UNIVERSITY OF LUCKNOW

Department of Botany

Master of Science Programme in Botany (Two Year) Under NEP-2024 Framework

University of Lucknow
Master of Science Programme in Botany (Two Year)
PG Ordinance (NEP) 2024

1. Applicability

M.Sc. in Botany programme from the session 2025-26.

2. Minimum Eligibility for Admission

A three/four-year Bachelor's degree or equivalent in Science with Botany in final year awarded by a University or Institute established as per law and recognised as equivalent by this University with minimum 45% marks or equivalent grade shall constitute the minimum requirement for admission to the Master in Botany programme.

3. Programme Objectives

The M.Sc. Botany programme covers all aspects of plant sciences and involves classical, modern and inter-disciplinary approaches. The proposed syllabus endeavours to provide training in botanical skills through lectures, projects, excursions, practical exercises and seminars/presentations.

4. Programme Outcomes

After completing the two-year M.Sc. Programme in Botany, the student would have gathered:

- Knowledge about plants and botanical skills needed for teaching and research, and an understanding of environmental issues needed to become naturalists or conservationists.
- Critical and reflective thinking skills to enable them to make an honest assessment of their strengths and weaknesses, so that they put in the necessary efforts to carve a better future for themselves.
- Communication skills through effective presentations and interactive sessions in the class.
- Problem-solving skills to help generate confidence for a more substantive life.
- Interest in reading quality books so as to engage in a life-long learning process, helping all along the way, beginning with home and reaching society.
- Ability to lend in-depth knowledge if handling pre-university students, for generating enhanced interest in the subject.
- Knowledge of the social and health issues that plague the modern society, contributing in their own little ways, showing empathy and spreading awareness.
- Computational biology component to enable ease of handling computer-based applications.

5. Programme Specific Outcomes (PSOs)

PSO1: The students will recognize the diversity of life forms exhibited by Viruses, Bacteria, Algae, Fungi, Lichens, Bryophytes and Pteridophytes, and understand the variations in microscopic techniques needed to study them. They will learn about plant diseases and methods and practices for controlling them.

PSO2: The students will learn about the past and present flora of Gymnosperms and Angiosperms, classification, structure (morphology and anatomy) of plants/plant parts/plant organs, reproduction, structure and chemical composition of genetic material, process of genetic inheritance, evolution theories, breeding methods for crop improvement and statistical methods to analyze biological data, including a basic understanding of molecular biology.

PSO3: The students will understand the ecological plant diversity and soil-plant interactions. They will carry out an in-depth study of the structure of plant cells and macromolecules, structural organization of the cell, various physiological and metabolic processes taking place in plants and their significance.

PSO4: The students will get the necessary training for writing thesis/preparing project report based on the information collected through review of literature.

6. Course Structure:

The course structure of M.Sc. Botany **(Two Year)** programme shall be as under:

Paper Code	Paper Title	Credit	Course Type
SEMESTER-I			
BOT-CC-1	Microbiology: Plant Virology and Bacteriology	04	Core Course
BOT-CC-2	Fungi, Plant Pathology and Lichens	04	Core Course
BOT-CC-3	Algae and Bryophytes	04	Core Course
BOT-CC-4	Pteridophytes, Gymnosperms and Palaeobotany	04	Core Course
BOT-CC-5	Practicals based on BOT-CC-1 to BOT-CC-4	02	Core Course
BOT-VC-IRA	Plant Resource Utilization and Conservation	02	Value-added Credited Course (Intradepartmental)
	Semester Total	**20**	
SEMESTER-II			
BOT-CC-6	Plant Development and Reproduction	04	Core Course
BOT-CC-7	Plant Systematics	04	Core Course
BOT-CC-8	Cytogenetics, Plant Breeding and Molecular Biology	04	Core Course
BOT-CC-9	Environment, Ecology and Plant-Soil Relationship	04	Core Course
BOT-CC-10	Practicals based on BOT-CC-6 to BOT-CC-9	02	Core Course
BOT-VC-IER	Natural Resources and their Conservation	02	Value-added Credited Course (Interdepartmental)
	Semester Total	**20**	
SEMESTER-III			
BOT-CC-11	Plant Physiology	04	Core Course
BOT-CC-12	Practicals based on BOT-CC-11	04	Core Course
BOT-CC-13	Academic Tour	04	Academic Tour
BOT-EC-14A	Applied Botany-I	04	Elective
BOT-EC-14B	Analytical Techniques and Computer Applications		
BOT-EC-15A	Mushroom Cultivation	02	Elective
BOT-EC-15B	Ecotourism		
BOT-IN	Internship/Field Study	02	Internship
	Semester Total	**20**	
SEMESTER-IV			
BOT-CC-16	Cell Biology and Plant Biochemistry	04	Core Course
BOT-EC-17A	Applied Botany-II	04	Elective
BOT-EC-17B	Biotechnology and Human Welfare		
BOT-EC-18A	Plant Disease Management	04	Elective
BOT-EC-18B	Gardening and Landscaping		
BOT-MT	Master Thesis/Dissertation	08	Master Thesis
	Semester Total	**20**	
	GRAND TOTAL	**80**	

BOT = Botany **CC = Core Course** **IN = Internship**
EC = Elective Course **MT = Master Thesis** **VC=Value-added Credited Course**
IRA = Intradepartmental **IER = Interdepartmental**

7. Course Outlines

Department of Botany
M.Sc. BOTANY (SEMESTER-I)
BOT-CC-1: MICROBIOLOGY: PLANT VIROLOGY AND BACTERIOLOGY
4 Credits/40 Hours

Course Outcomes:
After completion of the course, the student will:

- Learn about the prokaryotic domains, and their major phyla; cellular organization and functioning of prokaryotic cells, organization of the bacterial genome and plasmids, DNA replication, methods of genetic recombination in bacteria; gene expression and Operon concept.
- Understand metabolic diversity in bacteria; biotechnological applications of microbes in various spheres; mode of action of antibiotics and the development of antibiotic resistance in microbes.
- Develop an understanding of viruses and study their properties; classification based on morphological and genomic traits; transmission characteristics and molecular basis of interaction between the vectors and viruses; biochemistry of host-virus interactions.
- Understand the process of viral infection, replication, genome expression strategies; structural diversity of bacteriophage and functioning of the genetic switch; biology of the viroids.
- Learn about the techniques involved in the purification of viruses; use of serological and nucleic acid hybridization techniques in viral diagnosis; modern approaches in the control of plant viruses; role of microbes in recombinant DNA technology.

Unit-I
Development of Microbiology
Microbial taxonomy and phylogeny of prokaryotes
Bacterial and Archaeal groups based on molecular phylogeny
Prokaryotic cell structures and their functions
Bacterial genome organization, plasmid, replication, expression
Unit-II
Metabolic diversity and nutritional types: Phototrophs (anoxygenic and oxygenic photosynthesis), Chemotrophs (lithotrophs and organotrophs), Aerobic and anaerobic respiration, Fermentation
Microbe-plant interactions: Root nodule formation and nitrogen fixation by *Rhizobium*
Antibiotics and their mode of action, bacterial resistance to antibiotics
Genetic recombination in bacteria: General principles, transformation, transduction and conjugation
Unit-III
Nomenclature and classification of plant viruses
Particle morphology and genome organization of tobacco mosaic tobamovirus (TMV), brome mosaic bromovirus (BMV), and cauliflower mosaic caulimovirus (CaMV)
Hypersensitivity in host-virus interaction
Molecular aspects of virus-vector relationship in transmission of plant viruses
Unit-IV
Replication of TMV, BMV, and CaMV
Gene expression strategies in plant viruses
Structure, replication and pathogenicity of viroids
Life cycle of lytic and lysogenic bacteriophages; Genetic switch in phage Lambda
Unit-V
Purification of plant viruses
Virus detection by serological and nucleic acid hybridization methods
Modern methods of plant virus disease control
Role of microbes in recombinant DNA technology
Practicals based on Units I-V

Suggested Readings:

1. Prescott's Microbiology, J. Willey, K. Sandman, D. Wood, 12t^{h} edition, 2023, McGraw-Hill Education.
2. Brock Biology of Microorganisms, Madigan, Bender, Buckley, Sattley, Stahl, 16th edition (global edition), 2021, Pearson.
3. Microbiology: An Introduction, G.J. Tortora, B.R. Funke, C.L. Case, 11th edition, 2016, Pearson India Education.
4. Alcamo's Fundamentals of Microbiology, J.C. Pommerville, 2nd edition, 2013, Jones and Bartlett Learning.
5. A Textbook of Microbiology, R.C. Dubey and D.K. Maheshwari, 5th edition, 2022, S Chand Publishing.
6. Pelczar Microbiology, M.J. Pelczar, E.C.S. Chan and N.R. Krieg, 5th edition, 1985, Tata McGraw Hill.
7. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, A. Hofmann, S. Clokie (Eds), 8th edition, 2018, Cambridge University Press.
8. Matthew's Plant Virology, R. Hull, 4th edition, 2003, Elsevier.
9. Handbook of Plant Virology, J. Khan and J. Dijkstra, 2006, CRC Press.
10. Applied Plant Virology: Advances, Detection and Antiviral Strategies, L.P. Awasthi (Ed), 2020, Elsevier.
11. Applied Plant Virology, C.R. Wilson, 2014, CABI Publishing.
12. Basics of Plant Virology, H.N. Verma, 2003, Oup IBH.
13. Plant Pathology, G.N. Agrios, 5th edition, 2005, Elsevier.

Department of Botany
M.Sc. BOTANY (SEMESTER-I)
BOT-CC-2: FUNGI, PLANT PATHOLOGY AND LICHENS
4 Credits/40 Hours

Course Outcome:
After completion of the course, the student will:

- Have a general idea of classification and features of fungi.
- Have a comparative knowledge of structure and life cycle of selected fungi and allied organisms.
- Know the fungal disease symptoms and their management.
- Understand the host-pathogen interactions and also host defense mechanisms.
- Have an understanding of the epidemiology, symptoms, etiology, prevention and control of fungal diseases.
- Learn about plant diseases caused by fungal-like organisms, nematodes and abiotic factors
- Have an idea of the classification, structure, distribution, reproduction and importance of lichens.

Unit-I
Thallus organization and cell structure
Nutritional types of fungi: Biotrophs, hemibiotrophs, symbionts and necrotrophs
Reproduction, hormonal mechanism of sexual reproduction, parasexuality, life cycles
Fungal systematics and phylogeny
Unit-II
Myxomycota and Plasmodiophoromycota- *Stemonitis, Arcyria, Plasmodiophora*
Oomycota - *Saprolegnia, Achlya, Pythium, Phytophthora, Sclerospora, Peronospora*
Chytridiomycota - *Synchytrium, Allomyces, Monoblepharis*
Zygomycota - *Zygorhynchus, Pilobolus, Choanephora, Entomophthora*
Ascomycota - Yeasts, *Aspergillus, Taphrina, Protomyces, Penicillium, Erysiphe, Phyllactinia, Chaetomium, Claviceps, Morchella*
Basidiomycota - *Auricularia, Puccinia, Uromyces, Melampsora, Tolyposporium, Ustilago, Tilletia, Urocystis, Graphiola, Clavaria*
Unit-III
Concept of plant disease, Classification of plant diseases
Pathogenesis and disease development
Role of enzymes and toxins in pathogenesis
Plant disease diagnosis
Koch's postulates with special reference to parasitism
Host-pathogen interactions, Host defense mechanisms
Disease forecasting
Unit-IV
Green ear disease of bajra- *Sclerospora graminicola,* Damping off of seedling and Fruit rot- *Pythium,* Stem gall of coriander- *Protomyces macrosporus*
Peach leaf curl- *Taphrina deformans,* Ergot of rye- *Claviceps purpurea,* Rust of gram- *Uromyces ciceris- arietini*
Rust of linseed- *Melampsora lini,* Rust of wheat- *Puccinia recondita, P. striiformis*
Covered smut of barley- *Ustilago hordei,* Loose smut of oats- *Ustilago avenae,* Loose smut of bajra- *Tolyposporium penicillariae*
Mitosporic fungi and diseases- Leaf spot and shot holes- *Alternaria* spp., Tikka disease of groundnut- *Cercospora* spp., Foot rot of gladioli- *Fusarium* spp. Red rot of sugarcane- *Colletotrichum falcatum*
Diseases caused by nematodes - Ear cockle of wheat - *Anguina tritici,* Root knot of vegetables- *Meloidogyne incognita*
Abiotic/Non-pathogenic diseases- Black tip of mango, Black heart of potato
Unit-V

A general account, classification and distribution of lichens A comparative study of lichen thallus organization, cell structure, physiology and reproduction
Chemotaxonomy of lichens
Lichenometry
Practicals based on Units I-V

Suggested Readings:

1. Introductory Mycology by Alexopoulos, Mims and Blackwell; John Wiley and Sons Publications, 1996.
2. Text Book of Mycology by A.K. Sarbhoy; ICAR Publications, New Delhi, 2006.
3. Plant Pathology by R.S. Mehrotra and A. Aggarwal; Tata McGraw-Hill Publishing, 1980.
4. Plant Pathology by George N. Agrios; Academic Press, 1997.
5. Protocols in Medicinal and Aromatic Plants by Shukla and Dikshit; Today and Tomorrow's Printers and Publisher, India, 2016.
6. Introduction to Fungi, J. Webster and R. Weber, 2007, 3rd edition, Cambridge University Press.
7. The Fungi, S.C. Watkinson, N.P. Money, L. Boddy, 3rd edition, Elsevier Science Publishing Co Inc
8. A Hand book of Lichens, D. D. Awasthi, 1999.
9. Lichen Biology, 2nd edition, Edited by Thomas H. Nash, III, Arizona State University, Cambridge University Press, 2008.
10. Lichens: An Illustrated Guide, by Frank S. Dobson, Richmond Publishing, 2000.

Department of Botany
M.Sc. BOTANY (SEMESTER-I)
BOT-CC-3: ALGAE AND BRYOPHYTES
4 Credits/40 Hours

Course Outcomes:
After completion of the course, the student will:

- Have knowledge of the classification and general features of Algae.
- Understand the thallus organization, cell structure, reproduction, phylogeny and inter-relationships of selected members of Cyanophyta, Chlorophyta, Rhodophyta and other groups of Algae.
- Have knowledge of the classification, general features, ecology, physiology and reproductive biology of Bryophytes.
- Have an idea of the spore diversity, peristome structure and moss protonema.
- Know the diversity in gametophytic and sporophytic organization in Mosses, Liverworts and Hornworts.
- Know the origin, phylogeny, evolution and fossil history of Bryophytes.

Unit-I
Introduction to Algae: General characteristics, life cycle and classification (by Fritsch, Smith, Lee), modern trends for algal classifications (molecular and chemotaxonomy), fossil algae, Microscopy of cell organelles (cell wall, flagella, nucleus, eye-spot, pyrenoids), pigments, reserve food products, algal blooms
Introduction to blue-green algae/cyanobacteria (cell structure, akinete, heterocyst, chromatic adaptation)
Introduction to Bryophytes:General characteristics, life cycle, classification, origin, phylogeny and fossil history of Bryophytes
Unit-II
A comparative study of range of thallus organization, cell structure, reproduction (asexual and sexual), phylogeny and inter-relationships of the following classes of Algae Cyanophyceae: *Oscillatoria, Nostoc, Spirulina* Euglenophyceae: *Euglena* Dinophyceae: *Gymnodinium* Charophyceae: *Cosmarium, Closterium* Ulvophyceae: *Cladophora* Chlorophyceae: *Volvox, Stigeoclonium*
Unit-III
A comparative study of range of thallus organization, cell structure, reproduction (asexual and sexual), phylogeny and inter-relationships of the following classes of Algae Bacillariophyceae:*Melosira* Xanthophyceae: *Botrydium* Phaeophyceae: *Padina, Dictyota* Rhodophyceae: *Gelidium, Corallina*
Unit-IV
A comparative study of gametophytic and sporophytic organization in the following orders of Mosses and Liverworts Mosses Sphagnales: *Sphagnum* Andreaeales: *Andreaea* Takakiales: *Takakia* Buxbaumiales: *Buxbaumia* Bryales: *Physcomitrium, Fontinalis, Splachnum* Polytrichales: *Polytrichum* Liverworts Calobryales: *Haplomitrium* (*Calobryum*) Metzgeriales: *Pallavicinia, Riccardia*

Jungermanniales: *Jungermannia*, *Porella*, *Ptychanthus*, *Radula* Sphaerocarpales: *Riella*, *Sphaerocarpos* Monocleales: *Monoclea* Marchantiales: *Plagiochasma*, *Asterella*, *Lunularia*, *Dumortiera*, *Targionia*
Unit-V
A comparative study of gametophytic and sporophytic organization in the following orders of Hornworts Hornworts Anthocerotales: *Anthoceros* Notothyladales: *Notothylas, Dendroceros, Megaceros*
Ecology, Physiology, Reproductive biology of Bryophytes Endemism and endemic liverwort genera of India Spore diversity, dispersal and germination Moss protonema, protonemal differentiation and bud induction Moss peristome and their role
Practicals based on Units I-V

Suggested Readings:

1. Phycology, 5th Ed., Robert Edward Lee, Publisher-Cambridge University Press, 2018.
2. Introduction to the Algae, 2nd Ed., Bold and Wynne, 1984.
3. Introductory Phycology, H. D. Kumar, 1990.
4. Algae, 1st Ed, O. P. Sharma, 2011.
5. Principles and Techniques of Biochemistry and Molecular Biology, 8th Ed., Wilson and Walker, 2018.
6. Biology of Bryophytes - R.N. Chopra and P.K. Kumra. New Age International (P) Limited, New Delhi 1988.
7. An Introduction to Bryophyta (Diversity, Development and Differentiation) - A. Rashid. Vikas Publication House Pvt. Ltd., 1998.
8. Bryophytes - A Broad Perspective - Prem Puri. Atma Ram & Sons, Delhi & Lucknow, 1985.
9. Cryptogamic Botany Bryophytes and Pteridophytes. Vol.II.G.M. Smith. Tata McGraw-Hill Publishing Company Limited, New Delhi, 1972.
10. The Structure and Life of Bryophytes - E.V. Watson, BI publications, 1964.

Department of Botany
M.Sc. BOTANY (SEMESTER-I)
BOT-CC-4: PTERIDOPHYTES, GYMNOSPERMS AND PALAEOBOTANY
4 Credits/40 Hours

Course Outcomes:
After completion of the course, the student will:

- Have a general concept of Pteridophytes regarding their classification and phylogenetic associations.
- Have knowledge of major evolutionary trends in Pteridophytes, viz stelar and telome theory.
- Learn about the alternation of generation within various forms and economic significance of Pteridophytes.
- Understand the evolutionary trends, geographical distribution, affinities and inter-relationships, morphology, anatomy and reproductive biology of fossil and living members of different groups of Pteridophytes.
- Have a general concept of Gymnosperms regarding their classification, phylogenetic associations and economic importance.
- Have knowledge of evolutionary trends, geographical distribution, affinities and inter-relationships, morphology, anatomy of different orders of Cycadopsida.
- Know the evolutionary trends, geographical distribution, affinities and inter-relationships, morphology, anatomy and reproductive biology of members of Coniferopsida.
- Understand the evolutionary trends, geographical distribution, affinities and inter-relationships, morphology, anatomy and reproductive biology of Gnetopsida.
- Know about fossils, their formation and role in stratigraphy.

Unit-I
General characteristics of Pteridophytes
Criteria and comparative systems of classification of Pteridophytes
Origin and evolution of Pteridophytes - Algal and Bryophytic origin
Different types of fossils
Comparative study of the following- Rhyniopsida: *Rhynia* Psilopsida: *Psilotum, Tmesipteris*
Lycopsida: Asteroxylales- *Asteroxylon, Zosterophyllum* Lepidodendrales- *Lepidodendron, Sigillaria* Isoetales- *Isoetes, Stylitis*
Equisetopsida: Hyeniales- *Hyenia* Sphenophyllales- *Sphenophyllum, Cheirostrobus* Calamitales- *Calamites*
Unit-II
Evolution of Stelar system in Pteridophytes
Evolution of Telome theory in Pteridophytes
Comparative account of apogamy and apospory
Economic importance of Pteridophytes
Comparative study of morphology of sporophytes, soral arrangement, sporangial characters and development of gametophytes in different major groups of ferns: Eusporangiatae: Ophioglossales- *Ophioglossum* Marattiales- *Marattia*
Protoleptosporangiatae: Osmundales- *Osmunda*
Leptosporangiatae:

Schizaeales- *Lygodium*; Pteridales- *Pteris, Adiantum, Ceratopteris, Actiniopteris;* Dicksoniales- *Dicksonia*; Davalliales-*Davallia*; Hymenophyllales- *Hymenophyllum*; Gleicheniales- *Gleichenia*; Cyatheales- *Cyathea*; Polypodiales- *Polypodium*; Aspidiales- *Asplenium*, *Dryopteris;* Marsiliales- *Regnellidium*, *Pilularia*; Salviniales- *Salvinia*, *Azolla*
Unit-III
Classification, distribution, evolutionary tendencies and economic importance of Gymnosperms
Pteridospermales: A general account of the order with reference to families- (i) Lyginopteridaceae (ii) Medullosaceae (iii) Glossopteridaceae (iv) Corystospermaceae (v) Peltaspermaceae (vi) Caytoniaceae Cycadales: A general account Nilssoniales: A general account Bennettitales (Cycadeoideales): A general account, affinities and inter-relationships among the families (i) Williamsoniaceae (ii) Wielandiellaceae (iii) Cycadeoideaceae Pentoxylales: A general account and evolutionary tendencies
Unit-IV
Cordaitales: A general account of the order with reference to families: (i) Eristophytaceae (ii) Cordaitaceae (iii) Poroxylaceae Ginkgoales: A general account with special reference to *Ginkgo* Coniferales: Evolution of megastrobilus and seed-scale complex in various families. Study of various fossil genera, their reported structures with reference to families (i) Lebachiaceae (ii) Voltziaceae (iii) Palissyaceae Comparative morphological anatomical and reproductive studies in living genera with reference to families (i) Pinaceae (ii) Araucariaceae (iii) Taxodiaceae (iv) Cupressaceae (v) Cephalotaxaceae (vi) Podocarpaceae Taxales: A general account with special reference to *Taxus*
Unit-V
Gnetales - A general comparative account with reference to *Ephedra*, *Gnetum* and *Welwitschia* (affinities and inter-relationships, morphology, anatomy and reproductive biology) Study of fossils: Methods of preservation, investigation and importance in stratigraphy Continental drift and geological time scale
Practicals based on Units I-V

Suggested Readings:

1. The Morphology of Pteridophytes, K.R. Sporne, Hutchinson, and Co-Publishers Ltd., 1962.
2. An Introduction to Pteridophyta: Diversity and Differentiation, A. Rashid, Vikas Publication House Pvt. Ltd., 1999.
3. Cryptogamic Botany: Bryophytes and Pteridophytes, G.M. Smith, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1972.
4. The Biology and Morphology of Pteridophytes, N.S. Parihar, The Indian Universities Press, Allahabad, 1965.
5. Gymnosperms, S.P. Bhatnagar, A. Moitra, New Age International (P) Limited, 1996.
6. An Introduction to Gymnosperms, Cycas and Cycadales, Divya Darshan Pant, BSIP, 2002.
7. Gymnosperms- Structure and Evolution, C. J. Chamberlain, CBS Publishers and Distributors, 1986.
8. The Morphology of Gymnosperms, K.R. Sporne, Hutchinson and Co. (Publishers) Ltd., 1965.
9. Botany for Degree Students, Vol. V- Gymnosperms, P.C. Vasishta, A.K. Sinha, A. Kumar, S. Chand & Co. Ltd., 1976.
10. Gymnosperms- Extinct and Extant, C.M. Govil, Krishna Prakashan Media (P) Ltd., 2007.
11. Embryology of Gymnosperm, Hardev Singh, Gebruder Borntraeger, Berlin, 1978.
12. Gymnosperms of India and Adjacent Countries, K.C. Sahani, Bishen Singh Mahendra Pal Singh, 1990.
13. Botanical Monograph No. I – *Gnetum*, P. Maheshwari and V. Vasil, CSIR, New Delhi, 1961.
14. *Pinus*, P. Maheshwari and R.N. Konar, CSIR, New Delhi, 1971.

Department of Botany
M.Sc. BOTANY (SEMESTER-I)
BOT-CC-5: Practicals Based on BOT-CC-1 to BOT-CC-4
2 Credits

Department of Botany
M.Sc. BOTANY (SEMESTER-II)
BOT-CC-6: PLANT DEVELOPMENT AND REPRODUCTION
4 Credits/40 Hours

Course Outcomes:
After completion of the course, the student will:

- Understand the differentiation and development of different plant organs and specialized structures.
- Have knowledge of differentiation, development and functions of different tissues.
- Have an understanding of morphological nature of the flower along with its development and evolutionary history.
- Understand the concept of microsporogenesis and megasporogenesis.
- Understand the phenomenon of sexual incompatibility.
- Have knowledge of fertilization and post fertilization changes leading to fruit and seed formation.
- Have an understanding of the phenomenon of morphogenesis.

Unit-I
Development of Root: Organization of RAM, cell fates, differentiation of vascular tissue, formation of aerial roots and root hairs
Development of Shoot: Cytological analysis of SAM, growth and differentiation of shoot
Tissue differentiation: Cambium, Xylem, Phloem: their function, factors and development
Root-shoot transition; Stem-Node-Leaf continuum
Origin, differentiation and growth: Leaf, Mesophyll, Epidermis (including cuticle, stomata and trichomes) and Venation
Secretory ducts, Laticifers: Structure and formation
Plant surface: Structure and function of Lenticels, Hydathodes, Domatia, Epiphyllous branches, Epicuticular waxes, Extrafloral nectaries and Hydropotes
Unit-II
General morphology of floral parts, floral meristem
Formation of floral organs and their morphological nature
Genetics of floral organ differentiation, Homeotic mutants in *Arabidopsis* and *Antirrhinum*
Accessory floral organs: Epicalyx, Involucre, Cupule, Corona, Nectaries
Epigyny
Origin, history and evolution of Angiosperm flower
Unit-III
Microsporogenesis: Structure, function and development of male gametophyte
Megasporogenesis: Types of ovules, their evolution and ontogeny, organization and development of embryo sac, involvement of genes/gene functions during megagametogenesis
Sexual incompatibility: Barriers to fertilization and methods to overcome sexual incompatibility, pollen tube structure and growth, Dioecism
Unit-IV
Double fertilization, post-fertilization metabolic and structural changes in embryo sac
Endosperm: Structure and development; Polyploidy in reproductive organs and tissues
Embryogenesis; Physiological and morphogenetical relationship of endosperm and embryo
Polyembryony, Apomixis: Classification, causes and applications
Structure and growth of fruit and seed
Unit-V
Experimental and applied embryology
Morphogenetic Phenomenon: Symmetry, Polarity, Correlation, Differentiation, Totipotency and Regeneration; Phyllotaxy
Factors affecting Morphogenetic Phenomenon: Genetic, Physical and Chemical
Practicals based on Units I-V

Suggested Readings:

1. Plant Anatomy, Fahn (1967), Pergamon Press.
2. An Introduction to Plant Anatomy, A.J. Eames and L.H. Mac Daniels (1972), Mc Graw Hill
3. Embryology of Angiosperms, BM Johri (1984), Springer-Verlag, Berlin.
4. Seedling of Dicotyledons, E.F. deVogel (1980), Centre for Agricultural Publishing and Documentation, Wageningen.
5. Plant Morphogenesis, E.W. Sinnott (1960), McGraw-Hill Book Company, Inc. New York
6. Pollen Morphology and Plant Taxonomy-Angiosperms: An Introduction to Palynology I, G. Erdtman (1952), The Chronica Botanica Comp. Waltham, Mass, USA.
7. Anatomy of Seed Plants, K. Esau (1971), John Wiley and Sons
8. Field Identification of Fifty Important Timbers of India, K. Ramesh Rao & KBS Juneja (1971) FRI Publication.
9. Glimpses in Plant Research. Aspects of Reproductive Biology Vol VI P.K.K. Nair, Ed. (1980)
10. The Embryology of Angiosperms S.S. Bhojwani, S.P. Bhatnagar, P.K. Dantu (2015), Vikas Publishing House Pvt. Ltd., New Delhi, India.
11. Developmental Biology of Flowering Plants, V. Raghavan (2000), Springer-Verlag, New York.
12. Anatomy of Seed Plants, V. Singh, P.C. Pande and D.K. Jain (1987), Rastogi Publications, Meerut.
13. Elements of Morphogenesis, Y.V. Chadha (1994) Awasthi Associates, Allahabad, India.
14. Phytomorphology (Trends in Plant Sciences), Golden Jubilee Issue 2001.
15. Morphogenesis in Plants: A Contemporary Study, A.W. Wardlaw (1968). Methuen and Comp. Ltd.

Department of Botany
M.Sc. BOTANY (SEMESTER-II)
BOT-CC-7: PLANT SYSTEMATICS
4 Credits/40 Hours

Course Outcomes:
After completion of the course, the student will:

- Have an idea of the principles and relevance of different classification systems and their phylogenetic significance.
- Have clear concept of ethnobotany, phytogeographical distribution of plants, speciation, herbaria etc.
- Be well-versed with the modern tools of taxonomy, viz morphological, anatomical, reproductive, cytological and chemical parameters.
- Become aware of the distinguishing taxonomic features and inter-relationships of selected Dicot and Monocot families.
- Know the special features of Insectivorous/Parasitic and Saprophytic families.
- Understand the economic utility of plants as cereals, pulses, spices, fibres, timber etc.

Unit-I
Principles of Systematics, relevance and role of Systematics
Approaches to classification: Phenetic, Phylogenetic and Cladistics; Relative merits and demerits of major systems of classification viz. Bentham and Hooker, Engler and Prantl, Hutchinson, Cronquist, Dahlgren and Thorne; APG system
Unit-II
Herbarium and Botanical Gardens, ICN (History, Principles and Applications), Protologue and Botanic literature (Monographs, Icones, Floras and Taxonomic literature)
Species Concept: Various models; Speciation and Variation
Phytogeography with special reference to discontinuous areas, endemism, hotspots and hottest hotspots
GIS and PhyloCode
Unit-III
Modern tools and evidence of taxonomy: Morphology and Anatomy: Epidermis and other structures associated with it, Node, Leaf, Flower; Embryology, Palynology, Reproductive Biology, Ovular morphology and Seed coat; Cytotaxonomy, Phytochemistry, Sieve Elements; Plastids and Ecology
Unit-IV
Sexual dioecism; Interesting taxonomic features and inter-relationships of following Dicot families: Acanthaceae, Aizoaceae, Amaranthaceae, Asclepiadaceae, Asteraceae, Betulaceae, Bombacaceae, Cactaceae, Caesalpiniaceae, Capparaceae, Caryophyllaceae, Casuarinaceae, Cucurbitaceae, Ericaceae, Euphorbiaceae, Fagaceae, Fumariaceae, Malvaceae, Mimosaceae, Nelumbonaceae, Nymphaeaceae, Papaveraceae, Papilionaceae, Passifloraceae, Polygonaceae, Primulaceae, Ranunculaceae, Rosaceae, Rubiaceae, Scrophulariaceae, Tiliaceae, Trochodendraceae Special features of Insectivorous/Parasitic and Saprophytic families
Unit-V
Origin and evolution of Angiosperms
Interesting taxonomic features and inter-relationships of following Monocot families and treatment of monocots in evolutionary systems of classification: Alismataceae, Arecaceae, Commelinaceae, Cyperaceae, Liliaceae, Orchidaceae, Poaceae, and Zingiberaceae
Ethnobotany- Concepts, relevance and ethnic uses
Biodiversity and its conservation
Practicals based on Units I-V

Suggested Readings:

1. Chemotaxonomy of Leguminosae, J. Harborne, B.L. Turner and D. Boulter, Academic Press, London, 1971.
2. Flora of Upper Gangetic Plains, John Firminger Duthie, Shiva offset Press, vol.I, 1903, vol.II, 1911.
3. The Families of Flowering Plants, John Hutchinson, Clorendon Press, 1959.
4. The Evolution and Classification of Flowering Plants, Arthur John Cronquist, Shiva offset Press, 1981.
5. Principles of Angiosperm Taxonomy, P.H. Davis and B.H. Heywood, Princeton Press, 1963.
6. The Classification of Flowering Plants, Alfred Barton Randle, Harvard University, 1904.
7. Plant Systematics, Gurcharan Singh, Oxford and IBH Publishing Company Pvt. Ltd., 1999.
8. Plant Taxonomy, Tod F. Stuessy, Shiva offset Press, 2002.
9. Numerical Taxonomy, Peter H.A. Sneath and Robert, R. Sokal, Wayne State University Press, 1973.
10. Taxonomy of Angiosperms, T. Pullaiah, Regency Publications, New Delhi, 1998.

Department of Botany
M.Sc. BOTANY (SEMESTER-II)
BOT-CC-8: CYTOGENETICS, PLANT BREEDING AND MOLECULAR BIOLOGY
4 Credits/40 Hours

Course outcomes:
After completion of the course, the student will:

- Have a comprehensive, detailed understanding of the structure and chemical basis of chromosome and the physical basis of inheritance and heredity.
- Have an understanding of linkage and crossing over and methods of mapping genes.
- Understand different mechanisms of inheritance, including Mendelian and non-Mendelian systems.
- Understand the role of genetic mechanisms in evolution through practical demonstration of aberrations, mutation and polyploidy.
- Learn about the molecular basis of inheritance through comprehensive knowledge of the structure, replication and function of DNA and RNA.
- Learn about the regulatory mechanisms for gene expression in the cell, along with a detailed conceptualization of the cell cycle, genetic code and apoptosis.
- Be able to analyze the historical evolution of plant breeding and the key scientific and technical advances that have influenced its development.
- Gain knowledge of the different plant reproductive systems and their effect on genetic variability.
- Understand the strategies and processes of selection and breeding based on the reproductive mechanisms.
- Understand the importance of identifying genes, isolating them, determining their function and controlling their expression.
- Be able to identify genetic variability, also locate the genetic regions associated with traits of interest for breeding, and determining the connection between phenotypic and genetic variability.
- Be able to use statistical methods to analyse results.

Unit-I
Chromosome structure and organization, nucleus and its functions, special types of chromosomes
Linkage and Recombination: Concepts and Types of Linkage, Three-point test cross, Molecular mechanism of recombination
Structural changes in chromosome: Duplication, deficiency, inversion and translocation heterozygotes. Cytological consequences of crossing over in inversion and translocation heterozygotes
Numerical alteration in chromosomes: Origin of euploids and aneuploids, Production of autopolyploids, allopolyploids and haploids, Induction and characterization of trisomics and monosomics
Unit-II
Mendelian inheritance and interaction of genes
Cytoplasmic Inheritance: Cytoplasmic Inheritance involving chloroplast (*Mirabilis jalapa, Zea mays*) and mitochondria (petite yeasts and cytoplasmic male sterility in higher plants)
Population genetics: Gene and genotype frequencies, Hardy-Weinberg law, Factors affecting Hardy-Weinberg equilibrium
Cell cycle: Cell multiplication and turn over, cell cycle control mechanism, role of cyclins and CDKs, apoptosis
Unit-III
Plant Introduction, its merits and demerits
Domestication and germplasm conservation
Quantitative and qualitative characters
Types of Breeding methods: Pure line selection, mass and progeny selection, Pedigree selection and recurrent selection

Role of mutation in plant breeding
Hybridization (single cross hybrid, three-way cross hybrid, double-cross hybrid, synthetic and composite crosses) Heterosis and inbreeding depression, Protoplast fusion and somatic hybrids
Unit-IV
Breeding for resistance to abiotic and biotic stresses, marker assisted selection
Selection in self-pollinated and cross -pollinated crops
Biometrical techniques in plant breeding: Assessment of variability, varietal adaptation, Measure of central tendency, Measure of dispersion
Biostatistics in breeding studies: Chi-square test, t-test, ANOVA, cluster analysis, PCA and discriminate analysis
Computational Biostatistics: Introduction to SPSS and R programming language
Unit-V
Types and molecular basis of Mutation
DNA Replication of prokaryotic and eukaryotic DNA, DNA sequencing
Transcription: Transcription in prokaryotes and eukaryotes, RNA processing
Translation: Genetic code, Translation in prokaryotes and eukaryotes
Gene Regulation in prokaryotes and eukaryotes: Operon concept, positive and negative regulation of genes
Methods of gene transfer and transgenics
Practicals based on Units I-V

Suggested Readings:

1. Lewin's GENES XII , 12th edition, Jocelyn E. Krebs, Elliott S. Goldstein , Stephen T. Kilpatrick, Cenveo Publishers, 2018.
2. Molecular Biology of the Gene, James D. Watson, A. Baker Tania, P. Bell Stephen, Gann Alexander, Dorling Kindeley, 2006.
3. Principles of Genetics, Gardner, Simmons, Snustad, Replika Press, 1984.
4. Molecular Biology of the Cell, 6th edition, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Garland Science, 2015.
5. iGenetics: A Mendelian Approach, Peter J Russell, Pearson, 2010.
6. Principles and Techniques of Biochemistry and Molecular Biology, Keith Wilson and John Walkers, Cambridge University Press, 1975.
7. Molecular Cell Biology, Harvey Lodish, Arnold Berk , Chris A. Kaiser, Monty Krieger, Mathew P. Scott, Anthony, Brest Cher, Hidde Ploegh, Paul Matsudaira, W.H. Freeman and company, 1986.
8. Genetics: A Conceptual Approach, Benjamin A. Pierce, W.H. Freeman and company, 2003.
9. Genetics: Analysis of Genes and Genomes**,** Daniel L. Hartl, Elizabeth W. Jones, Jones and Bartlett publishers, 2001.
10. Introduction to Plant Breeding, R.C. Chaudhary, Oxford and IBH Publishers, 1982.
11. Plant Breeding, V. Kumaresan, Saras Publication, 2015.
12. Plant Breeding Principles and Methods, B.D.Singh, Kalyani Publishers, 1983.
13. Fundamentals of Plant Breeding, Phundan Singh, Kalyani Publishers, 2017.
14. Principles of Plant Breeding, I.D.Tyagi, Jain brothers, 2015.
15. Plant Breeding Methods, Mahabal Ram, PHI Learning Pvt. Ltd., 2014.
16. Principles of Plant Breeding, Robert W. Allard, John Wiley and sons, 1960.
17. Plant Breeding: Scholar Select, Liberty Hyde Bailey, Arthur Witter Gilbert, 2018.

Department of Botany
M.Sc. BOTANY (SEMESTER-II)
BOT-CC-9: ENVIRONMENT, ECOLOGY AND PLANT-SOIL RELATIONSHIP
4 Credits/40 Hours

Course Outcomes:
After completion of the course, the student will:

- Be aware of the current issues related to different types of pollution and also the significance of indicator plants.
- Have in-depth knowledge of environmental issues related to ozone depletion and air pollution leading to climate change.
- Have knowledge of biotic responses to various environmental factors constituting the ecosystem.
- Become aware of community and population dynamics along with principles of plant distribution.
- Have knowledge of soil types and their properties along with method of soil formation.

Unit-I
Pollution of air, water and soil; radioactive and noise pollution and its causes and prevention
Indicator Plants
Unit-II
Acid rain, Ozone depletion
Green house effect and Global warming
Unit-III
Plant responses to environmental factors (climate, edaphic, biotic, topographic and geographic factors)
Ecosystem: Concept, ecosystem components and major ecosystems of the world
Ecosystem functioning (Trophic organization and Ecological efficiency), Community dynamics-successional changes
Unit-IV
Characteristics of communities, methods of study (life forms, growth forms and biological spectrum) and classification of plant communities
Population dynamics: Principles of population regulation
Phytogeography: Vegetational zone, important forest types of India
Interpretative Phytogeography, Principles and concepts of plant distribution
Unit-V
Soil and natural medium for plant growth, origin of soil, minerals as a source of plant nutrients
Soil forming process and its impact on soil profile development, properties of soils, soil texture and structure
Ion-exchange, calcareousness, salinity, sodicity, organic matter
Practicals based on Units I-V

Suggested Readings:

1. The Nature and Properties of Soils, Nyle C. Brady and Ray R. Weil, Pearson Education Pvt. Ltd., 2002.
2. Environmental Science, Richard T. Wright and Bernard J. Nebel, Prentice Hall India Pvt. Ltd., 2002.
3. Encyclopedia of Ecology, Environment and Pollution Control, R. Swarup, S.N. Mishra, V.P. Jauhari, Mittal Publication, New Delhi, 1999.
4. Natural Resource Conservation, 10th edition, Daniel D. Ohiras, Pearson Publication, 2019.
5. Environmental Science, S.C. Santra, New Central Book Agency Pvt. Ltd., 2001.
6. Fundamentals of Ecology, 3rd edition, E.P. Odum, Natraj Publication, 1971.

Department of Botany
M.Sc. BOTANY (SEMESTER-II)
BOT-CC-10: Practicals Based on BOT-CC-6 to BOT-CC-9
2 Credits

Department of Botany
M.Sc. BOTANY (SEMESTER-III)
BOT-CC-11: PLANT PHYSIOLOGY
4 Credits/40 Hours

Course Outcomes:

After completion of the course, the student will:

- Understand the significance of plant and water relations, essentiality of mineral nutrients for plant growth and development.
- Have complete insight into various perspectives of photosynthesis and the function of plants as primary producers of food.
- Understand how plants undergo respiration (respiratory pathways) and provide energy (oxidative phosphorylation) for food synthesis.
- Study how plants synthesize lipids.
- Gain an understanding of physiology of flowering in response to light and temperature.
- Understand the mechanisms developed by plants to overcome abiotic stress.
- Be able to demonstrate proficiency in the experimental techniques and methods of analysis for various physiological processes.

Unit-I
Plant and water relations: Properties of water, diffusion, osmosis, water potential and its components
Translocation of water and solutes: Water absorption by roots, Transport of water and solutes, Phloem loading and unloading
Transpiration: Types and mechanism of stomatal opening and closing
Mineral Nutrition: Essential and beneficial elements, Role and deficiency effects of essential nutrient elements
Unit-II
Photochemistry and Photosynthesis: Historical background and action spectra, Photosynthetic pigments and light harvesting complexes, Photosystem I and II, Photolysis of water
Mechanism of electron transport: Photophosphorylation - cyclic, non-cyclic, Proton transport and ATP synthesis in chloroplast- ATP synthase
Carbon assimilation: Calvin cycle, Photorespiration (C2 cycle) and C4 cycle and their regulation; CAM pathway; Photosynthetic responses to light, CO_2 and temperature, Synthesis of starch and sucrose
Unit-III
Respiration: Aerobic and anaerobic respiration, Glycolysis, Pentose Phosphate Pathway, Kreb's cycle and their regulation, Substrate level Phosphorylation, Gluconeogenesis, Glyoxylate cycle
Electron Transport System and ATP synthesis: NADPH/NADH in plant mitochondria, F_1-F_0 ATPase, Alternate oxidase system, Chlororespiration
Lipid Metabolism: Synthesis of fatty acids (saturated and unsaturated) and lipids (phospholipids); α, β and ω oxidation
Unit-IV
Plant growth: Growth stages, apical dominance, germination, dormancy (bud and seed)
Flowering: Floral evocation, Photoperiodism (types, critical day length), Vernalization and devernalization Florigen concept and pathways affecting flowering
Phytochrome: Structure and functions; Biological clock and Circadian rhythms

Unit-V
Abiotic Stress Responses: Plant responses to abiotic stress; Stress Proteins (HSP, LEA etc.)
Water stress: Deficit/drought and water logging
Temperature stress: Heat, chilling and freezing
Light stress: High light intensity/UV radiations
Oxidative stress: Reactive oxygen and nitrogen species, antioxidative defense system
Practicals based on Unit I-V

Suggested Readings:

1. Plant Physiology and Development (2018), Lincoln Taiz, Eduardo Zeiger, Ian M. Moller, Angus Murphy, Sinauer and Oxford University Press.
2. Plant Physiology (2010), Hans Mohr, Peter Schopfer, G. Lawlor and D.W. Lawlor; Springer Publication.
3. Abiotic Stress Adaptation in Plants: Physiological, Molecular and Genomic Foundation (2010), Ashwani Pareek, S.K. Sopory, Hans J. Bohnert and Govindjee; Springer Publication.
4. Plant Physiology (2012), Mukherjee, S. and A.K. Ghosh; Tata McGraw Hill Publishers (P) Ltd. New Delhi.
5. Introduction to Plant Physiology, (2009) 4th edition, William G. Hopkins, Norman P. A. Hüner; Wiley and Sons Ltd.
6. Marschner's Mineral Nutrition of Higher Plants (2011), Petra Marschner; Elsevier Science Publishing Co Inc.
7. Plant Physiology (2006), Lincoln Taiz, Eduardo Zeiger, 4th edition; Sinnauer Associates, USA.
8. Plant Physiology (2006), Salisbury, F.B and C.W. Ross; CBS Publishers and Printers, New Delhi.
9. Introductory Plant Physiology (1989), Noggle, R. and Fritz; Prentice Hall of India.
10. Mineral Nutrition of Plants (1986) Horst Marschner, Academic Press, New York.

Department of Botany
M.Sc. BOTANY (SEMESTER-III)
BOT-CC-12: Practicals Based on BOT-CC-11
4 Credits

Department of Botany
M.Sc. BOTANY (SEMESTER-III)
BOT-CC-13: Academic Tour
4 Credits

Department of Botany
M.Sc. BOTANY (SEMESTER-III)
BOT-IN: Internship/Field Study
2 Credits

Department of Botany

M.Sc. BOTANY (SEMESTER-IV)

BOT-CC-16: CELL BIOLOGY AND PLANT BIOCHEMISTRY

4 Credits/40 Hours

Course Outcomes:

After completion of the course, the student will:

- Gain knowledge of the structural and functional aspects of the cytoskeletal system.
- Understand the plant cell structure and its significance in metabolic processes.
- Understand the structure and role of membranes in ion transport.
- Know about the structure and functions of carbohydrates, lipids, amino acids and proteins.
- Have an understanding of assimilation of nitrogen and sulfur.
- Gain an understanding of the plant growth hormones and their utility.
- Gain a complete insight of plant enzymes and their functions in living cells.
- Know the role of receptors in signaling the plant to perform the various metabolic functions.
- Learn about the secondary metabolites which are found in plants and how they are synthesized.
- Have an idea of programmed cell death.

Unit-I

Cell components:

Structural and functional aspects of cytoskeleton system, role in cell organization and movement, organization of microtubules, microfilaments and plasmodesmata

Ultrastructure and function of microbodies, golgi apparatus, lysosomes, peroxisomes, endoplasmic reticulum, vacuole, ribosomes, nucleus and nucleolus

Structure, genome organization and function of mitochondria and chloroplast

Structural organization and function of cell wall and plasma membrane

Membrane transport:

Structure and functions of ion carriers, channel proteins, ion pumps (Na^+/K^+ and Ca^{2+} pumps), Aquaporins, Membrane transport proteins: Plasma membrane H^+-ATPase, vacuolar H^+-ATPase and H^+-pyrophosphatases, ABC transporters

Unit-II

Classification, structure and functions of:

Carbohydrates- Monosaccharides, oligosaccharides, polysaccharides (storage and structural)

Amino acids- protein, non-protein, essential and non-essential

Proteins- simple and conjugated

Lipids- Fatty acids, simple and compound lipids

Nitrogen and sulfur metabolism:

Biological nitrogen fixation, nitrogenase enzyme complex, nodule formation and nod factors

Mechanism of nitrate reduction: Nitrate and nitrite reductase; Ammonia assimilation

Assimilation of sulfur

Unit-III

Plant growth hormones:

Biosynthesis, function and mechanisms of action of: Auxins; Gibberellins; Cytokinins; Abscisic acid, Ethylene; Brasssinosteroids, Polyamines, Jasmonic acid and Salicyclic acid

Unit-IV

Enzymes:

General aspects, characteristics and classification

Factors affecting enzyme activity

Active sites and mode of action

Regulation of enzyme activity and allosteric mechanism

Enzyme inhibition-reversible and irreversible, competitive and non-competitive

Enzyme kinetics and Michaelis-Menton equation

Signal transduction:

Overview, role of membranes, receptors and G-proteins; Ca-Calmodulin cascade, phospholipid signalling, cyclic nucleotides-adenylcyclase Protein kinases: Receptor like protein kinases (RLKs), mitogen-activated protein kinases (MAPKs), cyclin-dependent protein kinases (CDKs); Protein phosphatase, Auxin, GA and ABA signal transduction
Unit-V
Secondary metabolites and their function: Cutins, Suberins, Lignin, Anthocyanins, Chalcones, Isoflavones, Stilbenes, Terpenes, Sterols Secondary metabolic pathways: Shikimic acid pathway- Phenylalanine, Tyrosine and Tryptophan Acetate Malonate pathway- Phenylpropanoids Acetate Mevalonate pathway- Terpenes Nitrogen containing compounds- Alkaloids, Cyanogenic glycosides, Glucosinolates Programmed cell death (PCD): Concept of PCD and its types in plants during vegetative and reproductive stages, developmental and stress-induced PCD; PCD and plant senescence and its characteristics
Practicals based on Units I-V

Suggested Readings:

1. Lehninger Principles of Biochemistry (2017), David L Nelson & Michael Cox; WH Freeman and Co., New York, San Francisco.
2. Signal Transduction: Principles, Pathways, and Processes (2016), Lewis Cantley, Tony Hunter, Richard Sever; Cold Spring Harbor Press.
3. Biochemistry (2015), Jeremy M. Berg. Lubert Stryer, John Tymoczko, Gregory Gatto; W. H. Freeman and Co., New York, San Francisco.
4. Biochemistry and Molecular Biology of Plants (2015), Buchanan, Gruissem& Jones; Wiley Blackwell/IK International Pvt. Ltd., New Delhi.
5. Fundamentals of Biochemistry (2011) Donald Voet and Judith Voet; C.W John Wiley and Sons Inc, New York and Toronto.
6. Plant Biochemistry (2010), Hans-Walter Heldt and Birgit Piechulla; Academic Press.
7. Biochemistry and Molecular Biology (2009), W.H. Elliot and D.C .Elliott, Oxford University Press.
8. Introduction to Plant Structure and Development (2010), Charles Beck; Cambridge University Press.
9. Cell Cycle Control and Plant Development (2007), Edited by Dirk Inze; Blackwell publishing Ltd.
10. Cell and Molecular Biology (2007), J.G. Karp; John Wiley and Sons, USA.
11. Plant Hormones: Biosynthesis, Signal Transduction, Action, Davies P J. (2004). 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
12. Plant Biochemistry (2000), P.M. Dey and J.B. Harborne; Academic Press.

Department of Botany
M.Sc. BOTANY (SEMESTER-IV)
BOT-MT: Master Thesis/Dissertation
8 Credits

The students will submit the Thesis/Dissertation on the assigned topic of their interest in contemporary plant science.