SYLLABUS FOR
Master of Science

BOTANY

Under CBCS guidelines

COURSE STRUCTURE

SEMESTER	COURSE CODE	COURSE TITLE	CREDITS
I	MBOC 1.11	Microbiology &Algae	4
	MBOC 1.21	Bryophytes & Pteridophytes	4
	MBOC 1.31	Gymnosperms & Paleobotany	4
	MBOC 1.41	Plant Morphology & Anatomy of Angiosperms	4
	MBOC 1.12	Microbiology & Algae (Practical)	2
	MBOC 1.22	Bryophytes & Pteridophytes (Practical)	2
	MBOC 1.32	Gymnosperms & Paleobotany (Practical)	2
	MBOC 1.42	Plant Morphology & Anatomy of Angiosperms (Practical)	2
II	MBOC 2.11	Angiosperm Taxonomy	4
	MBOC 2.21	Mycology & Plant Pathology	4
	MBOC 2.31	Biochemistry & Biotechnology	4
	MBOC 2.41	Cell & Molecular Biology	4
	MBOC 2.12	Angiosperm Taxonomy (Practical)	2
	MBOC 2.22	Mycology & Plant Pathology (Practical)	2
	MBOC 2.32	Biochemistry & Biotechnology (Practical)	2
	MBOC 2.42	Cell & Molecular Biology (Practical)	2
III	MBOC 3.11	Genetics, Cytogenetics & Plant Breeding	4
	MBOC 3.21	Plant Physiology	4
	MBOC 3.12	Genetics, Cytogenetics & Plant Breeding(Practical)	2
	MBOC 3.22	Plant Physiology (Practical)	2
	MBOD 3.11(a)	Plant Systematics	4
	MBOD 3.11(b)	Medicinal Plants	4
	MBOD 3.11(c)	Biodiversity and Conservation	4
	MBOD 3.12(a)	Plant Systematics (Practical)	2
	MBOD 3.12(b)	Medicinal Plants (Practical)	2
	MBOD 3.12(c)	Biodiversity and Conservation (Practical)	2
	MBOD 3.21(a)	Research Methodology & Biostatistics	4
	MBOD 3.21(b)	Methods in Plant Sciences	4
	MBOD 3.21(c)	Agroecosystems – Principles and Applications	4
	MBOD 3.22(a)	Research Methodology & Biostatistics (Practical)	2
	MBOD 3.22(b)	Methods in Plant Sciences (Practical)	2
	MBOD 3.22(c)	Agroecosystems – Principles and Applications (Practical)	2
IV	MBOC 4.11	Plant Reproductive Biology	4
	MBOC 4.21	Ecology and Ecosystem Analysis	4
	MBOC 4.12	Plant Reproductive Biology (Practical)	2
	MBOC 4.22	Ecology and Ecosystem Analysis (Practical)	2
	MBOD 4.11(a)	Plant Resource Utilization	4
	MBOD 4.11(b)	Phytogeography and Evolution	4
	MBOD 4.11(c)	Biofertilizers and Biopesticides	4
	MBOD 4.12(a)	Plant Resource Utilization (Practical)	2
	MBOD 4.12(b)	Phytogeography and Evolution (Practical)	2
	MBOD 4.12(c)	Biofertilizers and Biopesticides (Practical)	2
	MBOD 4.21	Dissertation Work	6

SEMESTER – I

MBOC 1.11
ALGAE & MICROBIOLOGY

Theory Credit: 4

UNIT I Classification of algae by Fritsch and criteria for classification. Diversity of light harvesting pigments, algal plastids, reserve food material and cell wall composition in various groups of algae; Extracellular products and flagellar structures in algae. Algal ecology: Distribution of algae in diversified habitats. Algae of unusual habitats– cryophytes, halophytes, thermophilic algae, desert algae. Algae involved in biotic interactions with other organisms.

UNIT II General account of thallus structure and modes of reproduction (vegetative, asexual and sexual) in algae. Range of thallus and reproduction in Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae.

UNIT III Applied phycology: Uses of algae in agriculture (with special reference to use as biofertilizers), medicine, industries and as environmental indicators. Use of algae in carbon dioxide sequestration and biofuel production. Economic importance of algae. Techniques of culturing algae.

UNIT IV Introduction of microbes in soil, air, water. Microbes in food industry; microbes in food spoilage and food poisoning; microbes in industrial production of alcohol, organic acids and antibiotics. Microbial degradation of petroleum and xenobiotics, Bioremediation, Mycotoxins-harmful effects.

UNIT V Effect of environmental factors on microbial growth; various measurement methods of microbial growth, nutritional forms of microorganisms; microbial colonization, succession and climax; Interaction between microbes and plants (mycorrhizal associations, root nodules) Microbial products/associations and its role in forestry and agriculture.

MBOC 1.12

ALGAE & MICROBIOLOGY

Practical credit: 2

1. Collection, identification and study of morphological and reproductive features of common Indian fresh water, terrestrial and marine algae.

   Type study of the following:

   Cyanophyceae : Microcystis, Oscillatoria, Rivularia, Nostoc
   Chlorophyceae : Scenedesmus, Pediastrum, Hydrodictyon, Ulva
   Charophyceae : Chara
   Xanthophyceae : Vaucheria/Botrydium
   Bacillariophyceae : Pennate diatoms
   Phaeophyceae : Ectocarpus, Padina, Sargassum
   Rhodophyceae : Polysiphonia, Gracilaria

   Study and identification of common algae from a freshwater body.

2. Preparation of culture media
3. Enumeration of microorganisms from food spoilage (eg. Bread, fruits, vegetables)
4. Isolation and enumeration of microorganisms from soil, litter, water and air.
5. Serial dilution technique
6. Gram staining of bacteria.
7. Carbohydrate fermentation tests.
8. Study of different mycorrhizal association.

Recommended Books and References:

1. Alexander, M (1979). Advances in Microbial Ecology, Plenum Press.
2. Aneja K. R. (1996). Experiments in Microbiology, Plant Pathology and Tissue Culture. Wishwa Prakashan.
3. Atlas R. M. and Bartha R (1997) (4th Edition) Microbial Ecology: Fundamental Applications. Benjamin/Cummings Science Pub.
4. Barnett H. L. and Hunter, B. B. (1972). Illustrated genera of imperfect fungi. Burges Publ.
5. Benson H.J. (1990). Microbiological Applications - A Laboratory Manual in General Microbiology. Wm. C. Brown Publishers.
6. Bold, H.C., and Wynne, M.J. 1985. Introduction to the algae: structure and reproduction. Prentice Hall, Englewood Cliffs, N.J.
7. Cappuccino J. G. and Sherman N. (1999). Microbiology- A Laboratory Manual (Fourth Edition). Addison Wesley.
8. Chapman and Chapman, 1973. The algae, Macmillan & Co.
9. Creager, J. G., Black, G and Davidson, V. E (1990). Microbiology: Principles and Applications, Prentice Hall.
10. Dodge, J.D. 1973. Fine structure of algal cells. Academic Press, London.
11. Domsch K. H., Gams W. and Anderson T. H. (1980). Compendium of soil fungi.

Academic Press
12. Fritsch, F.E. 1945. Structure and reproduction of algae. Vols. I and II. Cambridge University Press, Cambridge.
13. George, N. A (1988) Plant Pathology (third edition) Academic Press.
14. Gilman J. C. (1967). A Manual of Soil fungi. Oxford and IBH Publishing Co.
15. Harley, H. L and Smith, S. E (1983). Mycorrhizal symbiosis. Academic Press.
16. Johnson L. F. and Curl E. A. (1972). Methods for Research on the Ecology of soil borne plant pathogens. Burgess Publishing Co.
17. Kingsley. R. 1998. Photosynthetic pigments of algae.
18. Kumar, H.D.1990. Introductory phycology. East West Pvt. Ltd. Bangalore
19. Lee F. R. (1980). Phycology. Cambridge Univ, Press.
20. Madigan, M. T., Martinko, J. M and Parker, J (2000). Brock Biology of Microorganisms. Prentice Hall International, Inc
21. Mishra, R.R. (1996). Soil Microbiology. CBS Publ.
22. Morris I. (1986). An Introduction to the Algae. Cambridge Univ. Press
23. Nester E. W., Roberts C. e. and Nester M. T. (1995). Microbiology: A Human Perspective. Wm. C. Brown Publisher.
24. Round F. E. (1986). The Biology of Algae. Cambridge Univ. Press.
25. Smith, G.M. 1951. Manual of phycology, Chronica Botanica Publ. Co. Waltham, Mas.
26. Stevens F. L. (1985). The fungi which cause plant diseases. IBS. Intl.
27. Stewart W. D. P. (1974). Biochemistry and Physiology of algae. Blackwell Scientific Publ.
28. Tate, R. L (1995). Soil Microbiology, John Wiley and Sons Inc.
29. Tortora, G., Berdell, R. R and Case. C. L (1995). Microbiology – An Introduction. The Benjamin/Cumming Publishing Company.
30. Trainer F. R. (1978). Introductory Phycology. John Wiley & Sons
31. Trivedi, P.C. 2001. Algal biotechnology, Poiner publishers, Jaipur, India.
32. Van Elsas J. D., Trevors, J. T., Wellington, e. M. H. (1997). Modern Soil Microbiology, Marcel Dekker Inc.

MBOC 1.21
BRYOPHYTES & PTERIDOPHYTES

Theory Credit: 4

Bryophytes:

UNIT I Origin of Bryophytes; classification of Bryophytes; range of thallus structure; Structure, reproduction and life cycle of *Riccia*, *Pellia*; *Anthoceros*; *Funaria*, *Polytrichum*.

UNIT II Evolution of sporophyte; Ecological significance: colonization, succession and role of bryophytes in ecosystem; Bryophyte as site-specific bio-indicator and phytoremediator for environmental pollution; Economic Importance of Bryophytes.

Pteridophytes:

UNIT III General characters of pteridophytes; classification of pteridophytes (according to Reimers (1954), Wardlow (1955), Cronquist et al. (1966)); Origin of Pteridophytes–Algal origin, Bryophyte Origin; Heterospory and seed habit. Stelar.

UNIT IV General account of modes of reproduction in pteridophytes. Morphology, reproduction and life cycle of *Psilotum, Lycopodium, Equisetum* and *Pteris*.

UNIT V Diversity of pteridophytes in different habitats. Affinities of pteridophytes with gymnosperms. Insect, microorganism-pteridophyte interaction. Economic importance of Pteridophytes. Recent advances on Pteridophytes.

MBOC1.22
BRYOPHYTES & PTERIDOPHYTES
Practical credit: 2

1. Study of morphology and anatomy of vegetative and reproductive structures of the following: Isoetes, Ophioglossum, Angiopteris, Marattia, Osmunda, Gleichenia, Hymenophyllum, Adiantum, Pteris, Cyathea, Salivinia and Azolla.
2. Work out the vegetative and reproductive structures of *Riccia*, *Pellia*; *Anthoceros*; *Funaria*, *Polytrichum*
3. Collection and identification of locally available taxa of bryophytes and pteridophytes.

Recommended Books and References:

Bryophytes

1. Cavers F. (1976). The interrelationships of the Bryophytes. S.R. Technic, Ashok Rajpath, Patana.
2. Chopra R.N. and Kumar P.K. (1988). Biology of Bryophytes. John Wiley & Sons, New York, NY.
3. Kashyap S.R. (1929). Liverworts of the Western Himalayas and the Punjab Plain. Part 1, Chronica Botanica, New Delhi.
4. Kashyap S.R. (1932). Liverworts of the Western Himalayas and the Punjab Plain

(illustrated): Part 2. Chronica Botanica, New Delhi.
5. Parihar N.S. (1980). Bryophytes: An Introduction to Embryophyta. Vol I. Central Book Depot, Allahabad.
6. Prem Puri (1981). Bryophytes: Morphology, Growth and Differentiation. Atma Ram and Sons, New Delhi.
7. Udar R. (1975). Bryology in India. Chronica Botanica, New Delhi.
8. Udar R. (1970). Introduction to Bryophytes. Shashidhar Malaviya Prakashan. Lucknow.
9. Watson E.V. (1971). Structure and Life of Bryophytes. 3rd Edn. Hutchinson University Library, London.
10. Vashista B.R., Sinha A.K., Kumar A. (2008). Botany for degree students – Bryophyta, S.Chands Publication.

Pteridophytes:

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. Gangulee and Kar (2006). College Botany. New Central Book Agency.
5. Parihar, N.S. (1976). Biology and Morphology of Pteridophytes. Central Book Depot.
6. Rashid, A.(1999).An Introduction to Pteridophyta. Vikas Publishing House Pvt. Ltd. New Delhi.
7. Sharma, O.P. (1990). Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
8. Smith G.M. (1955). Cryptogamic Botany Vol II. McGraw Hill.
9. Sporne, K.R. (1986). The morphology of Pteridophytes. Hutchinson University Library, London.
10. Stewart, W.N. and Rothwell, G.W. (2005). Paleobotany and the Evolution of Plants. 2nd Edn. Cambridge University Press.
11. Sundar Rajan, S. (1999). Introduction to Pteridophyta. New Age International Publishers, New Delhi.
12. Surange, K.R. (1966). Indian Fossil Pteridophytes. CSIR., New Delhi.
13. Vashista, B.R., Sinha A.K., Kumar A. (2008). Botany for degree students – Pteridophyta, S.Chands Publication.

MBOC 1.31
GYMNOSPERMS AND PALEOBOTANY

Theory Credit: 4

UNIT I History and recent systems of classification of gymnosperms; Origin and evolution of gymnosperms; Affinities of gymnosperms with pteridophytes and angiosperms; Distribution of gymnosperms in India; Economic importance of gymnosperms

UNIT II Diversity, morphology, anatomy, reproduction and affinities of living gymnosperms: Cycadales, Ginkgoales, Taxales, Coniferales, Ephedrales, Gnetales, Welwitschiales.

UNIT III Palaeobotany; Geological timescale, Continental drift/ plate tectonics. Types of fossil, fossilization process.

UNIT IV Salient structural features and affinities of fossil gymnosperms; Pro-gymnosperms; Pteridospermales; Cycadeoidales (Bennettitales); Pentoxylales; Cordaitales.

UNIT V Study of Fossil Pteridophytes. Applied aspects of palaeobotany.

MBOC 1.32 Gymnosperms and Paleobotany
Practical Credit: 2

1. Study of morphology, anatomy and reproductive parts of *Cycas, Ginkgo, Pinus, Cupressus, Cryptomeria, Cephalotaxus, Podocarpus, Ephedra* and *Gnetum.*
2. Study of vegetative and reproductive stages of fossil genera through specimens and permanent slides.
3. Study of types of fossil through specimens and permanent slides.
4. Study of fossil Pteridophytes through permanent slides.

Recommended Books and References:

1. Andrews H. N. (1961). Studies in palaeobotany. McGraw Hill.
2. Arnold C. A. (1947). An Introduction to Palaeobotany. McGraw Hill.
3. Beck B.(ed.) (1988). Origin and evolution of gymnosperms. Columbia University Press.
4. Bhatnagar and Moitra (1996) Gymnosperms. New Age International Press.
5. Bhatnagar, S.P. and Moitra A. (1996), Gymnosperms, New Age International Pvt. Ltd.,
6. Bierhorst D.W. (1971): Morphology of vascular plants McMillan, New York.
7. Biswas, C. and B. M. Johri (2004) The Gymnosperms, Narosa Publishing House, New Delhi
8. Chamberlain C.J. (1934). Gymnosperms, structure and evolution. Univ. of Chicago Press.
9. Chamberlain C.J. (1986); Gymnosperms, structure and Evolution, CBS publishers
10. Coulter J. M. and C. J. Chamberlain (1978) Morphology of Gymnosperms, Central Book Depot, Allahabad
11. Discordies Press, Fortland, USA.
12. Gebryder, Bortragear, Berlin.
13. Johansen D. A. (1940). Plant Microtechnique, 2nd Ed. Tata McGraw-Hill.
14. Kakkar, R. K. and B. R. Kakkar (1995) The Gymnosperms (Fossils and

Living) Central Publishing House, Allahabad New Delhi.
15. Palaeobotany. Systematic Association Special Volume.
16. Pant, D.D. (2003): Cycas and allied Cycadophytes, BSIP, Publications.
17. Sambamurty A. V. S. S., (2005) A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany, Today & Tomorrow's Printers and Publishers
18. Sharma O. P. (2002) Gymnosperms, PragatiPrakashan, Meerut.
19. Sharma P. N. and Sahni K. C. (2005) Gymnosperms of India and Adjacent Countries Publisher- Bhishan Singh Mahendra Pal Singh, Dehradun
20. Siddiqui, K.A. (2002) Elements of Palaeobotany, Kitab Mahal, Allahabad.
21. Singh, H. (1978), Embryology of Gymnosperms, Encyclopedia of Plant Anatomy X,
22. Spicer, R.A. & Thomas, B.A. (1986) Systematic and taxonomic approaches in
23. Sporne K. R. (1965). The morphology of Gymnosperms. Hutchinson & Co.
24. Thomas, B.A. & Spicer R.A. (1987): The Evolution and Palaeobiology of land plants.
25. Trivedi B. S and Singh D. K. (1965). Structure and reproduction of Gymnosperms.

MBOC 1.41
PLANT MORPHOLOGY & ANATOMY OF ANGIOSPERMS

Theory Credit: 4

UNIT I Vegetative Morphology: Roots- types and modifications; Stem- Erect and weak forms and modifications; Leaf- base (types, stipules and Stipels), petiole (modifications, ligules and auricles), lamina (types, shape, base, margin, apex, surface, texture, and venation); simple and compound leaves, phyllotaxy, modification of leaves.

UNIT II Floral Morphology: Inflorescence types, bracts and bracteoles. Floral parts and their adhesion and cohesion, aestivation, placentation, floral formula and floral diagram. Fruit- simple, aggregate and multiple.

UNIT III Apical Meristem: Organisation of shoot apical meristem (SAM), cytological and molecular aspects of SAM, cytological zonation- Anneaum and meristem, vegetative shoot apex in gymnosperms and angiosperms, vascular tissue differentiation. Organisation of root apical meristem (RAM), quiescent centre, lateral roots and root hairs.

UNIT IV Leaf and Epidermology: Development of leaf primordial, leaf anatomy- C3 and C4 plants. Structural composition of epidermis, stomatal complex- structure,types and ontogeny, ultrastructure of guard cells. Trichome complex- structure, classification and ontogeny. Transfer cells.

UNIT V Cambium and Wood: Structure and seasonal activity of cambium, secondary growth in dicot stem and root, Axial and Ray parenchyma and their value in wood identification, sapwood and heartwood, early and late wood, ring and diffuse porous wood, reaction wood, tyloses.

MBOC 1.42
PLANT MORPHOLOGY & ANATOMY OF ANGIOSPERMS (PRACTICAL)
Practical Credit: 2

1. Study of vegetative morphology and their modifications.
2. Study of inflorescence types.
3. Study of different floral parts.
4. Permanent slide preparation by microtomy technique.
5. Knowledge and use of photomicrography in anatomical studies.
6. Study of shoot and root apical meristems.
7. Study of kranz anatomy, stomata, trichomes.
8. Study of different types of wood.
9. Study of apotrichial and paratrichial parenchyma.

Recommended Books and References:

1. Barnova, M A. 1987: Historical developments of the present classification of morphological types of stomata. Bot.Res.53:53-79.
2. Carliquist. S. (1988). Comparative wood anatomy, Springer – Berlag, Berlin
3. Cutter, E G 1971 Plant Anatomy
4. Cutter, E.G. Plant Anatomy, Part I and II Edward Arnold; London, 1971 and 1978
5. Esau, K. 1962: Plant anatomy –anatomy of seed plants.
6. Esau, K. Anatomy of Seed Plants.
7. Esau, K. Plant Anatomy, 2nd Ed. Wiley N.Y. 1965.
8. Emmes, E J. and M C Danials, 1947: An introduction to plant anatomy.
9. Fahn, A. Plant Anatomy (4th Ed.), 1990.
10. Fahn, A.1969: Secretary Tissue system
11. Foster, A S 1942: Practical plant anatomy
12. Haberland, G.1965: Physiological
13. Jeffrey, E.C. The Anatomy of woody plants.
14. Lyndon R.F. 1990. Plant development – The cellular basis. Unnin. Hyman, London.
15. Masueth, J D. 1936: Plant anatomy
16. Metcalf (1982-87) Anatomy of Dicots Vol. I to III
17. Metcalf and Chalk. Anatomy of dicots (2nd Edition) (1983). Clarendon Press, Oxford
18. Metcalfe, C R and L Chalk, 1950: Anatomy of the dicotyledons
19. Pearspm & Brown – Commercial Timbers
20. Rao, K.R. & K.B.S. Juneja (1971) A Hand book for identification of fifty important Timbers of India.
21. Solender, H. 1908: Systematics anatomy of the dicots
22. Steeves T.A. & Sussex 1. M, 1989, Pattersacin plant development 92nd Edition) Cambridge UNIT y Press, Cambridge.
23. Tomlinson, P S 1961: Anatomy of the monocotyledons.

SEMESTER – II

MBOC 2.11
ANGIOSPERM TAXONOMY

Theory Credit: 4

THEORY

UNIT I: Principles and procedures of plant taxonomy/systematics; Basic components of plant systematics, different phases of taxonomy; the importance of taxonomy and need for classification, taxonomy as a synthetic discipline; the conceptual basis of classification: essentialism, nominalism, empiricism, Phenetics, Cladistics, and Phylogenetic; Hierarchical classification- ranks of taxa; taxonomic groups, categories and ranks; concept of species, genus and family.

Unit II: A Brief History of Pre-Darwinian Classifications: Systems based on habit: Theophrastus, Albert Magnus; The sexual system: Carolus Linnaeus and his students; Systems based on form-relationships: Michel Adanson, Bentham and Hooker.

A Brief History of Post Darwinian Classifications: The evolutionary theory by Darwin and Wallace; Systems based on phylogeny: The Englarian School of thoughts-August Wilhelm Eichler, Adoph Engler; The Ranalian School of thoughts-Charles E. Bessey, John Hutchinson.

Recent Systems of Classifications: Broad outline of classification by Armen L. Takhtajan and R. M. T. Dahlgren; Study of basic principles and recent Angiosperm Phylogeny Group (APG) system of classification.

UNIT III: General taxonomic indexes, world floras and manuals, monographs and revisions, bibliographies, catalogues, review serials, periodicals, glossaries, etc: Herbarium and botanical gardens, their role in teaching, research, and conservation.

Botanical keys: Diagnostic, synoptic and artificial keys-Single access (sequential)-bracketed and indented keys and multi-access keys, edge-punched and body-punched (polyclave) keys, tabular and lateral keys; computerized keys, their merits and demerits.
Biodiversity Strategy and Systematics Agenda for 2020.

UNIT IV: A brief history of the origin and development of nomenclature; Contents and major provisions of the latest International Code of Nomenclature for algae, fungi, and plants (ICN); Typification and different kinds of types; Effective and valid publication of names; Author citation; Rejection of names; Principle of priority and its limitations; Conservation of names; Names of hybrids; A very brief account on International Code of Nomenclature of Cultivated Plants (ICNCP).

UNIT V: Characteristic features, interrelationships, classification (APG latest) and economic importance of families: ANITA grade: Amborellaceae, Nymphaeaceae, Hydatellaceae; MAGNOLIIDS: Magnoliaceae, MONOCOTS: Araceae, COMMELINOIDS: Arecaceae, EUDICOTS: Papaveraceae, CORE EUDICOTS: Amaranthaceae, EUROSIDS-I: Malpighiaceae, EUROSIDII: Malvaceae, ASTERIDS: Sapotaceae, EUASTERIDS-I: Gentianaceae, Acanthaceae, EUASTERID-II: Apiaceae, Asteraceae.

MBOC 2.11
ANGIOSPERM TAXONOMY (Practical)

Practical Credit: 2

1. Herbarium technique
2. Study of the locally available plants: Description and identification at family, genus and species levels using Floras.
3. Study of different types of ovules and placentation.
4. Identification of key characters of families studied and construction of keys.
5. Identification of families studied based on flowers or essential parts of the flowers
6. Simple Nomenclatural problems.
7. Taxonomic literature – Checklists, Floras, Keys, Monographs and Laboratory identification manuals.
8. Field trips within and around the College campus, compilation of field notes and preparation of herbarium sheets of such plants.

Recommended Books and References:

1. Briggs David 2009. Plant microevolution and Conservation in Human-influenced Ecosystems. Cambridge University Press.
2. Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
3. Cronquist, A. 1988. The Evolution and Classification of Flowering Plants (2nded.) Allen Press, U.S.A.
4. Davis, P. H. and V. H. Heywood 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi.
5. Hutchinson, J. 1959. Families of Flowering plants. Clarendon Press, Oxford.
6. Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue. 2008. Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
7. Lawrence George H. M. 195.1 Taxonomy of Vascular Plants. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi.
8. Leadlay E. and S. Jury (ed.) 2006. Taxonomy and Plant conservation. Cambridge University Press.
9. Manilal, K. S. and M. S. Muktesh Kumar [ed.] 1998. A Handbook of Taxonomic Training. DST, New Delhi.
10. Naik, V. N. 1984. Taxonomy of Angiosperms. Tata McGraw-Hill Publication Com. Ltd. New Delhi
11. Quicke, Donald L. J. 1993. Principles and Techniques of Contemporary Taxonomy. Blakie Academic & Professional, London.
12. Simpson, M. G. 2010. Plant Systematics. Elsevier, Amsterdam.
13. Takhtajan, A. 1969. Flowering plants-Origin and Dispersal. Oliver and Boyd, Edinburg.
14. Taylor, D. V. and L. J. Hickey 1997. Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributers, New Delhi.

MBOC 2.21
MYCOLOGY & PLANT PATHOLOGY

Theory Credit: 4

UNIT I Historical introduction of mycology, General introduction of fungi, Fungal classification (Ainsworth &Alexopoulos). General accounts of Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina with type studies.

UNIT II Recent trends and criteria used in the classification of fungi with reference to vegetative and reproductive structures; Parasexuality; Heterothalism, wood decay fungi and their importance; Economic importance of fungi.

UNIT III General signs and symptoms of plant diseases, disease detection and scoring methods, field observation, laboratory investigation. Plant disease diagnosis: Field observation, Laboratory investigation, isolation of plant pathogens and purification, Kotch's postulates and identification of plant pathogens. Methods of plant disease control.

UNIT IV Role of enzymes and toxins in pathogenesis. Effects of temperature, pH, and moisture in the development of plant diseases, Mechanism of infection and host defense mechanism.

UNIT V Symptoms, etiology and disease cycle of disease caused by: a) Mastigomycotina: Damping off of seedlings, white rust of crucifers. b) Ascomycotina: Powdery mildew of grapes and Ergot of Bajra. c) Basidiomycotina: Loss smuts of wheat and Rusts of wheat. d) Deuteriomycotina: early blight of potato and Red rot of sugarcane.

MBOC 2.22
MYCOLOGY & PLANT PATHOLOGY (PRACTICAL)

Practical Credit: 2

Practical

1. Collection and preservation of diseased plant
2. Identification of causal organisms from the diseased plant materials.
3. Isolation of pathogen from diseased plant tissue
4. Preparation of pure cultures (bacteria & fungi)
5. Study of various vegetative and reproductive structures of fungi from culture
6. Measurement of spore concentration with haemocytometer
7. Inoculation procedures to develop disease
8. Effects of temperature, pH etc.
9. Preparation of permanent slides.

Recommended Books and References:

1. Alexander, M (1979). Advances in Microbial Ecology, Plenum Press.
2. Alexopolous C, J and Mirus, C. W (1983). Introductory Mycology, Wiley Eastern.
3. Aneja K. R. (1996). Experiments in Microbiology, Plant Pathology and Tissue Culture. Wishwa Prakashan.
4. Atlas R. M. and Bartha R (1997) (4th Edition) Microbial Ecology: Fundamental Applications. Benjamin/Cummings Science Pub.
5. Barnett H. L. and Hunter, B. B. (1972). Illustrated genera of imperfect fungi. Burges Publ.
6. Benson H.J. (1990). Microbiological Applications - A Laboratory Manual in General Microbiology. Wm. C. Brown Publishers.
7. Blakeman, J. P and Williamson B. (1994). Ecology of plant pathogens. CAB International.
8. Cappuccino J. G. and Sherman N. (1999). Microbiology- A Laboratory Manual (Fourth Edition). Addison Wesley.
9. Creager, J. G., Black, G and Davidson, V. E (1990). Microbiology: Principles and Applications, Prentice Hall.
10. Domsch K. H., Gams W. and Anderson T. H. (1980). Compendium of soil fungi. Academic Press
11. George, N. A (1988) Plant Pathology (third edition) Academic Press.
12. Gilman J. C. (1967). A Manual of Soil fungi. Oxford and IBH Publishing Co.
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15. Madigan, M. T., Martinko, J. M and Parker, J (2000). Brock Biology of Microorganisms. Prentice Hall International, Inc
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17. Michael J., Carlile, S., Watkinson C and Gooday, G. W. (1994). The Fungi (second edition) Academic Press.
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21. Sarbhoy A. K. (2002) Text Book of Mycology, ICAR.
22. Sharma, P.D. Microbiology and plant pathology, Rastogi Publications.
23. Stevens F. L. (1985). The fungi which cause plant diseases. IBS. Intl.
24. Tate, R. L (1995). Soil Microbiology, John Wiley and Sons Inc.
25. Tortora, G., Berdell, R. R and Case. C. L (1995). Microbiology – An Introduction. The Benjamin/Cumming Publishing Company.
26. Van Elsas J. D., Trevors, J. T., Wellington, e. M. H. (1997). Modern Soil Microbiology, Marcel Dekker Inc.
27. Vashishta, B.R and Sinha, A.K. Botany for degree students (Fungi). S. Chand and Company Ltd.

MBOC 2.31
BIOCHEMISTRY & BIOTECHNOLOGY

Theory Credit: 4

UNIT I Carbohydrates, their derivatives and inter-conversions; Lipids: types and their derivatives: biosynthesis of fatty acids and their regulation, fatty acid oxidation. Amino acids: structure and function, properties of amino acids, formation of peptide bonds; Proteins: Hierarchical structure of proteins, Ramachandran plot, protein functions.

UNIT II Bioenergetics: Laws of thermodynamics and their significance in free energy changes in biological systems, bioenergetically favourable reactions; Enzymes: general classes of enzymes, significance of ribozymes; general principles governing enzyme catalyzed reactions. Mechanism of enzyme catalysis, Michaelis-Menten steady-state kinetics. Factors affecting enzyme activity, regulatory enzymes.

UNIT III Signal Transduction: Overview, second messengers, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascade, MAP kinase cascade, protein kinases and phosphatases, specific signaling mechanisms and their regulation, e.g. simple and hybrid type of two-component sensor-regulator system in bacteria and plants: chemotaxis, osmosensing, ethylene and cytokinin signaling, quorum sensing.

UNIT IV Recombinant DNA technology: restriction enzymes and construction of hybrid DNA; Gene cloning: cloning vehicles (plasmids, bacteriophages, YAC, BAC), T-DNA, Ti- plasmid *(Agrobacterium temefaciens)* mediated gene transfer. Construction and screening of genomic DNA and cDNA libraries;

UNIT V Polymerase Chain Reaction: principle, primer designing, *Taq* polymerase, introduction to RT-PCR. Brief overview of nested PCR, inverse PCR, Hot start PCR, Touch down PCR, Nested PCR, Reverse transcriptase PCR, Assymetric PCR. DNA sequencing – Chain Termination Method and Chemical Degradation Method. Blotting techniques (Southern, Western & Northern). DNA Finger printing (AFLP, RAPD, RFLP)

MBOC 2.32
BIOCHEMISTRY & BIOTECHNOLOGY (PRACTICAL)

Practical Credit: 2

Practical

1. Estimation of starch from plant tissues by iodine reaction
2. Estimation of sugars from plant tissues by dinitrosalycilic acid
3. Estimation of amino acids from plant tissues by ninhydrin reaction
4. Estimation of soluble protein content from plant tissues by Lowry's method
5. Separation of soluble proteins by (a) gel filteration (b) gel electrophreis
6. Assay of phosphatase activity in plant cells
7. Assay of nitrate reducatase acivity in cells

8. Demonstration of of PCR technique
9. Study of blotting techniques.
10. Study of DNA fingerprinting techniques.

Recommended Books and References:

1. Nelson D.L. and Cox M.M. (2000). Lehningers Principles of Biochemistry. Macmillan Worth.
2. Stryer L. (1993). Biochemistry. W.H. Freeman.
3. Zubay G. (1993). Biochemistry. W.C. Brown.
4. Heldt H. (1997). Plant Biochemistry and Molecular Biology. Oxford Univ. Press
5. Boyer R. (1999). Concept in Biochemistry. Brooks/Cole Publ.
6. Conn E.E. and Stumpf P.K. (1994). Outlines of Biochemistry. Wiley Eastern.
7. Dennis D.T. (1998). Plant metabolism. Longman.
8. Dey P.M. and Harborne J.B. (1997). Plant Biochemistry. Acad. Press.
9. Nelson DL and Cox MM. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H.,Freeman and Company, New York, USA.
10. Kuby, J. 2000. Immunology, 4th edition, W.H. Freeman and Company, New York, USA.
11. Roitt et al., 1998, Immunology 5th edition, Mosby International Ltd. London. UK.
12. Buchanan, Grissem and Jones (2000). Biochemistry and Molecular Biology of
13. Plants. American Soc. Plant Biologists, Waldorf.
14. Lewin B. (2000). Gene VII. Oxford University Pres. New York, USA
15. Sinden P.R.R. (1994). DNA structure and function. Acad. Press.
16. Walker J.M. and Rapley R. (2002). Molecular Biology and Biotechnology. Panima.
17. Brown TA. (2002) Genomes, BIOS Scientific Publishers Ltd, Oxford, UK.
18. Brown TA. (2008) Gene cloning and DNA analysis (5th Edition),Blackwell Publishing, Oxford,UK.
19. Click, B.R. and Thompson, J.E. 1998. Methods in Plant Molecular biology and biotechnology.CRCPress, BOCA RBTON Florida.
20. Hackett, P.B., Funchs, J.A. and Messing, J.W. 1998. An Introduction to recombinantDNAtechniques: Basic experiments in gene manipulation. The Benjamin Cummings PublishingCompany, Inc. Memno Park, California.
21. Glover, D.M. and Hames, B.D. (Eds.) 1995. DNA cloning I: A practical approach, Coretechniques,first edition, TASIRL Press al Oxford University Press, Oxford.
22. Debata, A., Pamda, D. & Debata, A. (2014). Language of Biotechnology. New Central BookAgency (P) Ltd. London.

MBOC 2.41
CELL BIOLOGY & MOLECULAR BIOLOGY

Theory Credit: 4

UNIT I Prokaryotic and eukaryotic Cell: The ultra-structural details and comparative assessment. Plasma membrane: Molecular organization, current models and functions. Cell wall architecture, biosynthesis, assembly. Plasmodesmata: Structure and role in movement of molecules and macromolecules. Structure and function of Endoplasmic Reticulum & Golgi complex. Cell cycle- Phases of cell cycle, functional importance of each phase, Molecular events during cell cycle, Regulation of cell cycle.

UNIT II Cytoskeleton: Organization and role of microtubules, microfilaments and intermediate filaments. Vacuole: structure and function. Chloroplast and Mitochondria: Ultrastructure, function and biogenesis. Nucleus: Microscopic and submicroscopic organization, Nuclear Pore Complex. The ultrastructure of nucleolus and its role in rRNA biosynthesis. Ribosomes: Structure and site of protein synthesis. Lysosomes- Ultra structure, Membrane integrity and role. Glyoxysomes and peroxisomes: Structure and function.

UNIT III Structure of nucleic acids: DNA and its A, B and Z conformations, t-RNA, r-RNAs; DNA replication: (Unit of replication, enzymes involved, replication origin and replication fork). Machinery and mechanism in prokaryotes and eukaryotes; Genetic code and exceptions to its universality.

UNIT IV Transcription and Translation: RNA transcription- machinery and mechanism in prokaryotes and eukaryotes; RNA processing: processing of hnRNA; RNA editing; Translation machinery and mechanism (tRNA charging, initiation in prokaryotes and eukaryotes, elongation and termination); Regulation of gene expression in prokaryotes and eukaryotes; post translational processing, turnover in cells.

UNIT V Gene mutation: Mutagens, Molecular basis of mutation, Mechanism of Spontaneous and induced mutation. DNA damage and repair mechanisms, homologous and site-specific recombination.

MBOC 2.42
CELL BIOLOGY & MOLECULAR BIOLOGY (PRACTICAL)

Practical Credit: 2

Practical

1. Study of mitosis using onion root tip
2. Study of meiosis using flower bud
3. Staining of nucleolus
4. Study of giant chromosomes/ polytene chromosomes in C*hironomous* larva
5. Isolation of plant DNA using CTAB method
6. Agarose gel electrophoresis of DNA
7. Spectrophotometric estimation of DNA
8. DNA digestion by general restriction endonucleases

Recommended Books and References:

1. Alberts B. et al. (2002). Molecular Biology of the cell. Gerland.
2. Alberts, B., Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1989. Molecular Biology of the cell, Garland Publishing Inc., New York
3. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D.I 999.Molecular Biology of the cell. Garland Publishing, Inc. New York.
4. Arthur G (1979) (5th Edn). Cell Physiology, Toppan company Ltd., Tokyo, Japan.
5. Birge, E.A. (2000). Bacterial and bacteriophage genetics. Springer.
6. Brown, T.A. (1989).Genetics a molecular approach. Van Nostrand.
7. Buchanan B.B. et al. (eds) (2004). Biochemistry and Molecular Biology of Plants. Amer. Soc. Plant Physiol.
8. Cooper G.M and Hausman R.E. (2007) (4th Edn). The Cell molecular approach Sinauer associate, Inc, Suderland (USA).
9. David S. (2004) (1st Indian Edition). Cell Biology, New Delhi. 9. Albert et al (2002). (4th Edn). Molecular Biology of the cell, Garland Science (Taylar and Francis) New York Group (wt)
10. De Robertis and De Robertis (2005). (8th edition) (Indian) Cell and Molecular Biology, Lippincott Williams, Philadelphia. [B.I Publications Pvt. Ltd. New Delhi].
11. De Robertis, De Robertis (1988). Cell and Molecular Biology, 8th Edn. Info-Med,
12. De, D.N. 2000. Plant cell vacuoles. An introduction. CSIRO Publication, Collingwood, Australia.
13. Evolution, Ecology. S.Chand and Company, New Delhi.
14. Gunning B.E.S. and Steer, M.W. 1996. Plant cell biology, structure and function. Jones and Bartlet Publishers, Boston, Massachusetts
15. Hall, J.L. and Moore, A.L. 1983. Isolation of membranes and organelles from plant cells. Academic Press, London, U.K,
16. Harris, N. and Opataks, K. J. 1994. Plant Cell Biology: A practical approach. IRL Press at Oxford University Press, Oxford, U.K. 7. Shaw, C.H. (Ed.) 1988. Plant Molecular Biology: A Practical Approach. IRL Press, Oxford.
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18. Karp G. (1999). Cell and Molecular Biology- Concept and Expts. John Wiley and
19. Kleinsmith, I.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology (End Edition). Harper Collins College publishers, New York, U.S.A.
20. Lea P.J. and Leagood R.C. (1999). Plant Biochemistry and Molecular Biology.

Wiley.
21. Lewin B. (2002). Genes VIII. Oxford.
22. Lewin, B. 2000, Genes VII, Oxford University Press, New York.
23. Lodish et al (2004). 5th Edn). Molecular Cell Biology, W H Freeman and company, New York.
24. Lodish H, Berk A, Kaiser CA and Krieger M. (2008) Molecular Cell Biology, 6th Edition, W.H. Freeman and Company, New York, USA.
25. Lodish H. et al. (1996). Molecular Cell Biology. Sc. American Books.
26. Lodish S., Baltimore B., Bek C., Lawrence K. (1995).Molecular Cell Biology. 3rd Edn. Scientific American Books, New York.
27. Lpdish, H., Berk, A., Zipursky, S.Z., Matsudaira, P., Baltimore, D. and Darnell,J., 2000. Molecular Cell Biology. (4thEdition). W.H. Freeman and company, New York, U.S.A. Review Journals
28. Powar C.B. (2005) (3rd Edn). Cell Biology, Himalaya Publishing, Mumbai.
29. Roy S.C and De K.K. (2005). (2ndEdition). Cell Biology, New central Book Agency Private Ltd., Kolkata. Scne Ine., USA.
30. Verma P.S and Agarwal V.K. (2006) Cell Biology, Genetics, Molecular Biology,
31. Watson J.D. et al. (2004). Molecular Biology of the gene. Pearson Education
32. Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R. 2004. Molecular Biology of theGene, Pearson Education, Singapore
33. Wolfe, S.L. 1993. Molecular and cellular biology. Wodsworth Publishing Company, California,U.S.A.

SEMESTER – III

MBOC 3.11
GENETICS, CYTOGENETICS & PLANT BREEDING

Theory Credit: 4

UNIT I Modern gene concept. Mendel's laws of inheritance. Gene interactions; Incomplete dominance, epistasis, complementary factor, multiple alleles. Organization of eukaryotic chromosomes; Linkage and genetic recombination, linkage groups.

UNIT II Chromosomal aberrations in plants: structural aberrations, numerical aberrations; Interchange tester sets; Euploidy-autopolyploidy and allopolyploidy; aneuploidy-monosomy, trisomy and nullisomy; Interchange hetorozygotes, permanent hybrids.

UNIT III Origin and meiotic & breeding behaviours of haploids, autopolyploids and allopolyploids; Genome constitution and analysis; Genome and Chromosome engineering: Synthesis of tetraploid, hexaploid and octoploid triticales; Alien chromosome additions and substitutions; Chromosome fragment transfers and crop improvement; Giemsa banding of chromosomes; FISH.

UNIT IV Gene frequency in a population, genetic equilibrium and Hardy-Weinberg law, barriers to gene flow and mechanism of speciation; Heritability of traits and its estimation; Population improvement, inbred improvement, cultivar development. Concept of combining ability; Conventional methods of plant breeding: selection methods. Hybridization: pedigree method, bulk method, backcross, test cross.

UNIT V Concept of combining ability; Phenotypic and genotypic variance and its components; Heterosis, hybrid vigour, and inbreeding depression. Male sterility and its application in hybrid seed production. Breeding for diseases and pest resistance and stress resistance.

MBOC 3.12
GENETICS, CYTOGENETICS & PLANT BREEDING (PRACTICAL)

Practical Credit: 2

Practical

1. Preparation of materials and study of somatic chromosomes of some common plants
2. Collection of flower buds and study of meiosis of some common plants
3. Study of mitosis and meiosis of some aberrant plants
4. Camera lucida drawing of cytological preparations
5. Isolation of chlorophyll mutants following irradiation treatments
6. Numerical exercises on linkage and crossing over
7. Numerical exercises on X 2 for independence of attributes and goodness of fit
8. Giemsa banding of chromosomes
9. Experiment to perform self- and cross-pollination and fertilization.

Recommended Books and References:

1. Allard R. W. (1960). Principles of Plant breeding. John Wiley.
2. Ayala F. J. and Kiger J. A. (1980). Modern Genetics. Benjamin Cummings.
3. Brown T. A. (1989). Genetics- a molecular approach. Chapman & Hall.
4. Brown T. A. (1999). Genomes. John Wiley & Sons.
5. Chopra V. L. (1989). Plant Breeding. Oxford & IBH.
6. Clark M. S. and Wall W. J. (1996). Chromosomes. Chapman & Hall.
7. Elrod S. and Stansfield W. (2004). Genetics. Tata McGraw-Hill.
8. Fukui K. and Nakayam S. (1996). Plant Chromosomes: Laboratory Methods. CRC Press.
9. Griffiths A.J. F. et al. (2000). An Introduction to Genetic Analysis. W. H. Freeman.
10. Gupta P. K. (1995). Cytogenetics. Rastogi & Co.
11. Gupta P. K. (1998). Genetics and Biotechnology in Crop Improvement. Rastogi & Co.
12. Hartl D. L. (1991). Basic Genetics. Jones & Bartlett.
13. Hartl D. L. and Jones E. W. (2001). Genetics-Analysis of Genes & Genomes. Jones and Bartlett.
14. Jain H. K. (1999). Genetics. Oxford-IBH.
15. Poehlman J. M. and Sleper D. A. (1995). Breeding Field Crops. Iowa State University Press.
16. Sharma A. K. and Sharma A. (1999). Plant Chromosomes: Analysis, Manipulation and Engineering. Harwood Academic Publishers.
17. Sharma J. R. (1994). Principles & Practices of Plant Breeding. Tata-McGraw Hill.
18. Simmonds N. W. (1979). Principles of crop improvement. Longman.
19. Snustad D. P. and Simmons M. J. (2000). Principles of Genetics. John Wiley and Sons.
20. Stansfield W. D. (1969). Theory and Problems of Genetics. McGraw-Hill.
21. Strickberger M. W. (1985). Genetics. Macmillan.
22. Sybenga J. (1972). General Cytogenetics. North Holland.
23. Tamarin R. H. (2002). Principles of Genetics. Tata McGraw-Hill.

MBOC 3.21
PLANT PHYSIOLOGY

Theory Credit: 4

UNIT I Water relation in plants: Chemical potential of water, water potential in plants, soil-plant-atmosphere continuum; Movement of water in Plants; ascent of sap. Stress biology: water, temperature, salt and biotic stress.

UNIT II Organization of the light absorbing pigment systems; Mechanisms of photoexcitation of chlorophyll and electron transport chain; Regulation of photosynthetic activity and mechanisms of repair of photosynthetic apparatus; Carbon fixation in photosynthesis and its regulation.

UNIT III Glycolysis and its regulation; Mechanisms of oxidative decarboxylation of pyruvic acid; Mitochondrial electron transport and oxidative phosphorylation; Assimilation of mineral nutrients: Uptake and assimilation

of nitrate and sulphate ions; Biological nitrogen fixation and assimilation of ammonia.

UNIT IV Plant Growth Regulators: Auxins, gibberellins, cytokinins, abscisic acid, ethylene- physiological effects and mechanism of action; Hormone receptors; Steroids as plant growth regulators; Brassinosteroids, strigolactones, and jasmonic acid- types, physiological effects and mechanism of action. Secondary metabolites: synthesis of terpenes, phenols and nitrogenous compounds and their roles in plants.

UNIT V Dormancy: types and mechanism of regulation; Flowering: photoperiodism and vernalization; Partitioning of assimilates during different phases of plant growth; Senescence and ageing.

MBOC 3.22
PLANT PHYSIOLOGY (PRACTICAL)

Practical Credit: 2

Practical

1. Study of the effect of organic compounds on membrane permeability
2. Determination of water potential in plant tissues
3. Estimation of chlorophyll a, b and total chlorophyll content of plant tissues
4. Isolation of plant pigments and determination of their absorption spectra
5. Measurement of hill reaction activity by Winkler's method; Effect of light wavelength and light intensity
6. Assay of auxin activity by Avena hypocotyl elongation
7. Assay of amylase induction by GA in plant tissues
8. Assay of effect of cytokinin on chlorophyll degradation by leaf disc method.

Recommended Books and References:

1. Aducci P. (1997). Signal Transduction in Plants. Birkhauser Verlag.
2. Annual Reviews of Plant Physiology and Molecular Biology. Academic Press (Annual Series)
3. Bernle J. D. and Black M. (1992). Seed Physiology and Biochemistry. Springer-Verlag.
4. Buchanan B.B., Wilhelm G. and Russel J. (2003). Biochemistry and Molecular Biology of Plants. ASPB. US.
5. Dennis D. T. (1997). Plant Metabolism. John Wiley.
6. Dey P. M. and Harborne, J. B. (2000) Plant Biochemistry. Acadmeic Press.
7. Encyclopedia of Plant Physiology. Springer-Verlag. (Annual Series).
8. Gressholf P. M. (2000). Plant Biochemistry. John Wiley.
9. Goodwin T. W. and Mercer E. I. (1983). Introduction to Plant Biochemistry. Pergamon Press.
10. Hopkins W.G. and Hunter N.P. (2003). Introduction to Plant Physiology. John Wiley & Sons.
11. Krauss G. (1999) Biochemistry of Signal Transduction & Regulation. John Wiley.
12. Lender D. W. (2001). Photosynthesis. Mercel Deker.
13. Lincoln T. and Zeiger E. (2002). Plant Physiology. Palgrave Macmillian.

14. Lehniger A. L. (1993). Principle of Biochemistry. CBS.
15. Leopold A. C. and Kreidman P. E. (1980). Plant growth and development. Tata MacGraw Hill.
16. Mattoo A. K. and Shuttle, J. C. (1995). The Plant hormone Ethylene. CRC. Press.
17. Mukherji S. and Ghosh A. K. (1996). Plant Physiology. Tata- McGraw Hill.
18. Noggle G. R. and Fritz C. J (1989). Introductory Plant Physiology. Prentice Hall
19. Seigler D. S. (1994). Plant secondary metabolism. Narosa
20. Srivastava H. S. (1994). Plant Physiology. Rastogi and Co.
21. Thomas B. and Vince-Prue D. (1997). Photoperiodism in plants. Academic Press.

SEMESTER – IV

MBOC 4.11
PLANT REPRODUCTIVE BIOLOGY

Theory Credit: 4

UNIT I **Development of Reproductive Structures:** Male gametophyte: Structure of anther, anther wall, tapetum, Ubisch bodies, pollenkitt, microsporogenesis, microgametogenesis, pollen sterility. Female gametophyte: Ovule types, megasporogenesis, megagametogenesis, organisation of embryo sacs, structure of embryo sac cells, types of embryo sacs, haustorial behaviour of embryo sac.

UNIT II **Pollination and Fertilization:** Pollination types, contrivances of self and cross pollination, pollination mechanisms and vectors, pollen germination, pollen tube growth and guidance, pollen-pistil interaction, self-incompatibility, methods to overcome incompatibility, double fertilization.

UNIT III **Fruit and Seed Development:** Endosperm development and types, embryogenesis, suspensor, seed development, polyembryony, apomixis, parthenogenesis and parthenocarpy. Fruit development and growth. Importance and types of seed dormancy, overcoming seed dormancy, seed germination.

UNIT IV **Introduction to Palynology:** Scope and branches, pollen morphology, pollen units, polarity and symmetry, NPC-system, sporoderm stratification, exine ornamentation and sculpturing, pollen chemistry, palynotaxonomy.

UNIT V **Applied Palynology:** Bee colony, foraging behaviour of bees, unifloral and multifloral honey, physical and chemical characteristics of honey, application in crop productivity. Pollen viability, pollen storage and their significance. Pollen and spore allergy, pollen analysis, pollen calendar and importance.

MBOC 4.12
PLANT REPRODUCTIVE BIOLOGY (PRACTICAL)

Practical Credit: 2

Practical

1. Study of microsporogenesis in sections of anthers.
2. Preparation of dissected whole mounts of endothecium, tapetum and ovule
3. Study of nuclear and cellular endosperm and embryo through dissections and staining
4. Examination of modes of anther dehiscence and collection of pollen grains for Microscopic examination (maize, grasses, *Crotolaria, Tradescantia, Brassica, Petunia, Solanum* etc.).
5. Test for pollen viability using stains and in vitro pollen germination and percentage using hanging drop and sitting drop cultures, suspension culture and surface culture
6. Estimation of percentage and average pollen tube length in vitro
7. Study of ovules and embryo sacs.
8. Field study of types of flowers and pollination mechanism.
9. Study of unifloral and multifloral honey.
10. Study of pollen units.
11. Study of pollen morphology by Acetolysis method.

Recommended Books and References:

1. Bhattacharya, Hait & Ghosh. 2013 (Reprint). A text Book of Botany.
2. Bhattacharya, K., M R Majumdar and S G Bhattacharya 2006: A Text book of Palynology.
3. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised andenlarged edition). Vikas Publishing House, New Delhi.
4. Erdtman, G.1988 : Pollen morphology and plant taxonomy.
5. Fageri, K and J Inversen, 1964: Text book of pollen analysis.
6. Heslop-Harrison, Y. 1971: Pollen development and physiology.
7. Johari, B M. 1963: Experimental embryology of vascular plants.
8. Maheshwari, P. 1950: An introduction to the embryology of Angiosperm.
9. Maheshwari, P.1963: Recent advances on the embryology of Angiosperm.
10. Nair, P K K1964: Advances in Palynology.
11. Nair, P K K1966 : Essentials of Palynology
12. Pandey and Chadha, 1992: Plant Anatomy and Embryology.
13. Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge
14. Raven, P.H., Evert, R.F. and Eichhorn, S.E. 1992. Biology of Plants (5th Edition).worth, NewYork.
15. Shivanna K R and B M Johari, 1985: The Angiosperm Pollen, structure and function.
16. Shivanna K R and N S Rangaswami1992: Pollen Biology, A Laboratory manual.
17. Shivanna, K. R. and B M Johari 1989: The Angiosperm pollen, structure
18. Shubhrata R Mishra 1993Morphology of Plants.
19. Stanley, R G and F.L. Linkens 1974: Pollen biology, Biochemistry management
20. Tilak, S T. 1989: Airborne pollen and fungal spores.

MBOC 4.21
ECOLOGY AND ECOSYSTEM ANALYSIS

Theory Credit: 4

UNIT I Ecosystem concept, ecosystem organization. Concepts relating to limiting factors; environmental factors-soil, water, light,temperature and fire.

UNIT II Population ecology: Population concept, Population growth; survivorship curves and life-table analysis; population dynamics and plant population regulation; Life history strategies, r & k selection; population interactions with emphasis on resource competition and allelopathy, ecotypes. Ecological niche (niche width and overlap, fundamental and realized niches).

UNIT III Community Ecology: Structure and attributes of plant community, life forms and biological spectrum, species dominance, keystone stone species and species diversity (α, β, γ), edge effect and ecotone; measures of biodiversity and biodiversity indices.

UNIT IV Ecosystem functions: Primary productivity and its measurement; Primaryproductivity of terrestrial and aquatic ecosystems of the world;

energy dynamics: trophic organization, energy flow pathways, ecological efficiencies. Decomposition: mechanism and controlling factors. Biogeochemical cycles with particular reference to cycling of carbon, nitrogen, phosphorus and sulphur.

UNIT V Ecosystem dynamics: development of ecosystem; Ecological succession - models and mechanisms of ecological succession changes in ecosystem properties during succession, concept of climax; Ecosystem stability- ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecosystem resistance and resilience.

MBOC 4.22
ECOLOGY AND ECOSYSTEM ANALYSIS (PRACTICAL)

Practical Credit: 2

1. Study of interactions between plants and environment
    a. Study of microclimatic conditions in open and closed communities
    b. Study of plastic response of plant species under contrasting environmental conditions
2. Study of physico-chemical properties of soil;
    (a) texture, (b) porosity, (c) water holding capacity (d) organic matter content
3. Study of analytical characters of plant community using plot and plot-less methods
4. Study of survivorship plant populations and life-table analysis
5. Estimation of phytomass and its distribution in different compartments in grassland communities
6. Determination of leaf-area index in the grassland community
7. Estimation of primary productivity of plant community by (a) harvest method, and (b) light and dark bottle method
8. Estimation of rate of carbon dioxide evolution from different soils by alkali absorption method

Recommended Books and References:

1. Anderson J. M. and Ingram J.S. I (1993). Tropical soil biology and fertility: A handbook of methods. CAB International.
2. Begon M.Harper J.L. and Townsend C. R. (1990). Ecology: Individual, Populations and Communities. Blackwell Scientific Publisher.
3. Daubernmire R. (1974). Plants and environment. John Wiley & Sons.
4. Hanson H. C. and Churchill E. D. (1963). Plant Communities. Reinhold.
5. Kormondy E. J. (1996). Concepts of ecology. Prentice-Hall.
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8. Odum E. P. (1971). Fundamentals of Ecology. W. B. Saunders.
9. Odum E. P. (1983). Basic Ecology. Holt Saunders International.
10. Odum, E. P. (1971). Fundamentals of Ecology. W. B. Saunders.
11. Poole R. W. (1974). An Introduction to Quantitative Ecology. Mc Graw Hill Inc.
12. Underwood A. J. (1997). Experiments in ecology. Cambridge University Press.
13. White J. (1985). Studies on plant demography. Academic Press.

14. Whittaker R. H. (1975). Communities and Ecosystems. McMillan.
15. Wild A. (1994). Soils and the environment. Cambridge University Press.
16. Zar J. H. (1984). Biostatistical analysis. Prentice-Hall International.

DISCIPLINE SPECIFIC ELECTIVE 1

MBOD 3.11(a)
PLANT SYSTEMATICS

Theory Credit: 4

UNIT-I: Aims and principles of plant systematics; Systems of Angiosperm Classification: Phenetic versus phylogenetic systems.
Taxometrics: Principles, Numerical taxonomy, methodology, merits and demerits.
Cladistics: Principles, cladistic approach in plant classification, methodology, merits and demerits.
Phylogenetic terms; plesiomorphic and apomorphic characters; homology and analogy; parallelism and convergence; monophyly, paraphyly, polyphyly; phylogenetic diagram; phylogenetic data analysis.

UNIT-II: Angiosperms fossil, time of origin of angiosperms, cradle of angiosperms, monophyletic verses polyphyletic origin of angiosperms; probable ancestors of angiosperms- Euanthial theory, Pseudanthial theory, Anthocorm Theory, Gonophyll Theory, herbaceous origin hypothesis; origin of monocotyledons; basal living angiosperms; Co-evolution with animals.

UNIT-III: Plant speciation: Allopatric, abrupt, sympatric, hybrid, apomictic speciation, isolating mechanisms.
Biosystematics: Introduction to biosystematics, Principles, procedures and methods in biosystematic study; biosystematic categories: Turreson categories and Danser categories; scope and significance of Biosystematics Studies.

UNIT-IV: Types of variation; variance analysis; reproductive system types; outbreeding; Hybridization introgressive hybridization; recognition of hybrids; stabilization of hybrids; outbreeders with internal barriers; inbreeding. Evolution-mutation; random genetic drift; natural selection; Darwinian fitness and fitness coefficient; molecular evolution.

UNIT- V: Modern Trends in Angiosperm Taxonomy:
Embryology in relation to taxonomy; Anatomy in relation to taxonomy; Palynotaxonomy; Cytotaxonomy; Chemotaxonomy; Molecular Systematics.

MBOD 3.12(a)
PLANT SYSTEMATICS (PRACTICAL)

Practical Credit: 2

- Identification of key characters of families studied and construction of keys.
- Palynotaxonomy – Study of pollen characters of taxonomic significance.
- Study of different types of ovules and placentation
- Describing new taxon.
- Study of weeds found in the region.

Recommended Books and References:

1. Angiosperm Phylogeny Group (2003) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
2. Cracknell AP, Hayes L (2009) Introduction to Remote Sensing. CRC Press, Boca Raton, USA (Special Indian Edition).
3. Crawford DJ (2003) Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
4. Cronquist A (1981). An integrated system of classification of flowering plants. ColumbiaEvolution. Taylor and Francis, London.
5. Jain S.K. (1995). Manual of Ethnobotany. Scientific Publisher; Second edition (1995).
6. Judd WS, Campbell CS, Kellogg EA, Stevens PA and Donoghue MJ (2002). Plant Systematics: A Phylogenetic Approach. Sinauer Associaes, Inc., Massachusetts.
7. Nei M and Kumar S (2000). Molecular Evolution and Phylogenetics. Oxford University Press, New York.
8. Raven PH, Begr LR, Hassenzahl DM (2008). Environment. 6th edition. John Wiley & Sons, Inc., New York.
9. Semple C and Steel MA (2003). Phylogenetics. Oxford University Press, Oxford. 10. SimpsonMG (2006). Plant Systematics. Elsevier, Amsterdam.

MBOD 3.11(b)
MEDICINAL PLANTS

Theory Credit: 4

UNIT I Introduction: Medicinal plants, Ayurveda - Basic concepts, Tibetan system of medicine, Unani system of medicine, Siddha system of medicine, Medicinal plants in Homoeopathy system. Medicinal plants classification, Diseases of medicinal plants.

UNIT II Medicinal value of food plants (only a couple of examples): cereals, pulses, spices, fruits, vegetables and wild food plants. Medicinal and nutritive values of mushrooms.

UNIT III Herbal remedies: Plants used for treatment of heart and blood circulation, nervous 23 disorders, respiratory and intestinal disorders, jaundice, urinary, skin, hair, diabetics, cancer, gynecological disorders and infertility. Plants used as general tonics.

UNIT IV Ethno-botany and ethno-medicine: Importance of Ethno-botany and ethno-medicine in modern health care system, methods of collecting traditional knowledge on medicinal plants. Primary and secondary metabolites.

UNIT V Medicinal plants of Northeast India with special reference in Nagaland: identification and uses of at least ten plants.

MBOD 3.12(b)
MEDICINAL PLANTS (PRACTICAL)

Practical Credit: 2

Practical

1. Collection and identification of medicinal plants
2. Qualitative analysis of primary and secondary metabolites
3. Estimation of flavonoids
4. Estimation of phenol
5. Separation of secondary metabolites (TLC)
6. Pharmacological and Pharmacognostic analysis of crude plant drug

Recommended Books and References:

1. Harborne, J. 1984. Phytochemical methods. Ed Chapman & Hall, London
2. Kirtikar K.R. and Basu, B. D. 1932. Indian Medicinal Plants.
3. Maheshwari, J. K. 2000. Ethno-botany and Medicinal Plants of Indian Subcontinent, Scientific Publishers, India.
4. Mann, J., Davidson, R. S., Hobbs, J. B., Benthorpe, D. V, and Harborne Natural Products, Longman Scientific and Technical Co., Essex.
5. Nadkarni, A. K. 1954. Indian Materia Medica Vol. I & II.
6. Prajapati et al., 2003. A Hand Book of Medicinal plants - A complete Source Book. Agrobios, Jodhpur, India.
7. Prajapati., Purohit., Sharma and Kumar. 2007. Hand Book of Medicinal Plants: A complete Source Book, Agrobios India.
8. Rastogi R. P. and Meharota B. N. 1991. Compendium of Medicinal Plants. Vol. I & II. 1993. CDIR, Locknow and publication and information directorate New Delhi India.
9. Sivarajan, V.V. and Indira, B. 1994. Ayurvedic drugs and their plant sources. Oxford & IBH publishing Co., New Delhi
10. Smith, P.M 1976. The Chemotaxonomy of Plants. Edward Arnold, London.
11. Trease, G, E. and Evans, W. L, 1983. Pharmacognosy 12th ed. Baillie Tindal, London
12. Vaidya, B, 1982. Some controversial drugs in Indian Medicine. Chaukamba Oriental, Varanasi

MBOD 3.11(c)
BIODIVERSITY AND CONSERVATION

Theory Credit: 4

UNIT I Species concept: Concept and importance of biodiversity, Earth summit 1992, and Agenda 21, species diversity, genetic diversity, ecosystem diversity,

UNIT II Biodiversity of the world and India, Hotspots of world and India, Mega biodiversity centers of world and India. Origin centers of crop plants.

UNIT III Loss of Biodiversity: Casual factors of threat, Impact of habitat loss and habitat fragmentation, Categories of treat endangered, vulnerable, rare, threatened and extinct. Red Data Book. Environmental impact assessment,

sustainable development.

UNIT IV Biodiversity Conservation: Objectives, implication and action plans, International and National organizations for conservation of natural resources, *in situ* conservation – protected areas, biosphere reserves, national parks, sanctuaries and sacred groves, *ex situ* – conservation, botanical gardens, gene banks, medicinal conservation parks, herbal gardens.

UNIT V Biodiversity conservation Legal aspects: Legal aspects of biodiversity in India. Policy and priority setting. Biodiversity conservation future strategies for India.

MBOD 3.12(c)
BIODIVERSITY AND CONSERVATION (PRACTICAL)

Practical Credit: 2

Practical:

1. Field survey of important plants of the region.
2. Study of the characters and threatened plants included in the theory.
3. Survey of important timber yielding trees of the region.
4. Determination of the minimum size of the quadrat suitable for an area using 'species area curve' method.
5. Determination of Importance Value Index (IVI) of the plant species in the community by quadrant method.
6. Study of Phytogeographic maps of world and India.
7. Map of Hot spots, Continental drift.

Recommended Books and References:

1. CSIR 1986. The Useful Plants in India.
2. Glasson, J., Therivel, R. & Chadwick, A. 1995. - Introduction to environment impact assessment. UCL Press Ltd., London.
3. Heywood, V.H. & Wyse Jackson, R.S. (eds.), 1991. - Tropical Botanical Gardens- their role in conservation and development. Academic Press, San Diego.
4. Heywood, V.M. and Watson, R.T. 1985. Global Biodiversity Assessment, Cambridge Univ. Press, Cambridge.
5. Kothari, 1987. Understanding biodiversity, life sustainability and equity, Orient Longman.
6. Nayar, M.P. & Sastry, A.R.K. 1987, 1989, 1990. - Red Data Book of Indian Plants (3 vols.).
7. Nayar, M.P. 1996. - Hot spots of endemic plants of India, Nepal, and Bhutan. TBGRI, Trivandrum.
8. Negi, S.S. 1993. Biodiversity and its Conservation in India.
9. Peter B. Kaufman et al., 1999. Natural Products from Plants.
10. Richard B. Primack. 1993. Essentials of Conservation Biology. 6. Heywood, V.H. & Watson, R.T. 1995. Global Biodiversity Assessment.
11. Swaminathan, M.N. & Jain, R.S. Biodiversity: Implications for global security, Macmillan, 1982.
12. Walter, K.S. & Gillett, H.J. 1998. - IUCN Red List of threatened plants. The World Conservation Union, Cambridge.

DISCIPLINE SPECIFIC ELECTIVE 2

MBOD 3.21(a)
RESEARCH METHODOLOGY&BIOSTATISTICS

Theory Credit: 4

UNIT I Research Principles

Meaning of research; objectives of research; Types of research: descriptive, analytical, applied, fundamental, quantitative, qualitative, conceptual, empirical and other types of research; identifying research problems and approaches; research methods vs. Methodology; research and scientific method; research process: steps of research process; case study; criteria of good research.

UNIT II Research Ethics

Intellectual property and protection of intellectual property rights; International horrmonization of patent laws: TRIPS, India and TRIPS; Protection of biotechnological inventions.

Plant breeder's rights; Management of IPR; Benefits and problems from IPR; Geographical Indications; International convention on biological diversity (ICBD). Copyrights, Trade Marks; protection of plant variety and farmers rights PPVFR. Acquisition and management of IPRs.

UNIT III Experiment Design& Data Collection

Introduction to experiment design; Unpaired and paired designs; completely randomized design; randomization complete block design; factorial designs; and split-plot design; Null and alternative hypotheses; Sampling, Sample size determination;dependent and independent variables;Primary and secondary data; plan for data collection; methods of data collection; Plan for data processing and analysis.

UNIT IV Statistical Analysis

Introduction to statistical software; Calculating means, median, standard deviation, standard error, frequency distribution, coefficient of variance, degrees of freedom;Concept of normality, *p*-value, confidence interval, outliers, correlation, test of independence, test of homogeneity; Mean comparison procedures; Test of significance: Students' 't' test, Z test,chi square test;Analysis of variance and 'F' test; Type I & Type II errors; Correlation and regression analysis.

UNIT V Scientific writing

Meaning of Scientific and non-scientific writings; Structures of Research proposals, Synopsis, Dissertations, Thesis, Research paper writings (Abstract, Introduction, Review literature, methodology, Results, Discussions, Summary, Conclusion, Bibliography); Presentations: Graphical, Tabular, Animation, Power point. Scientific paper presentation in seminar and conference: oral and poster.

MBOD 3.22(a)
RESEARCH METHODOLOGY & BIOSTATISTICS (PRACTICAL)

Practical Credit: 2

Practical:

1. Laboratory on handling data analysis software.
2. Laboratory on scientific writing.
3. Laboratory session on peer review.
4. Laboratory of poster preparation.
5. Seminary presentation

Recommended Books and References:

1. Research Methodology - Methods and Techniques, Kothari, C.R., 2004 (2011), New Delhi,Wishwaprakashan.
2. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: ACompendium on Law and Policies. Daya Publishing House, New Delhi.

MBOD 3.21(b)
METHODS IN PLANT SCIENCES

Theory Credit: 4

UNIT I Microscopy: Micrometry, different types of microscopes & their working. Microbial Techniques: Sterilization methods, Fungal and bacterial stains, isolation from soil, air, water and other substrates. Dilution plate technique, Culture media, single spore isolation.

UNIT II Chromatography: Principle, Classification of Chromatographic methods, Paper Chromatography, Thin layer Chromatography (TLC), Column Chromatography, Gas Chromatography, High performance Liquid Chromatography – Application of Chromatography. Centrifugations: Introduction, Centripetal & Centrifugal force; Factors affecting Sedimentation, Sedimentation coefficient and Sedimentation constant, different types of Centrifuges.

UNIT III pH & pH Meters: Introduction, Glass electrode, Reference electrode, Combination Electrode, working of PH meter Electrophoresis: Introduction, Principles, Component of an Electrophoresis Unit, Factors affecting Electrophoretic mobility, Support medium Buffers, Different types of Electrophoresis and their applications, Blotting techniques.

UNIT IV Spectroscopy: Introduction, Principle of Beer- Lamberts Law, Colorimetry & Spectrophotometry, ultra violet and visible spectroscopy (UV-VIS) Flame photometry, Spectroscopy.

UNIT V Polymerase Chain Reaction: Principle and working mechanism. The cycling reactions, constraints in PCR, Inverse PCR, RT-PCR, Real time PCR, - Applications of PCR techniques. Nuclear Magnetic Resonance (NMR), Mass Spectrometry (MS), Infra- Red Spectrometry (IR) and Flow cytometry.

MBOD 3.22(b)
METHODS IN PLANT SCIENCES (PRACTICAL)

Practical Credit: 2

Practical:

1. Demonstration of sterilization methods
2. Isolation of bacteria and fungi from soil and plant parts
3. Demonstration of serial dilution technique
4. Demonstration of pH meter,
5. Demonstration of UV-Visible spectra,
6. Demonstration of Chromatography
7. Demonstration of PCR
8. Chromatography – separation of pigments

Recommended Books and References:

1. Birren B. E. et al., (2006): Genome Analysis – A Laboratory manual Vol.-I: Analyzing DNA. Panima Publishing House (reprinted) New Delhi/Bangalore.
2. Bold. R. W., and Primerose, S. B. Principles of gene manipulation- An introduction to genetic engineering. Black Well Scientific Publications. London, Edinbarg, Boscon,
3. C. T. Ingold. Funal spores, their liberation and dispersal oxford University Press, London. (1971)

4. Datta, A. (2009). Experimental Biology-A Laboratory Manual. Narosa Publishing house New Delhi.
5. Gurumani, N. (2006). Research methodology for Biological Sciences M.J.P.
6. Introduction to plant Biotechnology Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
7. K. R. Aneja. Experiments in microbiology, Plant Pathology and Tissue culture, Wiswa Prakashan, New Delhi, (1993) 16. V. N. Pathak. Laboratory Manual of Plant Pathology (2Ed.) Oxford and IBH Publishers, New Delhi (1984)
8. Marimuthu, R. (2011). Microscopy and microtechnoques.
9. P. H. Gregery. Microbiology of Atmosphere (2 Ed.) Leonard Hill Books 24 market Square, Aylesbury, Bucks (1961)
10. Pratibha Devi (2000). Principles and Methods of plats molecular Biology, Biochemistry and Genetics. Agrobios (India).
11. Purohit S.D. (2007). Molecular Biology and Biotechnology-A practical manual. Apex Publishing house, Udaipur/Jaipur
12. R. T. V. Fox. Principle of diagnostic techniques in pant pathology CAB International, Wallingford, UK. (1993).
13. Rick Wood D and Hames B. D. (1990). Gel electrophoresis of Nucleic acid – A practical approach. III edition IRL presses Oxford. New York.
14. Shukla, Y. M. Dhruve, J. J. Patel. N. J. Bhatnagar, R. Talati, J. G. and Kathiria K. B. (2009). Plant Secondary Metabolites New India Publishing House New Delhi.
15. Veera kumari, (2006). Bioinstrumentation MJP Publication.

MBOD 3.21(c)
AGROECOSYSTEMS – PRINCIPLES AND APPLICATIONS

Theory Credit: 4

UNIT I Concept of agroecosystem; experimentation in agriculture; basic chemical process- carbon cycle; Climate and adaptation of agricultural crops; Physical factors affecting crop-water; Energy flow in agroecosystems; Plant succession and competition;

UNIT II Cropping systems and agro-ecosystems in the landscape; crop rotation and cover crops; Intercropping; conservation tillage; Dry-land agriculture, irrigation and salinity; Tropical agro-ecosystems; intensive agriculture.

UNIT III Soil type and soil properties; Nitrogen in agroecosystems; application of fertilizers; Macro and micronutrients and their availability to crops; Decomposition: beneficial soil organisms; Mulches and organic amendments.

UNIT IV Weed ecology and management; Distribution and sampling of agricultural pests; introduction to insects; pesticides and the environment; traditional knowledge systems and agrodiversity management.

UNIT V Plant disease and environment; integrated pest management; plant-parasitic nematodes; host plant resistance and conservation of genetic

resources; impact of GMOs on crop biodiversity and agroecology; Food production and security; sustainable agriculture.

MBOD 3.22(c)
AGROECOSYSTEMS – PRINCIPLES AND APPLICATIONS (PRACTICAL)

Practical Credit: 2

Practical:

1. Soil sampling and analysis for macro and micro nutrients
2. Plant water requirement assessment
3. Assessment of fertilizer inputs on crop growth
4. Assessment of planting density on crop growth
5. Ecological foot print analysis

Recommended Books and References:

1. Gliesmann, S.R. (2006). Agroecology: The Ecology of Sustainable Food Systems.
2. Technology & Engineering.
3. Gliesmann, S.R. (2006). Field and Laboratory Investigations in Agroecology. Technology & Engineering.
4. Paul A. Wojtkowski, P.A. (2004). Landscape agroecology, Haworth Press, Inc., New York. 330 pp.
5. Warner, K.D. (2007). Agroecology in Action: Extending Alternative Agriculture Through Social Networks. The MIT Press, Cambridge, Massachusetts, USA, 291 pp.

DISCIPLINE SPECIFIC ELECTIVE 3

MBOD 4.11(a)
PLANT RESOURCE UTILIZATION

Theory Credit: 4

UNIT I **Plant Resources:** Diversity and distribution of exploited/underexploited/unexploited plants of economic value of Himalaya and the north eastern region; Use of plants by indigenous communities in Himalaya and the north eastern India for subsistence, medicine and cultural and religious rituals; value addition and product development of some economically important plants.

UNIT II **Ethnobiology & Ethnopharmacolgy of North East India:** Major ethnic group in North East India, their social institutions, livelihood, cultural and religious practices Shamanism and other belief systems, sacred groove and methods of biological resource conservation. Current status of Ethnobiology. Role of Ethnobotany in drug discovery. Ethnopharmacological validation of traditional medicine; approaches to drug discovery from ethnobotanical leads.

UNIT III **Traditional Knowledge:** Traditional knowledge system of plant resource

utilization by the indigenous communities of Nagaland. Application and practices of traditional knowledge system in agriculture, healthcare and livelihood with reference to plant resources. Traditional methods of soil conservation in agricultural lands. Sustainable utilization of biological resources and protection of traditional knowledge.

UNIT IV **Forest Resources of Nagaland:** Management of timber yielding plants: *Phoebe*spp (bonsom). *Duabanga grandiflora*, *Pinus* spp. *Tectonagrandis*. Management of firewood: *Quercus* spp., *Castanea* spp. (chestnut), *Alnusnepalensis* (alder), *Schimawallichi*.
Production, processing and management of bamboo species and canes Management of other forest resources: edible wild fruits, vegetable, fodder, mushrooms, and economically beneficial products.

UNIT V **Plant Resource Monitoring:** Human impacts on natural ecosystems - forest, grassland and mountain ecosystems; Soil erosion and its control; Shifting cultivation and its ecological implications; Biosafety and Environmental Monitoring of GEMs; Bio-pesticides; Bioconversion of waste products by microbes with special reference to biogas; Intellectual Property Rights in Biotechnology. Principles of bioprocess control, products with representative examples.

MBOD 4.12(a)
PLANT RESOURCE UTILIZATION (PRACTICAL)

Practical Credit: 2

Practical

1. Case study on Bamboo & canes utilization in Nagaland.
2. Case study on forest resources.
3. Field visits to identify and tabulate some traditional plant resource of local importance in Nagaland.
4. Preparation of herbarium on some ethnobotanically important plants.

Recommended Books and References:

1. Sapu Changkija and P. B. Gurung. 2017. Flora of Nagaland. Volume I &II. Department of Forest, Environment and Climate Change, Government of Nagaland.
2. Deorani S. C.., Sharma, G. D. 2007. Medicinal Plants of Nagaland. BSMPS, Dehra Dunz.
3. Nagaland Bioresource Mission, "Plant resources of Nagaland".
4. Kirtikar, K. R. and Basu, B. D. 1935. Indian Medicinal Plants. Lalit Mohan Basu; Allahabad

MBOD 4.11(b)
PHYTOGEOGRAPHY AND EVOLUTION

Theory Credit: 4

UNIT I Phytogeographical regions of the World. India: Western Himalaya, Eastern Himalaya, Indus plane, Gangetic sub-mountain zone, Temperate zone, Alpine zone. General characters of flora of India. Native taxa, naturalization of exotic taxa.

UNIT II Floristics: Floristic study of the world and India. Continental drift: A general account, tectonic movements, disjunct distribution, dispersal, migration and endemics.

UNIT III Patterns of geographic distribution, Disjunction and Vicariance, Vicariance biogeography, Endemism, Centres of diversity; Major plant communities; Type of Vegetation distribution in India and Nagaland.

UNIT IV Darwin and origin of species, models of speciation- Allopatric speciation, Sympatric speciation, Statispatric speciation. Isolating mechanism and rate of speciation. Genetic variation-inbreeding depression, protein polymorphism, variation in nucleotide sequences. Formation of species.

UNIT V Evolution of sex in plants-Asexual reproduction, origin and evolution of sex organs, alternation of generations. Parthenogenesis and its applications.

MBOD 4.12(b)
PHYTOGEOGRAPHY AND EVOLUTION (PRACTICAL)

Practical Credit: 2

Practical:

1. Floristic regions of India.
2. Evolutionary concepts
3. Drawing maps of continental drift
4. Listing plants of GUG campus
5. Listing of wild edible plants
6. Studying species distribution and its measurements
7. Examples of exotic / invasive species

Note:

- Submission of 5 maps / photographs / herbaria during practical Examination
- Botanical Study Tour of about seven days is compulsory.

Recommended Books and References:

1. Walter's Vegetation of the Earth: Ecological Systems of the Geo-Biosphere (4th Edition) by Heinrich Walter, Siegmar-Walter Breckle. Paperback - October 2002
2. Edible Wild Plants of the Prairie: An Ethnobotanical Guide by Kelly Kindscher (1987)
3. Advanced Plant Geography Author:Shiv Manikant Dube. 2011 Swastik

Publications.
4. Textbook of the Plant Geography of India. by F.R. Bharucha
5. Plant geography by George Simonds Boulger (Jan 1, 1912)

MBOD 4.11(c)
BIOFERTILIZERS AND BIOPESTICIDES

Theory Credit: 4

UNIT I Biofertilizers – Definition, Classification, Advantages and Constraints. Role of biofertil izers in modern agriculture. Bacterial biofertilizers - A general account of Azospirillum, Azotobacter, Frankia, Phosphobacteria and Rhizobium. Mass production of Azospirillum, Azotobacter and Phosphobacteria.

UNIT II Cyanobacteria (BGA) as biofertilizers - A general account of Anabaena, Cylindrospermum, Gloeocapsa, Lyngbya, Nostoc, Plectonema and Tolypothrix. Symbiotic association of Cyanobacteria. Field application of Cyanobacterial inoculants. Azolla as biofertilizer.

UNIT III Mycorrhizae as biofertilizers - A general account and applications of mycorrhizae. Methods of collection, wet sieving and decanting method and inoculum production. Culturing of mycorrhizae in Modified Melin - Norkrans (MMN) agar medium. Applications of Mycorrhizae. Trichoderma as biofertilizer.

UNIT IV Biopesticides - Uses and limitations of Biopesticides and their application. Advantages over chemical pesticides. Biocontrol of plant diseases. Cross protection. Fungal and Bacterial Biopesticides – Trichoderma, Bacillus thuringiensis. Bioinsecticides – Insecticidal plants (Neem and others). Virus, bacteria and fungi as insecticides.

UNIT V Organic Manure: Green manure, organic fertilizers, recycling of biodegradable municipal and agricultural wastes, methods of biocomposting, types and methods of vermicomposting.

MBOD 4.12(c)
BIOFERTILIZERS AND BIOPESTICIDES (PRACTICAL)

Practical Credit: 2

Practical

1. Isolation and culturing of Cyanobacteria (BGA)- Anabaena, Cylindrospermum, Gloeocapsa, Lyngbya, Nostoc, Plectonema and Tolypothrix.
2. Cultivation of Azolla
3. Isolation of Nitrogen fixing bacteria - Azobacter and Azospirullum
4. Demonstration and isolation of root nodules (Rhizobium)
5. Isolation and identification of fungal and insect biocontrol agents
6. Isolation and culturing of Aspergillus, Trichoderma and Bacillus sps.
7. Experiments on Fungal and bacterial Antagonism 8. Trap crops, mixed crops and crop rotation in Gulbarga Region
8. Demonstration of procedure for vermicomposting.

Recommended Books and References:

1. Agrios, G. N. Plant Pathology, Fourth Edition 1997, Academic Pre
2. Dubey, R. C. (2008): A Textbook of Biotechnology. S. Chand & Co., New Delhi.
3. Ilan chet (Ed.). Innovative Approaches to plant disease Control. Wiley Inter Science Publication, Ihon Wiley and Sons New York (1987)
4. Newton, W. E. et al. (1977): Recent Developments in Nitrogen Fixation. Academic Press, New York.
5. Schwintzer, C. R. and Tjepkema, J. D. (1990): The Biology of Frankia and Actinorhizal Plants. Academic Press Inc., San Die go, USA.
6. Stewart W. D. P. and Gallon J. R. 1980): Nitrogen Fixation. Academic Press, New York.
7. Subba Rao, N. S. (1982): Advances in Agricultural Microbiology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
8. Subba Rao, N. S. (2002): Soil Microbiology. 4th ed. Soil Microorganisms and Plant Growth. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Subba Rao, N. S. and Dommergues, Y. R. (1998): Microbial Interactions in Agriculture and Forestry. Vol. I, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
10. Verma, A. (1999): Mycorrhiza. Springer Verlag, Berlin. 17 9. Wallanda, T. et al. (1997). Mycorrhizae. Backley's Publishers, The Netherlands.

DISCIPLINE SPECIFIC ELECTIVE 4

MBOD 4.21 DISSERTATION

Credit: 6

Total Max. Marks-150

The Department offers following specializations for dissertation at M. Sc. Part-II:

1. Higher Plant Ecology
2. Taxonomy and diversity of angiosperms
3. Development and Reproduction of angiosperms
4. Lower plants
5. Plant pathology
6. Applied botany
7. Ethnobotany
8. Economic botany
9. Plant Tissue Culture
10. Molecular Biology
11. Microbiology

- The dissertation topics will be allocated based on the merit, willingness and availability of seatsoffered by the Department of Botany.
- The synopsis for the dissertation must obtain approval of board of studies.
- The dissertation work has to be defended through viva voce.
- The preliminary copy of dissertation must be approved by the board of studies to appear for vivavoce.
- The final copy of the dissertation has to be submitted to the department within one week afterthe viva voce.