



**PROF. RAJENDRA SINGH (RAJJU BHAIYA) UNIVERSITY,
PRAYAGRAJ**

**Structure of Syllabus for the
Program: M.Sc. Subject: BOTANY**

Structure of Syllabus Developed by			
Name of BoS Convener/BoS Member	Designation	Department	College/ University
DR. KANCHAN LATA	CONVENOR	BOTANY	DDU GOVERNMENT PG COLLEGE SAIDABAD PRAYAGRAJ
DR. JUHI SINGH	MEMBER	BOTANY	DDU GOVERNMENT PG COLLEGE SAIDABAD PRAYAGRAJ
DR. SANTOSH KUMAR SINGH	MEMBER	BOTANY	MAHAMAYA GOVERNMENT COLLEGE DHANUPUR PRAYAGRAJ
PROF. ANUPAM DIXIT	MEMBER	BOTANY	ALLAHABAD UNIVERSITY
PROF. N. B. SINGH	MEMBER	BOTANY	ALLAHABAD UNIVERSITY
PROF. N. K. DUBEY	MEMBER	BOTANY	BHU VARANASI

Course Code		Course Title	Credits	T/P	Evaluation	
A	B	C	D	E	CIE	ETE
SEMESTER I (YEAR I)						
B040701T	CORE	Plant Virology and Bacteriology	5	T	25	75
B040702T	CORE	Mycology and Plant Pathology	5	T	25	75
B040703T	CORE	Limnology, Phycology, Lichenology and Bryophyta	5	T	25	75
B040704T	FIRST ELECTIVE (Select any one)	Microbiology	5	T	25	75
B040705T		History of Botany and Microtechnique				
B040706P	SECOND ELECTIVE (Select any one)	Practical based on core/Elective	4	P	50	50
B040707P		Practical/ Field Visit/ Project Presentation				
SEMESTER II (YEAR I)						
B040801T	CORE	Pteridophyta, Gymnosperms and Palaeobotany	5	T	25	75
B040802T	CORE	Plant Morphology, Plant Anatomy and Embryology	5	T	25	75

B040803T	CORE	Taxonomy of Angiosperm	5	T	25	75
B040804T	THIRD ELECTIVE (Select any one)	Plant Resource Utilization	5	T	25	75
B040805T		Medicinal Plants and Ethnobotany				
B040806P	FOURTH ELECTIVE (Select any one)	Practical based on core/Elective	4	P	50	50
B040807P		Practical / Industrial Training/ Project Presentation				
SEMESTER III (YEAR II)						
B040901T	CORE	Plant Physiology	5	T	25	75
B040902T	CORE	Plant Biochemistry	5	T	25	75
B040903T	CORE	Cytogenetics and Biostatistics	5	T	25	75
B040904T	FIFTH ELECTIVE (Select any one)	Ecology and Phytogeography	5	T	25	75
B040905T		Plant Breeding and Crop Improvement				
B040906P	SIXTH ELECTIVE (Select any one)	Practical based on core/Elective	4	P	50	50
B040907P		Practical/Project presentation				
SEMESTER IV (YEAR II)						
B041001T	CORE	Molecular Biology and Molecular Technique	5	T	25	75
B041002T	CORE	Plant Biotechnology	5	T	25	75
B041003T	SEVENTH ELECTIVE (Select any one)	Applied Phycology	4	T	25	75
B041004T		Advance Plant Pathology				
B041005R	RESEARCH PROJECT/ DISSERTATION	Major Research Project/ Dissertation	10	R	50	50

NOTE:

- 1. Do not mark any Code/Information in Column-A, it will be indorsed by the University.**
- 2. T/P** in Column-E stands for **Theory/Practical**.
- 3. CIE** in Column-F stands for '**Continuous Internal Evaluation**' and depicts the maximum internal marks. Respective examination will be conducted by subject teacher.
- 4. ETE** in Column-G stands for '**External Evaluation**' and depicts the maximum external marks. Respective Examination will be conducted by the University.
- Column-B defines the nature of course/CORE. The word **CORE** herein stands for **Compulsory Subject CORE**.
- Column-D depicts the credits assigned for the corresponding course/CORE.
- First Elective:** It will be a Subject Elective. Students may select one of the two subject COREs under this category.
- Second Elective:** It will designate a Practical CORE or equivalently a Field Visit or Project Presentation. In case of Field Visit, student is required to submit a detailed report of the visit for the purpose of evaluation. The report should include the observational features and benefits of the visit. In case of Project Presentation, the student may be assigned to go for a survey/practical or theoretical project/assignment or seminar with presentation.
- Third Elective:** It will be a Subject Elective. Students may select one of the two subject COREs under this category.

10. **Fourth Elective:**It will accommodate a practical CORE or Industrial Training or Project Presentation. In case of Industrial Training, student may be allowed for the summer training and is required to submit a detailed training report including training certificate for the evaluation.
11. **Fifth Elective:**It will be a Subject Elective. Students may select one of the two subject COREs under this category.
12. **Sixth Elective:**It will be a Practical CORE or equivalently a Project Presentation based on Survey/ Seminar/ Assignment. In case of Project Presentation, student has to submit an exhaustive report on respective topic and to face an open presentation for the evaluation.
13. **Seventh Elective:**It will be a Generic Elective. The student may study or receive training of the any subject of his interest (depends on the availability in his institution of enrollment).
14. **Master Research Project:**It will be a Major Research Project or equivalently a research-oriented Dissertation on the allotted topic. The student will have to complete his/her research project under any supervisor. The supervisor and the topic for research project shall be allotted in second semester. The student straight away will be awarded 05 credits if he publishes a research CORE on the topic of Research Project or Dissertation.

SEMESTER I

CORE – I PLANT VIROLOGY AND BACTERIOLOGY

UNIT I

Morphology and Structure of Bacterial cell: Morphology of Bacterial cell based on size, shape and arrangement, fine structure of bacterial cell (of Gram positive and Gram negative bacteria)- Capsule, cell wall, cell appendages (Flagella, Fimbriae and pili), Structure of Plasma membrane, cytoplasmic inclusions- mesosomes, Chlorosome.

UNIT II

Morphology and Structure of Viruses: History, Discovery, General characteristics of Viruses, Biological status of Viruses, Morphology, Fine structure, Shape and Classification of viruses. Microphages, Viroids, Virusoids and Prions, Tobacco Mosaic Virus (TMV), T4 Bacteriophages and HIV- their fine structure, genome organization and multiplication, Bacteriophage therapy.

UNIT III

Microbial Nutrition: Microbial requirement, Nutritional forms (Autotrophic and Heterotrophic), Nutritional Classification of Microorganisms, Quorum sensing in Bacteria. Economic Importance.

UNIT IV

Some Important Diseases: Important Diseases caused by Bacteria, Viruses and mycoplasma. Citrus Canker, Tobacco Mosaic disease and yellow vein Mosaic of lady finger, Little leaf of brinjal.

Suggested Readings:

1. Matthew's Plant Virology, R. Hull, 4th edition, 2003, Elsevier.
2. Prescott (2000). Microbiology.
3. Dubey, R.C. and D.K. Maheshwari (2010). A Textbook of Microbiology. S. Chand and Co. Pvt. Ltd. New Delhi.
4. Singh, R.S. 2008. Plant Diseases, Oxford and IBH Publishing Co. Pvt Ltd.
5. Singh, R.S. 2008. Principles of Plant Pathology, Oxford and IBH Publishing Co. Pvt Ltd.

CORE II- MYCOLOGY AND PLANT PATHOLOGY

UNIT I

General characteristics of Fungi, Nutrition (Saprophytic, Symbiotic and biotrophic), Reproduction, Recent trends in Classification of Fungi. Heterothallism, Heterokaryosis, Parasexual cycle and sex hormones in Fungi, Phylogeny of Fungi, Economic Importance of Fungi. Symbiotic Association of Fungi, Mycorrhizae

UNIT II

Systematic study of Structure, Reproduction and life cycle, Phylogeny and affinities of main groups of Fungi with special reference to following: Myxomycetes (Trichiales, Stemonitales, Physarales), Plasmodiophoromycetes (Plasmodiophorales).

Oomycetes: Saprolegniales (Saprolegnia, Achyla), Peronosporales (Phytophthora, Peronospora)

Chytridiomycetes: Chytridiales, Blastocladales, Monoblepharidales.

Zygomycetes: Mucorales, Entomophthorales.

UNIT III

Systematic study of Structure, Reproduction and life cycle, Phylogeny and affinities of main groups of Fungi with special reference to following:

Ascomycetes: Protomycetales (Protomyces), Endomycetales (Saccharomyces), Taphrinales (Taphrina), Eurotiales (Aspergillus, Penicillium), Erysiphales (Erysiphe, Phyllactinia), Sphaeriales (Neurospora, Xylaria, Claviceps), Pezizales (Ascobolus, Peziza, Morchella).

Basidiomycetes: Uredinales, Ustilaginales, Auriculariales (Auricularia), Agaricales (Agaricus, Amanita), Lycoperdales (Lycoperdon),

Deuteromycetes: Moniliales (Cercospora, Helminthosporium, Alternaria, Fusarium), Melanconiales (Colletotrichum), Sphaeropsidales.

UNIT IV

Plant Pathology: General Principle, Classification of Plant disease, Symptoms of Fungal, Bacterial and viral disease. Disease Management, Forecasting and Defence mechanism. Principle of Plant disease control (Chemical and Biological).

Fungal Disease: White rust of crucifers, Late blight of potato, Early blight of potato, Powdery mildew of pea, Black rust of wheat and Red rot of sugarcane.

Suggested reading:

1. Gangulee, H.C. & Kar, A.K. College Botany Vol. II (Algae + Fungi + Bryophyta + Pteridophyta), New Central Book Agency, Kolkata
2. Singh, Pande, Jain, 2010, A Text Book of Botany (Algae + Fungi + Bryophyta + Pteridophyta) Pub. Rastogi Publication, Meerut
3. Agrios, G.N., 1998. Plant Pathology, Academic Press.
4. John A Lucas, 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press.
5. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996, Introductory Mycology, Wiley
6. Cathie, M.J., Watkinson S.C. and Booday, G.W., 2001, The Fungi, Academic Press
7. Maheshwari, R., 2012, Fungi: Experimental Methods in Biology, CRC Press, Boca Raton, Florida.

CORE-III LIMNOLOGY, PHYCOLOGY, LICHENOLOGY AND BRYOPHYTA

UNIT –I

Limnology: Introduction to limnology, General study of morphological and reproductive feature of micro and macrophytes growing in sea water with special reference to their adaptation. General account of abiotic and biotic factors influencing the growth of fresh water and marine water flora. Physical factors: Light, Temperature Heat and Stratification. Chemical factors: DIC, Oxygen in lakes, effect of DOC and BOD. Size spectrum of planktonic organisms, Human impact on lake ecosystem.

UNIT- II

Algae in diversified habitats (terrestrial, freshwater and marine), Thallus organization, cell ultra structure, reproduction, Classification of algae, cell wall composition, reserve food material, Flagellation and Heterocyst. Symbiotic algae, algal bloom, Ecological and economic importance of algae. A comparative study of range of thallus organization, cell structure, reproduction (asexual & sexual), of flowing class: Cyanophyceae (Scytonema, Spirulina), Chlorophyceae (Chlamydomonas, Volvox, Chara, Nitella, Acetabularia), Phaeophyceae (Laminaria, Dictyota), Bacillariophyceae (Navicula), Xanthophyceae (Vaucheria, Botrydium), Rhodophyceae (Batracospermum, Gelidium).

UNIT –III

Lichens – A general account classification and distribution of Lichens. A comparative study of thallus organization, cell structure, physiology and reproduction. Economic importance of lichens.

UNIT-IV

Bryophyta: General introduction, classification, Origin and evolution of bryophytes, Fossil history of Bryophytes, Ecological significance and economic importance of Bryophytes. Characteristic features, criteria of classification, range of gametophytic and sporophytic organization(morphology, anatomy and their distribution in India) in various orders/families of the class: Marchantiales (Plagiochasma, Targionia, Cyathodium), Sphaerocarpaceae (Sphaerocarpus, Riella), Calobryales (Calobryum), Metzgeriales (Riccardia), Jungermanniales (Porella, Frullania), Anthocerotales (Anthoceros, Notothylus), Sphagnales (Sphagnum), Polytrichales (Polytrichum, Pogonatum), Buxbaumiales (Buxbaumia), Bryales (Funaria).

Suggested reading:

1. Dodson, S. (2005). Introduction to Limnology. New York. McGraw-Hill.
2. Moss, B. (1998). Ecology of fresh waters: man and medium, past to future. Oxford, Blackwell Science.
3. Horne, A. J. and C. R. Goldman (1994). Limnology. Toronto, McGraw-Hill.
4. Lee, Robert Edward, 2008, Phycology, Fourth edition, Cambridge University Press
5. Graham Robin South and Alan Whittick, 1998, Introduction to Phycology, Blackwell Scientific Publication
6. Bold, H.C. and Wynne, M.J., 1985, Introduction to the Algae, 2nd Edition, Prentice-Hall Inc.
7. Dixon, R. , Biology of Rhodophyta, Kock Science Publisher, West Germany
8. Fritsch, F.E., Structure and Reproduction of Algae, Vol. 1 & II, Cambridge University Press, Cambridge
9. Smith A. L.(1921) Lichens, Cambridge university Press
10. Orange A, James PW and White FJ (2001) Microchemical methods for identification of lichens. British Lichen Society.
11. Parihar N. S. 1965, An Introduction to Embryophyta- Bryophyta. Central Book Depot. Allahabad.
12. Kashyap S. R. 1972, Liverworts of the Western Himalayas & the Punjab Plains. Part 1 & 2.
13. Richardson D. H. 5, The Biology of Mosses.
14. Janice. M. Glime, 2006, Bryophyte Ecology.
15. GoffmetB.&Shaw.A.J.2008,BryophyteBiology.

FIRST ELECTIVE - MICROBIOLOGY

UNIT- I

General account of Microorganisms: History of microbiology, characteristic features of Bacteria and actinomycetes, classification of microorganisms- Three domain classification, Bergey's classification. Morphology of Bacterial cells, capsule, cell wall, cell appendages (flagella, fimbriae and pili). Methods of isolation and culture of microorganisms, measurement of microbial growth, microbial genetics.

UNIT- II

Role of microorganisms: Root nodules, nif gene organization, role of microorganisms in soil (decomposition and nutrient cycling), water and air; role in industry- production of antibiotics, bio-fertilizers and bio-pesticides.

UNIT-III

Microbial Ecology and Environmental Microbiology of air, water and soil. Microbiology of Solid waste, Sewage and Industrial waste, Bioleaching and Biomining. Microbiology of food, Milk and dairy products.

UNIT- IV

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

Suggested Readings:

1. Madigan, M.T., Martinko, J.M., Dunlap, P.V., Clark, D.P., 2011. Brock Biology of Microorganisms. 13th edition, Pearson Education Inc.
2. Stanier, R.Y., Ingraham, J L Wheelis, M.L., Painter, P.R., 1987. General Microbiology. Fifth edition. MacMillan.
3. Dubey, RC and Malieshwari. DK. 1999. A Textbook of Microbiology. S. Chand & Company Ltd.
4. Atlas, RM. 1995. Principles of Microbiology. Mobsy.
5. Lim, DV. 2003. Microbiology. Kendall/Hunt.
6. Boundless.2013. Microbiology. Boundless Learning, Incorporated.
7. Comelissen, CN, Harvey, RA and Fisher, BD. 2012. Microbiology. Lippincott Williams & Wilkins,
8. Talaro, K.P., Chess, B. 2011, Foundations in Microbiology. 8th edition. McGraw-Hill.
9. Tortora, G.I., Funke, B.R., Case, C.L. 2003, Microbiology: An Introduction. Benjamin Cummins
10. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology. 8th edition, McGraw-Hill.

FIRST ELECTIVE- HISTORY OF BOTANY AND MICROTECHNIQUE

UNIT- I

A brief introduction of major discoveries in Botany and contribution of renowned Indian Scientist: Prof. Birbal Sahni, Prof. Panchanan Maheshwari, Prof. Shiv Ram Kashyap, Prof. M.O.P. Iyenger, Prof. P.N. Mehra, Prof. Divya Darshan Pant, Prof. K.C. Mehta, Prof. R.N. Singh, T.V. Desikachary, Prof. Ramdeo Mishra and K.S. Bhargava.

UNIT-II

A brief introduction of major discoveries in Botany and contribution of renowned scientists: Pier Antonio Micheli, Melvin Kelvin, Sir Hans A. Krebs, Kary Bank Mullis, E.J. Butler, F.E. Fritsch, Prof. T.H. Morgan, Sir Charles Darwin, Sir George Bentham, Sir Joseph Dalton Hooker, Carlous Linnaeus.

UNIT-III

Microscopy: Optical, Electron, Scanning probe, Ultraviolet, Infrared, Fluorescence. Staining techniques: Gram staining and Acid Fast staining. Reagents used for the microscopic examinations eg. Methylene Blue, Fast Green, Phloroglucin/HCl, Safranin, Hematoxylin, Lugol's solution, Retenium red, Cotton Blue and eosin.

UNIT-IV

Chromatography: Basic concept, GC, TLC, HPLC, HPTLC, Affinity chromatography, Ion Exchange chromatography. Spectroscopy: Basic concept, Mass Spectroscopy, X-Ray Diffraction. Gel Electrophoresis: AGE, PAGE, SDS-PAGE, 2D Electrophoresis, IEF.

Suggested reading:

1. Wilson, K. And Walker, J., 2000. Practical Biochemistry: Principles & techniques (5th Edition), Cambridge University Press.

SECOND ELECTIVE

PRACTICAL- I : Lab work based on Core/Elective OR

PRACTICAL/FIELD VISIT/PROJECT PRESENTATION

(The Candidate are required to choose only one elective)

SEMESTER II

CORE- I PTERIDOPHYTA, GYMNOSPERM AND PALAEOBOTANY

UNIT-I

A brief account of origin of pteridophytes, classification of pteridophytes, heterospory and seed habit, evolution of stelar system, telome theory, evolution of sorus, apogamy, apospory and apomixis.

A brief account of the following classes with emphasis on the given genera:

Psilophytopsida: Rhynia, Horneophyton; Psilotopsida: Psilotum; Lycopsida: Lycopodium, Lepidodendron, Lepidocarpon, Selaginella, Isoetes'; Sphenopsida: Hyenia, Sphenophyllum, Calamites, Equisetum; Pteropsida: Eusporangiate (Ophioglossales and Marattiales) with special reference to phylogeny of Ophioglossales; Protoleptosporangiate (Osmunda, Leptopteris); Leptosporangiate: (a) Filicales (Hymenophyllum, Adiantum, Pteris, Dryopteris) (b) Marsileales (Marsilea) (c) Salviniiales (Salvinia, Azolla)

UNIT-II

Introduction: History, classification, distribution and evolution of Gymnosperms with special reference to Progymnosperms and origin of seeds. Endangered gymnosperms, their conservation and present status. Economic importance of Gymnosperms.

UNIT-III

Brief account of the families of Pteridospermales (Lyginopteridaceae, Medullosaceae, Caytoniaceae and Glossopteridaceae) and Cycadeoideales. General account of Cordaitales. General account of Pentoxylales. Morphology, anatomy and reproduction in Cycadales, Ginkgoales and Coniferales. General account of Ephedrales, Welwitschiales and Gnetales.

UNIT-IV

Preservation of fossil plants. Types of fossils, modes of formation of different kinds of fossils, Gondwana flora.

Suggested readings:

1. Rashid, A, 2011, An Introduction to Pteridophyta, 1st edition, (Reprint), Pub. Vikas Publishing House Pvt. Ltd., Noida.
2. Gifford, Ernest, M., Foster, Adriance.S., 1989, Morphology and Evolution of vascular plant. W. H. Freeman; Third Edition.
3. Rashid, A.1999, An Introduction to Pteridophyta: Diversity,Development,Differentiation. Vikas Publishing House Pvt Ltd.
4. Parihar, Narayan Singh., 1977, The Biology and Morphology of The Pteridophyte. Central Book Depot
5. Eames, A.J. (1936) Morphology of Vascular plant-lower group. Tata Mc Graw Hill, New Delhi.

6. Chamberlain, Charles Joseph, b.1863, *Gymnosperm Structure and Evolution*. Chicago, Ill., The University of Chicago Press
7. Chhaya Biswas and B.M. Johri. *The Gymnosperm*. Springer; 1997 edition (16 April 2014)
8. Bhatnagar, S.P. Moitra, Alok. 1996. *Gymnosperms*. New Age International.
9. Pant DD. 2002, *An Introduction to Gymnosperms, Cycas, and Cycadales*, Birbal Salmi Institute of Palaeobotany.

CORE-II PLANT MORPHOLOGY, PLANT ANATOMY AND EMBRYOLOGY

UNIT-I

Morphology of flower, stamen and carpel. Plant adaptations and their morphological nature. Shoot Development: Organization of the shoot apical meristem (SAM); control of cell division and tissue differentiation especially xylem and phloem; secretory ducts and laticifers; wood development in relation to environmental factors and wood anatomy. Leaf growth and differentiation (structural development and classification of stomata and trichomes). Root development: Organisation of root apical meristem (RAM); vascular tissue differentiation; lateral roots; root hairs.

UNIT-II

Tissue - General account; Stem anatomy - Dicot and Monocot; Root anatomy - Dicot and Monocot. Anomalous Secondary Growth - *Boerhaavia*, *Dracaena*, *Nyctanthes*, *Mirabilis*, *Salvadora*, *Laptadenia*. Periderm formation.

UNIT-III

Male gametophyte: Structure of anther; microsporogenesis; pollen germination, pollen allergy; pollen embryos. Female gametophyte: Ovule development; megasporogenesis; development and organization of the embryo sac.

UNIT-IV

Pollination, Pollen-pistil interaction and fertilization: Floral characteristics, pollination mechanism and vectors; commercial consideration; structure of the pistil; pollen stigma interactions, sporophytic and gametophytic self-incompatibility (cytological, biochemical and molecular aspects); double fertilization; in vitro fertilization. Seed development and fruit growth: Endosperm development during early, maturation and desiccation stages; embryogenesis, cell lineages during late embryo development; polyembryony; apomixis, embryo culture.

Suggested readings:

1. Katherine Esau (1965), *Plant Anatomy*, published by John Wiley and Sons. Inc, New York.
2. Arthur J. Earnes; Laurence H. Mac Daniels (1951), *An Introduction To Plant Anatomy*, published by London; New York: Mc Graw Hill.
3. Carquist, S. (1961), *Comparative Plant Anatomy* Holt, Rinehart and Winston, published by New York Press.

4. A.Fahn (1982), Plant Anatomy Vol I and Vol II, published by Pergamon Press. Oxford New York
5. Pandey, B.P., Angiosperms-Taxonomy, Embryology and Anatomy, S. Chand and Co., New Delhi
6. Bhojwani, S.S. and Bhatnagar, S.P., Embryology of Angiosperms, Vikash Publishing House, New Delhi

CORE- III TAXONOMY OF ANGIOSPERM

UNIT-I

History of plant taxonomy in India, history of plant classification, needs and aim of classification, units of classification, delimitation of taxa and their practical consideration, artificial, natural and phylogenetic system of classification, A critical study of Takhtajans, modern system of classification, an introduction of angiosperm phylogeny group (APG), characteristics and phylogeny of orders. A brief account of major contribution made by the following Taxonomists: Carl Linnaeus, Joseph Dalton, Hooker, William Roxburgh, John Friminger and Duthie.

UNIT-II

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 taxonomy with morphology, anatomy, embryology, palynology, cytology, genetics, phytogeography and Chemistry, A general survey of recent advances in taxonomy: Biosystematics, biochemical and molecular systematic and numerical taxonomy.

UNIT-III

Indigenous flora of the country with special reference to local flora (Uttar Pradesh), A general knowledge of Herbarium and Botanical garden of the world and India, organization of Botanical Survey of India and its role.

UNIT-IV

Distinguishing features only of the following families and their economic importance: Ranunculaceae, Rutaceae, Fabaceae, Rosaceae, Cucurbitaceae, Apiaceae, Asteraceae, Apocynaceae, Asclepiadaceae, Acanthaceae, Rubiaceae, Solanaceae, Lamiaceae, Verbenaceae, Polygonaceae, Euphorbiaceae, Orchidaceae, Zingiberaceae, Cyperaceae and Poaceae.

Suggested readings:

1. Sumbhamurti A. V. S. S., Taxonomy of Angiosperm, I. K. international Pvt Ltd.
2. APG III 2009. An update of the Angiosperm Phylogeny Group Classification for the Order and Families of Flowering Plants: APG III. *Bot. J Linn. Soc.* 161: 105-121.
3. Jain, S.K. and Rao, R.IL 1977. *A Handbook of Field and Herbarium Methods*. Today and Tomorrow's Printers and Publishers, New Delhi.
4. Jones, SB. 1986. *Plant Systematics*. McGraw Hill
5. N. S. Subramaniam, Taxonomy of Angiosperm, Vikas publishing house Pvt Ltd.

6. Pandey, A. K., J.V.V. Dogra. & Wen, J. 2006. *Plant Taxonomy: Advances and Relevance*. CBS Pvt. Ltd.
7. Pullaiah, T. 2007. *Taxonomy of Angiosperm*. Regency Publications, New Delhi.
8. Rao, R. It 1994. *Biodiversity in India (Plant Aspects)*, Bishan Singh Mahandrapal Singh, Dehradun.
9. S. N. Pandey and S. P. Mishra, *Taxonomy of Angiosperm*. Awe Books Pvt Ltd.
10. Sharma, O. P. 1993. *Plant Taxonomy*. Tata McGraw Hill Publishing Co. Ltd., New Delhi
11. Singh, V. and Jain, DX., *Taxonomy of Angiosperms*. Rastogi Publication, Meerut
12. Velma, B. K. 2010. *An introduction to Taxonomy of Angiosperms*. PHI Learning Pvt, Ltd. New Delhi.

THIRD ELECTIVE - PLANT RESOURCE UTILIZATION

Unit-I

Food Plants: Cereal crops, sugar yielding plants, legume or pulses, vegetables, fruit, oil and fats, spices, condiments.

Unit-II

Medicinal and Aromatic Plants: Medicinal plant, aromatic plants, insecticide, herbicide and sacred plants.

Unit-III

Beverages and Masticatories: Tobacco, areca, cannabis, coca, tea, coffee

UNIT IV

Timber, fibre and petro crops: Timber, tannins and dye stuffs, rubber, gums, resin and bio-fuels.

Suggested reading:

1. S. L. Kocchar, *Economic Botany in the Tropics*. Macmillan Publisher,
2. Albert F. Hill, *Economic Botany: A Textbook of Useful Plants and Plant Products*. McGraw-Hill publications, New York

THIRD ELECTIVE - MEDICINAL PLANTS AND ETHNOBOTANY

UNIT-I

Ethnobotany: Its Concept, Scope and Relevance. Indigenous systems of medicines in India. Traditional Agriculture Practices in Ancient India. Some aspects of Biodiversity and Indian Traditions.

UNIT-II

Role of Ethnobotany in primary health care programmes and development of new drugs. Ethnobotany on development and conservation of bioresources.

UNIT-III

Plant exploration, Crop and Germplasm collection of land races: Methods and strategies. Traditional knowledge of Uttar Pradesh: With special reference to food and medicine. Ethnobotany of major tribal communities (Gond, Bhil, Baiga etc) of Uttar Pradesh.

UNIT-IV

Contributions of Ethnobotanists: J.W.Harshberger, R.E.Schultes, E.K.Janakiammal, S.K.Jain, K.S.Manilal, V.V Sivarajan & P.Pushpangadan. Role of ethnobotany in conservation and sustainable development.

Suggested Reading:

1. Jain, S. K. (1981). Glimpses of Indian Ethnobotany. Oxford & IBH publishing Co. Pvt. Ltd., New
2. Jain, S. K. (1989). Methods and approaches in Ethnobotany. Society of Ethnobotanists, Lucknow13.
3. Jain, S. K. (1995). A manual of Ethnobotany. Scientific Publishers, Jodhpur.

FOURTH ELECTIVE**PRACTICAL : Lab work based on Core/Elective OR****PRACTICAL/INDUSTRIAL TRAINING/PROJECT PRESENTATION****(The candidate are required to choose only one elective)****SEMESTER-III****CORE-I PLANT PHYSIOLOGY****UNIT-I**

Membrane transport and translocation of water and solutes: Plant-water relations, mechanism of water transport through xylem, phloem loading and unloading, passive and active solute transport, membrane transport of proteins. 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

Nitrogen fixation and metabolism: Biological nitrogen fixation, mechanism of nitrate uptake and reduction, ammonium assimilation. Glycolysis, TCA Cycle, electron transport and ATP Synthesis, pentose phosphate pathway, glyoxylate cycle, Cyanide resistant respiration, Lipid metabolism.

UNIT-III

Photosynthesis: General concepts and historical background, steps of photosynthesis, Emerson's effect, two pigment systems, Calvin cycle, photorespiration and its significance, C4 cycle, CAM pathway.

UNIT-IV

Plant growth regulators: Physiological effects and mechanism of auxins, gibberellins, cytokinins, ethylene, abscisic acid, polyamines, jasmonic acid, hormone receptors and vitamins and hormones. Photoperiodism and vernalization: Photoperiodism and its significance, floral induction and development, significance of vernalization, devernialization.

Plant growth: Growth stages, Apical dominance, germination, dormancy (bud and seed).
Phytochrome: Its structure and functions. Biological clock and circadian rhythms. Stress physiology: Plant responses to biotic and abiotic stress, mechanism of biotic and abiotic stress tolerance, water deficit and drought resistance, salinity stress, freezing and heat stress, oxidative stress.

Suggested Readings:

1. Hopkins, W. G. 1995. Introduction to plant physiology.
2. Salisbury & Ross 2003. Plant Physiology.
3. Frank Boyer Salisbury and Cleon Ross, 1991, Plant Physiology, CA
4. Peter Scott, Physiology and Behaviour of Plants. Wiley-Blackwell.

CORE-II PLANT BIOCHEMISTRY

UNIT-I

Bioenergetics: Laws of thermodynamics, concept of enthalpy and entropy and their significance in biological systems, Water biochemistry, high energy molecules, redox potential; Amino acids and proteins: Structure and physiochemical properties of amino acids; Proteins: Primary, Secondary, tertiary and quaternary structure of proteins, physical and chemical properties of proteins and biological significance. Enzymes: Classification, physical-chemical nature, enzyme kinetics, mechanism of action and regulation.

UNIT-II

Carbohydrates: Structure and physical-chemical properties of carbohydrates, biological significance, Glycoprotein, Lipids: Classification, structure and properties of important lipids, biological significance of glycolipids, fatty acid biosynthesis and storage lipids and their catabolism. Vitamins and Coenzymes: Structure and general biochemistry.

UNIT-III

Nucleic Acid: Structure and conformation of nucleic acids; replication and transcription of DNA, regulation of transcription, DNA damage and repair, Structure of mRNA, rRNA and tRNA, Splicing, transport of RNAs, RNA editing.

UNIT-IV

Biological Nitrogen Fixation: Nitrogenase enzyme, substrate for nitrogenase, Reaction mechanism, strategies to exclude oxygen and need to control hydrogen evolution.

Suggested readings:

1. Devi, P. 2000. Principles and methods of Plant Molecular Biology, Biochemistry and Genetics.
2. Cooper, T. G. 1977. Tools in Biochemistry.
3. Lehninger. Principles of Biochemistry
4. Srivastava, H. S. 1983. Elements of Biochemistry. Rastogi Publications, Meerut.

CORE-III CYTOGENETICS AND BIOSTATISTICS

UNIT-I

Basic concept and organization: Chromosome structure, nucleosome, solenoid model, euchromatin and heterochromatin, special type of chromosomes- Polytene chromosomes, lampbrush chromosomes, B chromosomes. Gene concept; allele concept, multiple alleles, isoalleles, Pseudoalleles, cell division.

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: 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.

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, Induction of trisomics and monosomics.

Structural changes in chromosomes: Deficiency, duplication, inversion, translocation heterozygotes.

UNIT-IV

Importance and scope of Biostatistics. Measures of Central tendency, Measures of dispersion: range, mean deviation, Standard deviation, Variance, Standard error of mean, Standard error of SD, Students 't' test, Chi-square test. Analysis of Variance (ANOVA). Correlation and regression- meaning, kinds of correlation, coefficient of correlation, method of studying correlation. Aims of regression analysis. Kinds of regression analysis.

Suggested Reading:

1. Lewin, B. 2000, Gene. Vol. VII. Oxford Univ. Press, New York, USA.
2. Watson, J. D. Molecular Biology of the Gene.
3. Gahalain, S. S. 2004. Fundamentals of Genetics.
4. Gupta, P.K., Cytogenetics, Rastogi Publication, Merrut.

FIFTH ELECTIVE - ECOLOGY AND PHYTOGEOGRAPHY

Unit I

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.

Unit II

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.

Unit III

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 and climate change: kinds, sources and effects of pollution, heavy metals (Pb, Cd,, Hg), green house gases (CO₂, CH₄, N₂O, CFCs), green house effect and global warming, ozone layer depletion and ozone hole, acid rain. Environmental impact assessment, threatened and endangered plant species, role of diversity in ecosystem stability, general account of remote sensing and its application, sustainable development. Major terrestrial biomes, biogeographical area of India, major vegetations.

Suggested reading:

1. Odum, E. P. and Barret G.W. 2005. Fundamentals of Ecology. Cengage publication
2. Odum, E.P., 1983. Basic Ecology., Saunders College Publishing
3. Singh, LS., Singh S.P. and Gupta S.R. 2006. Ecology Environment and Resource Conservation. Anamaya Publishers

FIFTH ELECTIVE - PLANT BREEDING AND CROP IMPROVEMENT

UNIT-I

Importance, scope and major achievements of plant breeding. Germplasm; kinds of germplasm, collection, evaluation and organizations concerned with germplasm, in-situ and ex-situ conservation. Modes of reproduction in crop plants; sexual and asexual reproduction, apomixis, identification of apomictic plants. Incompatibility; genetic, physiological and biochemical basis of incompatibility, utility of self incompatibility. Male sterility; genetic and cytoplasmic male sterility and its applications.

UNIT-II

Plant introduction; types of introduction, procedure, uses of plant introduction and organizations associated with introduction. Pure line selection, mass and progeny selection, procedure and achievements. Pedigree selection, recurrent selection and their applications.

Role of mutation in plant breeding, isolation of useful mutants and major achievements. Role of polyploidy in crop improvement.

UNIT-III

Hybridization- kinds of hybridization, procedure of hybridization, types of hybridization and utility of hybridization. Hybrid breeding in self- and cross-pollinated crops. Back cross breeding. Heterosis; theories of heterosis, inbreeding depression.

UNIT-IV

Protoplast fusion and somatic hybrids. Method of gene transfer and transgenics. Marker assisted selection. Breeding for disease resistance, salinity tolerance and quality traits.

Suggested Readings:

1. Introduction to Plant Breeding, R.C. Chaudhary, Oxford & IBH Publishers, 1982.
2. Plant Breeding, V. Kumaresan, Saras Publication, 2015.
3. Plant Breeding Principles & Methods, B.D.Singh, Kalyani Publishers, 1983.
4. Fundamentals of Plant Breeding, Phundan Singh, Kalyani Publishers, 2017.
5. Principles of Plant Breeding, I.D.Tyagi, Jain brothers, 2015
6. Principles of Plant Breeding, Robert W. Allard, John Wiley & sons, 1960.

SIXTH ELECTIVE

PRACTICAL : Lab work based on Core/Elective OR

PRACTICAL/PROJECT PRESENTATION

(The candidate are required to choose only one elective)

SEMESTER- IV

CORE-I MOLECULAR BIOLOGY AND MOLECULAR TECHNIQUE

UNIT-I

Structure of nucleotides and DNA: A, B, and Z form of DNA and properties, coding and noncoding sequences, satellite DNA, DNA damage and repair, replication and transcription of DNA, structure of mRNA, rRNA and tRNA, replication of RNA, Splicing, transport of RNAs, RNA editing

UNIT-II

Protein synthesis: Mechanism of translation-Initiation, elongation and termination, post translational modification, protein targeting to organelles, regulation of protein synthesis at transcription and translation level in prokaryotes and eukaryotes.

UNIT-III

Molecular Technique: Isolation and purification- genomics and plasmid DNA, RNA, Proteins, Blotting principles, types of blotting, immunoblotting- Southern, Northern, Western and dot blots, ELISA, RIA, DNA amplification and genome mapping: PCR, RT-PCR, RFLPs, RADP, FISH, gene silencing

UNIT-IV

DNA Sequencing: Various methods of DNA Sequencing- Sanger's Dideoxy method, Maxam and Gilbert method, Shotgun, Pyrosequencing.

Genome expression analysis: SAGE, EST, Microarray, Quantitative Real Time PCR; RNA Interference (RNAi), Genome Editing- CRISPR

Suggested reading:

1. Buchanan, B., Grissem, W., & Jones, R.L., 2002, Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists, USA.
2. Bourton E. Tropp, Molecular Biology, 4th Ed., Jones & Barlett learning.
3. Brown, T.A., DNA Cloning and Gene Sequencing Willey-Blackwell, Oxford.
4. Dubey, R.C. A textbook of Biotechnology. S. Chand Publication. Pvt. Ltd.
5. Ramawat, K.G. Molecular Biology and Biotechnology. S. Chand Publication. Pvt. Ltd.

CORE-II PLANT BIOTECHNOLOGY

UNIT-I

Recombinant DNA technology: Restriction endonuclease, DNA modifying enzymes, Vectors, Cloning techniques, Polymerase chain reaction, Gene transfer method: Direct gene transfer, Agrobacterium mediated genetic transformation, Microinjection, Electroporation; Nucleic acid hybridization.

UNIT-II

Organization of Plant genomes; Molecular markers and its application; Genomic and cDNA library; Modern approaches for the analysis of plant genome and proteome, Mutagenesis, Gene transfer.

UNIT-III

Scope of plant biotechnology in crop improvement, human welfare and industry: Genetic manipulation of pest resistant, abiotic and biotic stress tolerance, improvement of crop yield and quality; Molecular farming, Biosafety concerns in Plant Biotechnology, Transformation of chloroplast genome and its advantage.

UNIT-IV

Plant cell and tissue culture: General introduction, history and scope; Concept of cellular differentiation and totipotency; Organogenesis and adventitious embryogenesis: Fundamental aspects of morphogenesis: Somatic embryogenesis and androgenesis, Tissue culture techniques and culture media; Cryopreservation and germplasm conservation. Somatic hybridization: Protoplast isolation, culture and regeneration, Somatic hybridization and hybrid selection; Application of plant tissue culture: Clonal propagation, artificial seed, production of hybrids and soma clones, production of secondary metabolites/natural products.

Suggested reading:

1. Chawla, H.S. 19 Introduction to plant biotechnology
2. Gupta, P. K. Elements of biotechnology.
3. S H Mantell, et. al. Principles of Plant Biotechnology: An introduction to genetic engineering in plants.
4. Singh, B. D. Plant Biotechnology Kalyani Publications.
5. Dubey, R.C. Advanced Biotechnology. S. Chand. Pvt. Ltd.

SEVENTH GENERIC ELECTIVE- APPLIED PHYCOLOGY

UNIT-I

Cultivation of microalgae, culture medium and methods, Assessment of pollutants effects, bioassays, algae of polluted and unpolluted waters, influences of salt, heavy metals, radiation and pesticides on algae.

UNIT-II

Eutrophication, dynamics of fresh water and marine algal blooms, consequences of blooms including toxins of algae, Algal ponds for the treatment of wastewaters and role of algae in phytoremediation.

UNIT-III

Alga of specialized habitats: Terrestrial algae, parasitic algae, thermal algae, freshwater algae, freshwater red algae, snow algae.

UNIT-IV

Algae and human affair: edible algae, algae in single cell protein production, algal biofertilizers, phycocolloids and other useful products of algae, biotechnological application of algae.

Suggested reading:

1. Lee, Robert Edward, Phycology, Fourth edition 2008, Cambridge University Press.
2. Bold, H.C. and Wynne, M.J. ,1985, Introduction to the Algae, 2nd Edition, Prentice-Hall Inc.

3. Singh, Pande, Jain, 2010, A Text Book of Botany (Algae+Fungi+Brophyta+Pteridophyta) , Pub.Rastogi Publication, Meerut
4. Gangulee, H.C. & Kar, A.K. College Botany Vol. II (Algae+Fungi+Brophyta+Pteridophyta) , New Central Book Agency, Kolkata

SEVENTH GENERIC ELECTIVE- ADVANCE PLANT PATHOLOGY

UNIT-I

General introduction of Plant Pathology, Chemical weapons of pathogens-Enzymes and toxins; Role of growth hormones in plant diseases, Defense mechanism of the host, how the pathogen affects plant physiological functions.

UNIT-II

Genetics of plant disease, effect of environmental factors on the plant disease development, Plant disease epidemiology: Preexisting structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds. Management of plant diseases: Cultural, chemical, biological, biopesticides, breeding for resistant varieties, Plant quarantine, integrated pest management.

UNIT-III

Diseases caused by Fungi, Bacteria, Viruses and Mycoplasma.

UNIT-IV

Molecular plant pathology: Molecular aspects of host pathogen interaction – PR proteins, degradation of phytoalexins, systemic resistance mechanism; application of molecular biology to plant disease control- transgenic approach for crop protection.

Suggested Readings:

1. Mehrotra R.S. Plant Pathology. Tata Mc Grow Hill Publishing Co. Ltd. New Delhi.
2. Agrios, G.N. Plant Pathology.
3. Mehrotra and Agrawal. Plant Pathology.
4. Narayansamy, P. Plant Pathogen detection and disease diagnosis.
5. Butler, E.J. Fungi and Diseases in Plants.
6. Singh, R. S. Plant Disease, Oxford and IBH Publishing Co. Pvt.Ltd.

(The candidate are required to choose only one generic elective)

RESEARCH PROECT/DISSERTATION

The students will submit the thesis/Dissertation on the assigned topic of their interest on existing branches of botany. It will be the part of Semester IV. The title of thesis/dissertation will be assigned by concerned faculty member/board in the beginning of Semester III to provide sufficient time to complete thesis/dissertation.