol II, published by Pergamon Press. Oxford New York.
8. Pandey, D.P., Angiosperms-Taxonomy, Embryology and Anatomy, S. Chand and Co., New Delhi

9. Ray F. Evert , 2007, Esau's Plant Anatomy, published by John Wiley and Sons, Inc. Hoboken New Jersey
10. Kashinath Bhattacharya, Manas Ranjan Majumdar, Swati Gupta Bhattacharya, A Text of Palynology, published by New Central Book Agency.
11. Barrett SCH, 2008 Major Evolutionary Transitions in Flowering Plant Reproduction. Univ. of Chicago Press
12. O' Nell SD & Roberts JA, 2002 Plant Reproduction, Sheffield Academic Press.
13. Shivanna KR,2003 Pollen Biology and Biotechnology. Enfield, New Hampshire, U.S.A: Science Publishers

## **Paper III**

### **PLANT PHYSIOLOGY**

**CODE: BOT2TH03**

#### **Unit I**

**Transport and translocation of water and solutes:** Plant water relations, concept of water potential, mechanism of water transport through Xylem, mineral nutrition, nutrient uptake, solute transport, comparison of xylem and phloem translocation, phloem loading and unloading,

#### **Unit II**

**Nitrogen metabolism, respiration and lipid metabolism:** Biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation, foliar nitrogen nutrition. Interaction of nitrogen assimilation with carbon metabolism. Glycolysis, TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, Cyanide resistant respiration, Lipid metabolism

#### **Unit III**

**Photochemistry and photosynthesis:** History of photosynthesis, photosynthetic apparatus, photoreceptor, light reaction of photosynthesis, photo oxidation of water mechanism photophosphorylation, Structure and function of Rubisco and PEP Carboxylase, carbon assimilation,

#### **Unit IV**

**Plant growth substances and signal molecules:** Chemical structure, physiological effects and mechanism of action of auxin, gibberellins, cytokinins, ethylene, abscisic acid. Growth regularly nature of Polyamines, Jasmonic acid Salicylic acid and Brassinosteroids, systemin, secondary metabolite and plant defense

#### **Unit V**

**Growth and Development Aspects:** Metabolic changes during seed germination, factors affecting seed germination and dormancy, breaking of dormancy, biochemistry of flowering: initiation and development of flower, induction of flowering- vernalization, physiology and biochemistry of leaf abscission and senescence. Sensory photobiology: Phytochromes and cryptochromes and their photochemical and biochemical properties, photo physiology of light-induced responses, cellular localization, molecular mechanism of action of photomorphogenic receptors, signaling and gene expression.

#### **Suggested Readings:**

1. Bens, J.M, Tymoczko J.L; Stryer. L., 2006 Biochemistry, 6th Edition, freeman and Company New York.
2. Buchanan B, Grulsem G and Jones R. (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.
3. Davies PJ. (2004) Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, Netherlands.
4. Hopkins, W.G. and Huner N.P.A., 2009, Introduction to Plant Physiology, 4 Edition Wiley International Edition, John Wiley & Sons, USA
5. Jones, Russell L. Buchanan, Bob B. Guissem, Wilhelm.. 2002, Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists.
6. Peter Scott, Physiology and Behaviour of Plants. Wiley-Blackwell.

7. Salisbury Frank Boyer and Cleon Ross, 1991, Plant Physiology, CA
8. Taiz and Zeiger, 2010, Plant Physiology, 5th Edition, Sinurer Associates.

## **Paper IV**

### **CYTOGENETICS AND PLANT BREEDING**

**CODE: BOT2TH04**

#### **Unit I**

**Basic concept and organization of Chromosome:** Chromosome structure, nucleosome, nucleosome solenoid, euchromatin and heterochromatin, Centromere and telomere, special type of chromosomes- Polytene chromosomes, lampbrush chromosomes, B chromosomes. Chromosomal basis of heredity and cell division. Meiosis and Mendelism.

#### **Unit II**

**Inheritance Genetics:** Principles of Mendelian Inheritance and interaction of genes, Cytoplasmic inheritance involving chloroplast and mitochondria, mitochondrial and chloroplast genomes, interaction between nuclear and cytoplasmic genes, Sex determination in plants.

#### **Unit III**

**Cytogenetics and Induced Variations:** Gene concept; allele concept, multiple alleles, isoalleles, Pseudo- alleles, Linkage and recombination: Concept of Linkage, evolution of linkage concept, cis and trans arrangement of linked gene, kinds of linkage, germinal and somatic crossing over, detection of crossing over, kinds of crossing over.

#### **Unit IV**

**Mutation:** Spontaneous and induced mutations, point mutation, transitions, transversions, physical and chemical mutagens, molecular basis of mutations. Numerical alterations in chromosomes: Euploidy, polyploidy and its significance, Aneuploidy, Autopolyploidy, Allopolyploidy, Induction of trisomics and monosomics. Structural changes in chromosomes: Deficiency, duplication, inversion, translocation heterozygotes.

#### **Unit V**

**Plant Breeding:** Breeding systems, methods, selection in self and cross pollinated crops, male sterility. Self-incompatibility, Heterosis and Hybrid vigour,

#### **Suggested Readings:**

1. Acquaah G, 2007, Principles of Plant Genetics and Breeding. Blackwell Publishing Ltd. USA.
2. Albert B. Bray, D Lewis, J Raff, M. Robert, K. and Walter 1989, Molecular Biology of the Cell (Second Edition) Garland Publishing Inc, New York.
3. Allard RW (1999). Principles of Plant Breeding (2nd Edition), John Wiley and Burnham, Sons C.R 1962. Discussions in Cytogenetics. Burgess Publishing Co. Minnesota.
4. Clark, M.S. and Wall, W.J. 1996, Chromosomes : The Complex Code. Chapman & Hall, London.
5. Gardner and Simmons Snustad. 2005 (Eighth Edition). Principles of Genetics, John Wiley and Sons, Singapore.
6. Gupta, P.K., Cytogenetics, Rastogi Publication, Meerut
7. Hartl and Jones, 2007. Genetics - Analysis of Genes and Genomes, 7th edition, Jones and Bartlett publishers.
8. Lewine, Benjamin, Jones and Bartlet, Genes X, Sudbury, Massachusetts
9. Ram J. Singh , 2002. Plant Cytogenetics. 2nd edition, CRC Press. Simmonds (1995). Evolution of Crop Plants (2nd Edition) Longman.
10. Sariau C, 2004 (Sixth Edition) Genetics. TATA MCGraw-Hill Publishing Company Ltd., New Delhi.



11. Sharma, A.K. and Sharma, Archana, 1985, *Advances in Chromosome and Cell Genetics*. Oxford & IBH Publishing Co., Calcutta.
12. Snustad, D.P and Simmons, M.J 2000. *Principles of Genetics* (Second Edition).
13. Stebbins, G.L.1950, *Variation and Evolution in Plants*. Columbia Univ. Press, New York.
14. Strickberger 2005. (Third Edition). *Genetics*. Prentice Hall of India Pvt. Ltd., New Delhi.
15. Swanson, C. P., Mertz, T.F. and Young, W.J. *Cytogenetics: The Chromosomes in Division, Inheritance*
16. and Evolution (2<sup>nd</sup> Edn). Englewood Cliff, Prentice-Hall, New Jersey.

## SEMESTER III

### Paper I

### TAXONOMY OF ANGIOSPERM

CODE: BOT3TH01

#### Unit I

Latin diagnosis, definition and use of Taxonomic terms, History of Plant Taxonomy, in India, History of Plant Classification, Need and aim of classification, Units of classification, delimitations of taxa and their practical consideration, Artificial, Natural and Phylogenetic system classification, a critical study of Takhtajan

#### Unit II

Characteristics and phylogeny of orders and families: Nymphaeales: Nymphaeaceae, Caryophyllales: Phytolaccaceae, Nyctaginaceae, Portulacaceae, Polygonales: Polygonaceae, Violales: Passifloraceae, Malvales: Teliaceae, Sterculiaceae, Utricales: Moraceae, Myrtales: Combretaceae, Onagraceae, Sapindales: Sapindaceae, Rutales: Rutaceae, Meliaceae, Rubiales: Apocynaceae, Boraginales: Boraginaceae, Oleales: Oleaceae, Lamiales: Scrophulariaceae, Bignoniaceae, Verbenaceae, Commelinales: Commelinaceae, Juncales: Cyperaceae, Typhales: Typhaceae

#### Unit III

Needs and aim of nomenclatures, International Rules of Botanical Nomenclature, Concept of species genus, family with special reference to the type concept. Interrelationship of plant with morphology, taxonomy anatomy, embryology, palynology, cytology, genetics, phytogeography and Chemistry.

#### Unit IV

Recent advances in taxonomy, Biosystematics, serology and molecular systematic including barcode and phylocode, and numerical taxonomy, Phenetics, Cladistics, an introduction of angiosperm phylogeny group (APG).

#### Unit V

Taxonomic literatures viz., Floras, Monographs, Botanical Dictionaries, etc., Taxonomic societies/associations, Indigenous flora of the country with special reference to local flora, Prospects of Taxonomy in Urbanization-Ornamental-indoor and outdoor plants, A general knowledge of Herbarium and Botanical garden of the world and India, organization of Botanical Survey of India and its role. Biodiversity and its conservation with special reference to India.

#### Suggested Readings:

1. APG II 2009. An update of the Angiosperm Phylogeny Group Classification for the Orders and Families of Flowering Plants: APG II, Bot. J. Linn. Soc. 161: 105-121.
2. Bhattacharya, B. and B. M. JohrI. 1998. Flowering Plants-Taxonomy and Phylogeny. Narosa Publishing House, New Delhi.
3. Crawford, DJ. 1990. Plant molecular systematics. Macromolecular approaches. John Wiley & Sons, Inc.
4. USA.
5. Davis, PH and Heywood VH. 1991. Principles of Angiosperm TaxonomY. Krieger Publishing Company.\
6. Duthie J., S.: Flora of upper Gangetic plains, Calcutta superintendent, government printing India.

7. Forey, PL. 1993. Cladistics: A Practical course in Systematics. Clarendon Press.
8. Harborne, JB and Turner, BL. 1984. Plant Chemosystematics. Academic Press.
9. Heywood, V. H. and Moore, D. M. 1984. Current Concepts in Plant Taxonomy. Oxford University Press.
10. Jain, S.K. and Rao, R.R. 1977. A Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers, New Delhi.
11. Jones, SB. 1986. Plant Systematics. McGraw Hill.
12. Judd, W.S., Christopher, S., Campbell, Kellogg, A. E. Stevens, P.F. 1999. Plant Systematics: A Phylogenetic Approach. Sinauer Associates Inc. Publishers.
13. Leadley E. and Jury S., Taxonomy and plant conservation, The cornerstone of the Conservation and the Sustainable use of Plants, Cambridge university press 2006.
14. Subramaniam N.N, Taxonomy of Angiosperm, Vikas publishing house Pvt Ltd.
15. Pandey, A. K., J.V.V. Dogra & Wen, J. 2006. Plant Taxonomy: Advances and Relevance. CBS Pvt. Ltd.
16. Pullaiah, T. 2007. Taxonomy of Angiosperms. Regency Publications, New Delhi.
17. Rao, R. R. 1994. Biodiversity in India (Plant Aspects), Bishan Singh Mahandrapal Singh, Dehradun.
18. Sharma, O. P. 1993. Plant Taxonomy. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
19. Simpson M. G., 2006, Plant Systematics. Elsevier Academic Press.
20. Singh, G. 2004. Plant Systematics: An integrated approach. Science Publishers, INC.
21. Singh, Gurucharan, Plant Systematics- Theory and Practices, Oxford and I.B.H. Publishing Co. New Delhi
22. Singh, MP, Singh, BS and Dey S. 2002. Plant Biodiversity & Taxonomy. Daya Publishing House, New Delhi.
23. Singh, V. and Jain, D.K., Taxonomy of Angiosperms. Rastogi Publication, Meerut
24. Sivarajan, VV. 1991. Introduction to principles of plant Taxonomy, edited by NKB Robson. Press Syndicate of University of Cambridge.
25. Sokal, RR and Sneath PHA. 1963. Principles of Numerical Taxonomy. W.H. Freeman.
26. Soltis PE, Soltis DE and Doyle JJ. 1992. Molecular Systematics of Plants. Chapman & Hall, New York.
27. Stace, CA. 1989. Plant Taxonomy and Biosystematics. Press Syndicate of University of Cambridge.
28. Stuessy, TE, Crawford, DJ, Soltis, DE and Soltis PS. 2014. Plant Systematics: The origin, interpretation, and ordering of plant biodiversity. Koeltz Scientific Books, Königstein.
29. Sumbhamurti A. V. S. S., Taxonomy of Angiosperm, I. K. international Pvt Ltd.
30. Subramanyam, NS. 1996. Laboratory Manual of Plant Taxonomy. Vikas Publishing House Pvt Ltd.
31. Takhtajan A. 2009. Flowering plants, 2nd edn. St. Petersburg Russia: Springer
32. Verma, B. K. 2010. An introduction to Taxonomy of Angiosperms. PHI Learning Pvt. Ltd. New Delhi.

**Paper II**  
**PLANT ECOLOGY**  
**CODE: BOT3TH02**

**Unit I**

**Population Ecology:** Introduction to ecology, and environmental terminology, population dynamics, vegetation organization and development: population characteristics, population growth forms, density dependent and density independent controls, population structure (distribution, aggregation, isolation territoriality) energy partitioning, r - and k-selection, concept of carrying capacity; Wild life sanctuaries, botanical gardens, threatened and endangered plant species and endemism.

**Unit II**

**Community Ecology:** Concepts of community and continuum, analysis of communities (analytical and synthetic characters), community coefficients, competition, ecological niche, succession, mechanism of ecological succession (relay floristic and initial floristic composition facilitation, tolerance and inhibition models), concept of climax, Major terrestrial biomes, biogeographical area of India, major vegetations.

**Unit III**

**Ecosystem:** Ecosystem organization, structure and function: primary production (methods of measurement), energy dynamics (tropic organization, energy flow pathway, energy quality, ecological efficiencies), biogeochemical cycles.

**Unit IV**

**Pollution ecology:** Pollution and climate change: kinds, sources and effects of pollution, heavy metals (Pb, Cd, Hg), green house gases (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, CFCs), Green-house effect and global warming, ozone layer depletion and ozone hole, acid rain.

**Unit V**

**Environment Management:** Introduction and scope of environmental management, concept of sustainable development. Environmental impact assessment, role of biodiversity in ecosystem stability, general account of remote sensing and its application, environmental, energy and green audit, Environmental management and safety, International summits and treaties related with environment.

**Suggested Readings:**

1. Barrow, C.J. 2005, Environmental Management: Principles & Practices
2. Khitaliya. R. K, 2008, Environmental Management and Conservation
3. Odum, E. P. and Barret G.W. 2005. Fundamentals of Ecology. Cengage publication
4. Odum, E.P., 1983. Basic Ecology., Saunders College Publishing Oxford.
  5. Roy S. 2003, Environmental Science: a comprehensive treatise on Ecology and Environment. publishing syndicate, Kolkota.
  6. Sharma P.D. Ecology and Environment, Rastogi Publication.

7. Singh, J.S., Singh S.P. and Gupta S.R. 2006. Ecology Environment and Resource Conservation. Anamaya Publishers
8. Wilkinson, D.M. 2007. Fundamental Processes in Ecology: An Earth system Approach.

## Paper III

### MICROBIOLOGY AND PHYTOPATHOLOGY

CODE: BOT3TH03

#### Unit I

History and Developmental Microbiology, History of Plant Pathology, General techniques used in microbiology and plant pathology, Microbial evolution, Systematics and taxonomy of microorganisms. Primitive organisms, their metabolic strategies and molecular coding. The microbial cell: general organization of cell and cell wall of prokaryotes, eukaryotes and Archaea, Viruses structure, chemical composition, replication and classification of viruses. General account of Mycoplasma.

#### Unit II

Growth- growth kinetics and regulation, effect of environmental factors on growth, batch and Continuous cultures, nutritional classification of microorganisms, Microbes in extreme environment: The basis of extremophiles and their applications, thermophile and halophiles. Quorum sensing in Bacteria: gram negative bacteria: LUXI LUXR-Type: gram positive bacteria: peptide mediated quorum sensing.

#### Unit III

Application of microbiology in industrial, agriculture and waste water management: symbiotic nitrogen fixation, *Rhizobium*, *Azotobacter* Cyanobacteria (*Anabaena*, *Azolla* etc.), Mycorrhizal symbiosis. Major industrial products from microbes viz., beverages, antibiotics, secondary metabolites, recombinant products. Biodegradation by microbes, sewage pollution control, control of oil spills, super bugs.

#### Unit IV

Classification of Plant Diseases, Kinds and amount of losses, Parasitism and disease development, symptoms, Epidemiology, Control of plant diseases, quarantines and inspection, physical, chemical, cultural and biological methods of disease control, Genetic Engineering and Plant Pathology.

#### Unit V

Plant diseases caused by fungi, bacteria, viruses and mycoplasma/phytoplasma and their control measures

#### Suggested Readings:

1. Agrios, G. N., 1988. Plant Pathology, Academic Press.
2. Aneja, KR, Jain, P and Aneja, KR. 2008. A Text book of Basic and Applied Microbiology. New Age
3. International Publishers, New Delhi.
4. Bishen. PS, 2014, Microbes in Practice. I.K. International Publishing House Pvt. Ltd.
5. Comelissen, CN, Harvey, RA and Fisher, BD. 2012. Microbiology. Lippincott Williams & Wilkins.
6. Dhingra, O.D. and James, B. Sinclair, 1995. Basic Plant Pathology Methods. CRC Press
  7. Dickinson, C. M., 2003. Molecular Plant Pathology, Bios Scientific Publisher.
  8. Dubey, RC and Maheshwari, DK. 1999. A Textbook of Microbiology. S. Chand & Company Ltd.
  9. John A Lucas, 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press.
  10. Madigan, M.T., Martinko, J.M., Dunlap, P.V., Clark, D.P., 2011. Brock Biology of Microorganisms. 13<sup>th</sup> edition, Pearson Education Inc.
  11. Pelczar, JM, Chan, ECS and Krlig, MR. 1993. Microbiology. Tata McGraw Hill.
  12. Singh, R. S, 2008. Principles of Plant Pathology, Oxford and IBH Publishing Co. Pvt Ltd.

13. Stanler, R.Y., Ingraham, J.L., Wheelis, M.L., Painter, P.R., 1987. General Microbiology. Fifth edition. MacMillan.
14. Talaro, K.P., Chess, B. 2011, Foundations in Microbiology. 8h edition. McGraw-Hill.
15. Tortora, G.J, Funke, B.R., Case, C.L. 2003, Microbiology: An Introduction. Benjamin Cummins
16. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology. 8th edition, McGraw-Hill.

## Paper 4

### PLANT BIOCHEMISTRY AND MOLECULAR BIOLOGY

Code: BOT3TH4

#### Unit I

**Bioenergetics:** Law of thermodynamics, concept of enthalpy and entropy and their significance in biological systems, Water biochemistry, high energy molecules, redox potential

**Carbohydrates:** Structure and physico-chemical properties of carbohydrates, biological significance, important, glycoprotein

**Lipids:** Classification, structure and properties of important lipids, biological significance of glycolipids, fatty acid biosynthesis and storage lipids and their catabolism.

#### Unit II

**Amino acids and Proteins:** Structure and physicochemical properties of amino acids; Proteins: Primary, secondary, tertiary and quaternary structure of proteins, physical and chemical properties of proteins and biological significance; Protein folding, Ramachandran plot

**Enzymes:** Properties, classification, physico-chemical nature, enzyme kinetics mechanism of action and regulation, allosteric regulation, Enzyme inhibition, Ribozyme, apozyme, Coenzymes, Vitamins

#### Unit III

**DNA:** Structure and conformation of nucleic acids; DNA as genetic material, Structure and types of DNA, DNA topology, DNA melting and hyperchromic effect, Replication of DNA (prokaryotes and eukaryotes), DNA damage and repair

**RNA:** Mechanism of transcription of DNA (eukaryotes and prokaryotes), RNA processing and splicing, transport of m-RNA, RNA editing and post-transcriptional modification

#### Unit IV

**Protein synthesis:** Genetic code, Role of different types of RNA in protein synthesis, Structure of tRNA and wobbling, Mechanism of translation (initiation, elongation and termination), Post-translational modification,

**Regulation of Protein synthesis:** Regulation of gene expression at transcription level in prokaryotes (positive and negative regulation), Regulation of protein synthesis in eukaryotes, Protein targeting to organelles,

#### Unit V

**Cell signaling:** Principle of cell signaling, Overview of receptors, Secondary messengers, G-proteins, Phospholipids, signifying role of cyclic nucleotides, Calcium-calmodulin cascade.

**Signaling mechanism:** Diversity in protein kinase and phosphates specific signaling mechanism, GPCR, RTKS, Ras-MAP Kinase pathway

#### Suggested readings:

1. Conn, E. .E, Stumpf, P K, Bruening, G and Doi, R Y, 1987, Outlines of Biochemistry, 5th Edition, John Wiley and Sons, New York.
2. Nelson, D .L. and Cox, M.M., 2008, Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman & Co, New York, USA.
3. Berg J.M. Tymoczka & Stryer, I. 2011, Biochemistry, Seventh Edition, Freeman & Co. New York. USA.



4. Weil J.H. 1990 General Biochemistry. Sixth Edition, Wiley Eastern Limited, New Age International Limited. New Delhi.
5. Lea P.J. and Leegood R.C., 199, Plant Biochemistry & Molecular Biology. Second Edition, Wiley & Sons. New York.
6. Buchanan B.B., Gruissem W., Jones R.L., 2002, Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists, USA.
7. Lodish, Harvey, Berk, Arnold. Chris A Kaiser Monty Krieger. Matthew P. X Bretscher, Scott, Anthony
8. Bretscher, Midde Ploegh, Paul Matsudaira Molecular Cell| Biology. 6th Ed. W, H. Freeman and Comp., New York
9. Bourton E. Tropp, Molecular Biology, 4th Ed. Jones & Barlett Learning
10. Brown, I.A., DNA Cloning and Gene Sequencing Willey-Blackwell, Oxford |1.
11. Genes IX by Benjamin Lewin, Jones and Barlett
12. Y Gerld Karp, Cell and Molecular Biology 6th Ed., John Willey & Sons
13. Cooper, G.M. und Robert, E. Hausman The Cell: A Molecular Approach 5th Ed. (Co-published by ASM Press and Sinauer Assoc. Inc.)
14. Watson, J.D, Baker, T.A, Bell. SP Gann A Levine M and Richard L 2008. Molecular Biology of the Gene. Pearson Education Inc.
15. Murray, R, Murray, R.K, Bender, D, Gotham, K.M, Kennelly, P.I. Rodwell, V and Weil, P.A. 2012. Harpers Illustrated Biochemistry 29th Edition. McGraw Hill.
16. Vema, P.S. 2004 Cell Biology. Genetics. Molecular Biology: Evolution and Ecology. S. Chand Limited.
17. Jain, J.L. 2004. Fundamentals of Biochemistry. S. Chand Limited.
18. Gupta, S.N., 2011. Biochemistry. Rastogi Publication., Meerut.

## 4<sup>TH</sup> SEMESTER

### Paper I

### PLANT BIOTECHNOLOGY

Code: BOT4TH1

#### Unit I

**Recombinant DNA technology:** A brief introduction to Biotechnology and Genetic Engineering. Recombinant DNA technology and in-vivo gene cloning: Restriction endonucleases; DNA Modifying enzymes, Gene cloning and expression vectors, Markers and reporter genes; Linkers and adaptors; Screening of recombinant clones

#### Unit II

**Gene cloning and identification:** Polymerase chain reaction: Principle, method, variants and their practical application: Genomic and cDNA library; Molecular markers and its application; Functional genomics; Gene sequencing, Modern approaches for the analysis of plant genome and proteome: DNA microarray, RNA interference, Gene silencing and Genome editing.

#### Unit III

**Gene transfer methods:** Vectorless and vector (*Agrobacterium*) mediated genetic transformation in plants, Regeneration methodologies and screening of transformants; Genetic engineering and its application in Agriculture: Genetic manipulation for pest resistance, abiotic and biotic stress tolerance, improvement of crop yield and quality; Molecular farming, Transformation of chloroplast genome and its advantage.

#### Unit IV

**Plant tissue culture techniques:** General introduction, history and scope; Tissue culture techniques and culture media; Concept of cellular totipotency; dedifferentiation, redifferentiation through Organogenesis and Somatic embryogenesis; Synthetic seed technology, Androgenesis and haploid culture techniques; Micropropagation and clonal propagation through meristem culture, Somaclonal variation

#### Unit V

**Plant cell and protoplast culture:** Protoplast isolation, culture and regeneration, Somatic hybridization and cybridization, hybrid selection; Possibilities, achievements and limitations of protoplast research; Production of secondary metabolites through Cell culture and Biotransformation; Applications of plant tissues culture and plant biotechnology in Agriculture, Pharmaceutical industries, Cryopreservation germplasm and biodiversity conservation; Biosafety concerns in Plant Biotechnology.

#### Suggested Readings:

1. Larry, Snyder and Wendy Champnees, Molecular Genetics of Bacteria, ASM Press Washington, DC
2. Jermy, W Dale and Simon F Park Molecular Genetics of Bacteria, IVth Edition - John Wiley and Sons Ltd.

3. Joseph, W. Lenzyler, Gerhart Drews and Hans G. Schlegel *Biology of the Prokaryotes* Blackwell Science Ltd., Oxford
4. Benjamin Lewin- Jones and Bartlett, *Genes* X Publishers Sudbury, Massachusetts
5. James, D. Watson, Tunia A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losick *Molecular Biology of the Gene* VI Edition- Cold Spring
6. Sanly, R, Malov, John (honan and )avi belfelder *Microbial Genetics* Narosa Publisher, NCW Delhi
7. Bernard R. Gillick and Jack J. Pasternak, *Molecular Biotechnology: Principles und application of recombinant DNA* ASM Press Washington, D.C
8. TA, Brown, *Genomes* - Garland Science (Tavlor & Francis Group), New York & London
9. *Molecular Biology of the Cell* Alberts Bruce. Johnson Alexander. Lewis Julian, Raff Martin, Roberts Keith and Walter Peter- Garland Science (Tavlor & Francis Group), New York & London
10. Lodish Harvey, Berk Arnold, Zipursky S. Lawrence, Matsudaira Paul, Baltimore David and James E. Danell-*Molecular*.
11. Dubey RC, 2008, *Advanced Biotechnology*. S. Chand & Company. PVT. LTD.

## PAPER II

### BIOANALYTICAL TECHNIQUES, BIOINFORMATICS, BIOETHICS AND BIOSTATISTICS

Code: BOT4TH2

#### Unit I

**Biophysical techniques:** Principle and Techniques of Centrifugation, Separation of Sub-cellular Fractions, Ultracentrifugation, isopycnic, density gradient centrifugation; Spectroscopy Basic Concept, MALDI-TOF, Mass Spectroscopy, X-Ray Diffraction, NMR And ESR Spectroscopy; Microscopy: Light, Phase Contrast, Confocal, Fluorescence, Scanning and Transmission Electron Microscopy. Labeling Techniques (Radiolabeling and Fluorescent Labeling of Biomolecules and their detection, Safety Guideline).

#### Unit II

**Biochemical techniques:** Chromatography (Basic Concept, Paper, TLC, HPLC, gas chromatography Ion Exchange, affinity Chromatograph); Electrophoresis (Definition and Principle of Electrophoresis, Buffers and Solutions, Agarose Gel Electrophoresis, Polyacrylamide Gel Electrophoresis (PAGE), Native PAGE, SDS-PAGE); 2D-Electrophoresis, Isoelectric Focusing (IEF): Principles and Kinds of pH Gradients used In IEF- Immobilized pH Gradients.

#### Unit III

**Molecular Techniques:** Isolation and Purification of Nucleic Acids and Proteins, Blotting Techniques: Principles, Southern, Northern, Western and Dot Blots; ELISA, RIA; Genome Mapping: RFLP, RAPD. AFLP, SSR, SNP, FISH, Mc FISH, Molecular probing DNA Sequencing: Various Methods of DNA Sequencing- Sanger's Dideoxy Method, Maxam & Gilbert Method), Flow cytometry. Genome Editing.

#### Unit IV

**Bioinformatics and bioethics:** Data base, Overview of Sequence Analyses Genome Information Resources, Bioinformatics Tools, Similarity Searching Tools: BLAST and FASTA, Phylogenetic Analysis Methods.

**Bioethics:** Concept of bioethics, benefits and harm, protection of environment, biosphere and biodiversity. Intellectual Property Right: Organization of patent office's India with significance, world Intellectual Property Right (WIPO), role of worldwide academy of WIPO, procedure of obtaining patent, copy right and trade mark, kinds of patent classification, patent criteria, career in IFR, definition of IPR, kinds of property, website of important patent office.

#### Unit V

**Biostatistics:** General concepts and terminology, sampling methods, Measures of location, scale and Shape, contingency tables and chi-square test, comparison of means: t-test, multiple range tests, Simple experimental design and analysis of variance, correlation and regression analysis, Introduction to multivariate methods, Types of statistical software and their application in analysis of data.

#### Suggested Readings:

1. Atwood TK and Parry-Smith DJ (2004) Introduction to Bioinformatics, Pearson Education (Singapore) Pvt. Ltd.
2. David Edwards (Ed.) (2007) Plant Bioinformatics: Methods and Protocols, Humana Press, New Jersey, USA

3. Green, M. R. and Sambrook, J. 2000, Molecular Cloning: a laboratory manual (4th Edition) Cold Spring Harbor Laboratory Press.
4. Pagano M, Gauvreau K (2007) Principles of Biostatistics. Thomson India Edition, New Delhi.
5. Rosenkrantz WA (2009) Introduction to Probability and Statistics for Science, Engineering and Finance. CRC Press, Boca Raton.
6. Wilhelm Gruissem, Russell L. Jones, 2000, Biochemistry and molecular biology of plants. American Society of Plant Physiologists,
7. Wilson, K. and Walker, J., 2000, Practical Biochemistry: principles & techniques (sth Edition), Cambridge University Press. ISBN 0521799651.

**Paper III**  
**DISSERTATION/THESIS**  
**CODE: BOT4TH03**

The topic would be decided by the candidate in consultation with the respective supervisor. Dissertation/ thesis will be based on existing branches of botany and the title will be decided keeping the view on the modern aspect in the related discipline. It will be the part of semester IV; however, the title of dissertation / thesis will be assigned by concerned faculty member/board in the beginning of semester III to provide sufficient time to complete dissertation/thesis.

**Paper IV**  
**ELECTIVE PAPER : There shall be SIX elective papers, and student has to opt only one**

## **(A) MOLECULAR CYTOGENETICS**

**CODE: BOT4TH04A**

### **Unit I**

Cell components and their significance: Molecular structure and functions of cell wall and plasma membrane, cell signalling; new insights in structure and function of cytoplasmic cell organelles; Organization and function of mitochondrial and chloroplast genomes and transfer of these genes. Nucleus: its components, detailed structure of nuclear pore complex and nuclear lamina, nucleolus and nuclear transport. Structure and function of plant cytoskeletal genes and gene products.

### **Unit II**

Cytogenetics: Chromosome: Structure and nomenclature, centromere and telomere; karyotype analysis, Chromosomal aberrations, Ploidy changes: Haploids, polyploids and aneuploids; Molecular basis of mutations; Transposons and their use in mutagenesis and gene tagging in plant systems; Oncogenes and cancer; Cell turn over: cell cycle regulations, check points, cancer and apoptosis

### **Unit III**

Mendelian and Non Mendelian genetics: Meiosis; Chromosome theory of inheritance; Mendelian laws; Gene interactions; Organelle inheritance, Linkage, Crossing over, linkage maps, sex linked inheritance. Sex determination: mechanisms, Population genetics and Quantitative genetics.

### **Unit IV**

Molecular Genetics: Modern concept of gene, genetic code, gene mapping, gene structure, expression and regulation. DNA replication; transcription - RNA polymerases, transcription factors, Introns, RNA splicing, RNA stability - cap structure and function, polyadenylation; translation, Post translational modifications.

### **Unit V**

Recombinant DNA technology: Restriction and nucleic acid modifying enzymes; restriction mapping: choice of vectors; plasmids, phages, cosmids, plant viruses, synthetic DNA vectors; cDNA and genomic libraries; cloning; PCR and its applications; Principles of DNA sequencing. Genetic transformation.

### **Suggested Readings:**

1. Albert B. Bray, D Lewis, J Raff, M. Robert, K. and Walter 1989, Molecular Biology of the Cell (Second Edition) Garland Publishing Inc, New York.
2. Bernard, R., Glick and Jack J. Pasternak, Molecular Biotechnology: Principles and application of recombinant DNA ASM Press, Washington, D.C
3. Brown, T.A., DNA Cloning and Gene Sequencing Willey-Blackwell, Oxford
4. Burnham, C.R 1962. Discussions in Cytogenetics. Burgess Publishing Co. Minnesota.
5. Clark, M.S. and Wall, W.J, 1996, Chromosomes : The Complex Code. Chapman & Hall, london.
6. Cooper .G.M. and Robert, E. Hausman, The Cell: A Molecular Approach 5 Ed. (Co published by ASM Press and Sinauer Assoc. Inc
7. Gardner and Simmons Snustad., 2005 (Eighth Edition). Principles of Genetics, John Wiley and Sons, Singapore.
8. Gupta, P. K., Cytogenetics, Rastogi Publication, Meerut
9. Karp, G., 2008 Cell and Molecular Biology concepts and experiments 6" Ed., John Willey & Sons

10. Lea P.J. and Leegood R.C., 1999, Plant Biochemistry & Molecular Biology, John Second Edition Wiley & Sons, New York.
11. Lewine, Benjamin, Jones and Bartlet, Genes X, Sudbury, Masschusetts Lodisch H, Berk A, Kaiser CA, Krieger M. Scott MP, Bretscher A, Ploegh H and Matsudaire P, 2008; Molecular Cell Biology. WH Freeman & Co., New York.
12. Nelson, D. L. and Cox, M.M., 2008, Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman & Co, New York, USA.
13. Ram J. Singh ,2002. Plant Cytogenetics, 2nd edition, CRC Press. Simmonds (1995). Evolution of Crop Plants (2nd Edition) Longman.
14. Sharma, A.K. and Sharma, Archana. 1985. Advances in Chromosome and Cell Genetics. Oxford & IBH Publishing Co., Calcutta.
15. Strickberger 2005. (Third Edition). Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.
16. Swanson, C. P., Mertz, T.F. and Young, WJ. Cytogenetics: The Chromosomes in Division, Inheritance and Evolution (2<sup>nd</sup> Edn). Englewood Cliff, Prentice-Hall, New Jersey.
17. Watson, JD, Baker, TA, Bell, SP, Gann, A, Levine, M and Richard, L. 2008. Molecular Biology of the Gene. Pearson Education Inc.

**(B) APPLIED MICROBIOLOGY**  
**CODE: BOT4TH04B**

**Unit I**

Microbial Ecology and Environmental Microbiology: Microbiology of Air, Water and Soil. Microbiology of Solid Wastes, Sewage (Waste water) and Industrial Waste, Biobleaching and Biomining

**Unit II**

Food Microbiology: Microbiology of Foods, Milk and Dairy Products

**Unit III**

Industrial Microbiology: Microbial production of organic acids, antibiotics, amino acids, enzymes, vitamins etc.

**Unit IV**

Agricultural Microbiology: Microbes-Plant Associations, Microbial Biofertilizers and Biopesticides, Microbial Bioremediation of Agricultural Product, Biodegradation of Pesticides

**Unit V**

Medical Microbiology: Infection and Diseases, Human Diseases caused by Fungi, Bacteria and Viruses, their diagnostics and managements.



## **(C) ECOLOGY AND ENVIRONMENT**

### **CODE: BOT4TH04C**

#### **Unit I**

**Plant Ecology:** Characteristics of a population, population growth curves, population regulation and r and k selection, concept of metapopulation. Ecological succession: Types, mechanisms, change involved in succession.

#### **Unit II**

**Community Ecology:** Nature of communities, community structure and attributes, analytical, quantitative and qualitative characters and synthetic characters, levels of species diversity and its measurement edges and ecotones, life forms.

#### **Unit III**

**Ecosystem Ecology:** Ecosystem – structure and function, major ecosystems, energy flow, mineral cycling (C,N,P), primary production and measurement, structure and function of terrestrial and aquatic ecosystems.

#### **Unit IV**

**Applied Ecology:** Environmental pollution, greenhouse gases their sources and greenhouse effect, global warming; ozone depletion biodiversity, biodiversity management, Project tiger, biosphere reserves, conservation biology, principles of conservation, conservation and management strategy.

#### **Unit V**

**Environmental Management:** Introduction and scope of environmental management, concept of sustainable development. Environmental impact assessment, role of biodiversity in ecosystem stability, general account of remote sensing and its application, environmental, energy and green audit, Environmental management and safety, International summits and treaties related with environment.

## **(D) ADVANCED TAXONOMY OF ANGIOSPERM**

**CODE: BOT4TH04D**

### **Unit I**

History of plant Taxonomy of the world, history of plant classification of the world, Modern of classification. system Angiosperm Phylogeny Group (APG): Outline of Classification, function and Application

### **Unit II**

International Code of Nomenclature (ICN): Principles, rules and recommendations and appendices; application of nomenclature.

### **Unit III**

Biodiversity: characterization, generation maintenance and loss, magnitude, distribution and conservation, remote sensing. Indigenous flora of the country with special reference to local flora and flora of the special habitats, Methods of plant identification.

### **Unit IV**

Inter relationship of plant taxonomy with morphology, anatomy, embryology, palynology, cytology, genetics, phytogeography and Chemistry. Biosystematics, serology and molecular systematic and numerical taxonomy.

### **Unit V**

Botanical gardens, Herbarium, digital herbarium and their significance, Herbarium techniques, Applications of plant taxonomy in medicine, forensic science and urbanization (indoor and outdoor plants).

**(E) PALEOBOTANY**  
**CODE: BOT4TH04E**

**Unit I**

Basic geological information - structure of Earth Types of rocks, stratigraphy, basic concepts of continental drift and plate tectonics. Dating the past, Geological time scale. Fossilization process, Types of fossils, including chemical fossils and nannofossil, techniques to study fossils, reconstruction and nomenclature of fossil--- concepts of Parataxa and Eutaxa, objectives of palaeobotany.

**Unit II**

Prebiotic Environment, chemical evolution and origin of life, Pre-Cambrian life. Indian Pre-cambrian stratigraphy and life forms. Diversification of algae, fungi and bryophytes through the ages. Origin and evolution of land plants, earliest records of pteridophytes and their evolutionary tendencies.

**Unit III**

Emergence of first seed plants, preovules, diversification of Gymnosperms in geological time scale. First Angiosperms, Angiosperm palaeofloristics. Concept of Indian Gondwana sequence, stratigraphy and correlation of Gondwana sequence in Peninsular Indian basins. Mega and microfloristics of Indian Gondwana formation. Indian Perigondwana floras.

**Unit IV**

Applied Palaeobotany Life as fuel maker, sources of natural fossil fuels, Peat, coal and its varieties, constitution of coal, Coal Palynology, coal maceral, Petroleum - its origin, migration and concentration, palynology in oil exploration.

**Unit V**

Fundamentals of Paleofloristics, Palaeogeography and Palaeoclimatology. Application of Palaeopalynology. Plant and animal interactions correlation Archaeobotany with special reference to phytoliths and palynological studies.

## **(F) MORPHOLOGY OF SEED PLANTS**

### **CODE: BOT4TH04F**

#### **Unit I**

Origin and evolution of seed plants: Heterospory and origin of seed habit, Origin and evolution of Ovules, concept of seed and its development in plants, Structure and types of seeds in gymnosperms and angiosperms (dicotyledons and monocotyledons), germination of seeds and development of seedlings, vivipary, origin and evolution of gymnosperms and angiosperms and their affinities

#### **Unit II**

General features of gymnosperms, classification of gymnosperms (traditional and modern approach), world distribution of gymnosperms, gymnosperms of India and their distribution, economic importance and impact of gymnosperms on human society, biotechnology and conservation of gymnosperms. General features of angiosperms their adaptation and economic importance.

#### **Unit III**

Vegetative and reproductive morphology of Pteridospermales, Bennettitales, Pentoxylales and Cycadales.

#### **Unit IV**

Vegetative and reproductive morphology of Cordaitales, Ginkgoales, Coniferales, Taxales and Gnetales.

#### **Unit V**

Morphology of flowering plants: Morphology of shoot system (stem, buds, leaves and phyllotaxy), root system and their modifications in angiosperms, Inflorescence and flower morphology, flower as a modified shoot, morphology of fruits.