Annex 1

UNIVERSITY OF RAJASTHAN

JAIPUR

BOTANY

SYLLABUS SEMESTER SCHEME

I, II, III, IV

SESSIONS 2012-2014

UNIVERSITY OF RAJASTHAN

(2)

M.Sc. BOTANY SEMESTER SCHEME (SESSIONS 2012-2014)

FIRST SEMESTER

Paper	NAME OF COURSE
I	CELL BIOLOGY
II	MOLECULAR BIOLOGY
III	GENETICS & PLANT BREEDING
IV	ALGAE, FUNGI & BROYOPHYTA
	PRACTICALS

SECOND SEMESTER

Paper	NAME OF COURSE
V	PTERIDOPHYTA, GYMNOSPERMS & PALEOBOTANY
VI	TAXONOMY OF ANGIOSPERMS
VII	MICROBIOLOGY
VIII	PRINCIPLES OF PLANT PATHOLOGY
	PRACTICALS

THIRD SEMESTER

Paper	NAME OF COURSE
IX	PLANT PHYSIOLOGY & METABOLISM
X	PLANT MORPHOLOGY & DEVELOPMENTAL ANATOMY
XI	PLANT ECOLOGY
XII : ELECTIVE PAPERS	A. ADVANCED PLANT PATHOLOGY-I B. SEED SCIENCE & TECHNOLOGY -I C. ENVIRONMENTAL BIOLOGY & ARID ZONE ECOLOGY-I D. ADVANCED PLANT PHYSIOLOGY-I E. ADVANCED MORPHOLOGY & MORPHOGENESIS-I F. BIOSYSTEMECS OF ANGIOSPERMS-I
	PRACTICALS

FOURTH SEMESTER

Paper	NAME OF COURSE
XIII	PLANT REPRODUCTIVE BIOLOGY
XIV	PLANT RESOURCE UTILIZATION & ETHONOBOTANY
XV	PLANT BIOTECHNOLOGY & GENETIC ENGINEERING
XVI: ELECTIVE PAPERS	A. ADVANCED PLANT PATHOLOGY-II B. SEED SCIENCE & TECHNOLOGY -II C. ENVIRONMENTAL BIOLOGY & ARID ZONE ECOLOGY-II D. ADVANCED PLANT PHYSIOLOGY-II E. ADVANCED MORPHOLOGY & MORPHOGENESIS-II F. BIOSYSTEMECS OF ANGIOSPERMS-II
	PRACTICALS

(3)

Semester: I

BOT 101 : CELL BIOLOGY

Introduction to modern tools and techniques of cell biology: advances in light and electron microscopy, techniques supplementing microscopy (cytochemistry, microprobe analysis, x-ray diffraction, etc.), Cell fractionation and visualization/characterization of various cell fractions.

The Dynamics of cell, shape and motility: Structural organization of the plant cell, biochemical energetics. cytoskeleton, microtubules and microfilaments, motor and flagellar movements.

Cell wall, plasma membrane and plasmadesmata: Structure and functions, biogenesis, growth models and functions, sites for ATPases, ion carriers, channels and pumps, receptors. Role in movement of molecules and macromolecules, comparison with gap junctions.

Chloroplast and mitochondria: Structure,, Organization and function of mitochondrial and chloroplast genomes, diversity and evolution of organelle genomes, chloroplast protein targeting to different compartments, mitochondrial DNA and male sterility, transfer of genes between nucleus and organelles.

Plant vacuole: Structure and function

Other Cellular organelles: Structure and functions of micro-bodies, Golgi apparatus, ribosomes, lysosomes, endoplasmic reticulum.

Nucleus: Structure, nuclear pores, nucleosome organization, nucleolous,.

Cell cycle and apoptosis: Control mechanisms, role of cyclins and cyclin-dependent kinases, retinoblastoma and E2F proteins, cytokinesis and cell plate formation, mechanisms of programmed cell death.

Chromatin organization : Chromosome structure and packaging of DNA, molecular organization of centromere and telomere, nucleolus and ribosomal RNA genes,

euchromatin and heterochromatin, karyotype analysis, banding patterns, karyotype evolution, specialized types of chromosomes, polytene, lampbrush, B-chromosomes and sex chromosomes, molecular basis of chromosome pairing.

Suggested Laboratory Exercises

1. Modern tools and techniques of cell biology
2. EM study of cell organelles
3. Study of stages in cell cycle
4. Isolation of mitochondria and the activity of its marker enzyme, succinate dehydrogenase (SDH)
5. Isolation of chloroplasts and SDS-PAGE profile, of proteins to demarcate the two subunits of Rubisco.
6. Fluorescence staining with FDA for cell viability and cell wall staining with calcofluor.
7. Demonstration of SEM and TEM.
8. Karyotype analysis, banding patterns
9. Polytene, lampbrush, B-chromosomes and sex chromosomes.
10. Linear differentiation of chromosomes through banding techniques such as G-banding, C-banding and Q-banding.
11. Silver banding for staining nucleolus- organizing regions, where 18S and 28S rDNA are transcribed.
12. Orcein and Feulgen staining of salivary gland chromosomes of Chironomas and Drosophila.
13. Characteristics and behavior of B chromosomes using maize or other type appropriate material.

Suggested Readings :

1. Krishnamurthy, K.V. 2000. Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
2. De, D.N: 2000. Plant Cell Vacuoles: An Introduction. CSIRO Publication, Collingwood, Australia.
3. Kleinsmith, L.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology (2nd Edition). Harper Collins College Publishers, New York, USA.

4. Hall, J.L and Moore, A.L. 1983. Isolation of Membranes and Organelles from Plant Cells. Academic Press, London, UK.
5. Harris, N. and Oparka, K.J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, U.K.
6 Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function. Jones and Bartlett Publishers. Boston, Massachusetts.
7. Karp, G. 1999. Cells and Molecular Biology: Concepts and Experiments.John Wiley & Sons, Inc., U.S.A.
8. Lewin, B. 2000. Gene VII. Oxford University Press, New York, USA.

BOT 102 : Molecular Biology

Cell signaling: Hormones and their receptors, Cell surface receptors, signaling through G protein coupled receptors, signal transduction pathways, mechanism and cellular response to environmental signaling.

Cellular communication: Regulation of hematopoiesis, General principles of cell communication, Cell adhesion and role of different adhesion molecules, Gap junctions, Extracellular matrix integrins, Neurotransmission and its regulation.

DNA Replication: Prokaryotic and eukaryotic DNA replication- Unit of replicon, enzymes involved, mechanism of DNA replication origin and replication fork, fidelity of replication, accessory proteins involved in DNA replication, extra chromosomal replicon.

Structure and function of different types of RNAs- mRNA, t-RNA, r-RNA, snRNA, small nuclear proteins, ribosomes- subunits and its molecular structure and functions, Genetic code- nuclear and organelle.

Transcription: Prokaryotic and eukaryotic transcription: Transcriptional factors and machinery, RNA polymerases, regulatory elements and mechanism of transcription regulation- formation of initiation complex, transcription activators and repressors, capping, elongation, and termination, RNA processing, RNA editing, splicing, polyadenylation, RNA transport- nuclear transport of m RNA, mRNA stability.

Translation: Prokaryotic and eukaryotic translation- translational machinery, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, aminoacylation of tRNA, aminoacyl tRNA synthatase, termination of translation, regulation of translation- translational proof-reading, translational inhibitors, co and post-translational modifications of proteins.

Control of gene expression at transcription and translational level: Regulation of phages, viruses, prokaryotes and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing.

Suggested Readings:

1. Lewis, B. 2000. Genes VII. Oxford University Press, New York.
2. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of the Cell. Garland Publishing, Inc., New York.
3. Wolfe, S.L. 1993. Molecular and Cellular Biology. Wadsworth Publishing Co., California, USA.
4. Rost, T. et al. 1998. Plant Biology. Wadsworth publishing Co., California, USA.
5. Buchanan, B.B., Gruissem, W., and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, Maryland, USA.
6. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology (4th Edition). W.H. Freeman and Co., New York, USA.
7. Glick, B.R. and Thompson, J.E. 1993. Methods in Plant Molecular, Biology and Biotechnology. CRC Press, Boca Raton, Florida.
8. Glover, D.M. and Hames, B.D. (Eds.), 1995. DNA Cloning 1: A Practical Approach, Core Techniques. 2nd edition. PAS, IRL Press at Oxford University Press Oxford.
9. Hackett, P.B., Fuchs, J.A. and Messing, J.W. 1988. An Introduction to Recombinant DNA Techniques: Basic Experiments in Gene Manipulation. The Benjamin/Cummings Publishing Co. Inc., Menlo Park, California.
10. Shaw, C.H. (Ed.), 1988. Plant Molecular Biology: A Practical Approach. IRL Press Oxford.
11. Albert B. Bray, D., Lewis, J., Raff, M., Robert, K. and Watson, J.D. 1989., Molecular Biology of the Cell (2nd editions), Garland Publishing Inc., new York.
12. Malacinski, G.M. and Freifelder, D. 1998 : Essentials of molecular Biology (3rd edition). Jones and B Artlet Publishers, Inc., London.

Refer the following Review Journals:

1. Annual Review of Plant Physiology and Molecular Biology.
2. Current Advances in Plant Sciences.
3. Trends in Plant Sciences.
4. Nature Reviews: Molecular and Cell Biology.

Suggested laboratory Exercises

1. Isolation of nuclei and identification of histones by SDS-PAGE.
2. Isolation of plant DNA and its quantitation by a spectrophotometric method.
3. Isolation of DNA, and preparation of 'cot' curve.
4. Isolation of RNA and quantitation by a spectrophotometric method.
5. Separation of plant RNA by agarose gel electrophoresis and visualization by EtBr staining.
6. Southern blot analysis using a gene specific probe.
7. Northern blot analysis using a gene Specific probe.

Note : Chemicals and kits for conducting some of the above molecular biology experiments are available in India, for example from M/s Bangalore Genei and Centre for Biotechnology (CSIR), Mall Road, Delhi.

(9)

BOT 103: GENETICS AND PLANT BREEDING

GENETICS

Gene Structure and expression : Genetic fine structure, cis-trans test, fine structure analysis of eukayotes, introns and their significance, RNA splicing, regulation of gene expression in prokaryotes and eukaryotes. Panoply of operon, catabolite repression, attenuation and antitermination.

Genetic recombination and genetic mapping : Recombination, independent assortment and crossing over, molecular mechanism of recombination, role of RecA and RecBCD enzymes, site-specific recombination, chromosome mapping, linkage groups, genetic markers, construction of molecular maps, correlation of genetic and physical maps, somatic cell genetics - an alternative approach to gene mapping.

Mutations : Spontaneous and induced mutations, physical and chemical mutagens, molecular basis of gene mutation, transposable elements in prokaryotes and eukaryotes, mutation induced by transposons, site-directed mutagenesis, DNA damage and repair mechanisms, inherited diseases and defects in DNA repair, initiation of cancer at cellular level, protooncogenes and oncogenes. Sex determination, sex, linked inheritance, sex limited characters and sex reversal, multiple allele's and blood groups in man.

Structural and numerical alterations in chromosomes : Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes, Origin, occurrence, production and meiosis of haploids, aneuploids and euploids, origin and production, of autopolyploids, chromosome and chromatid segregation, allopolyploids, types, genome constitution and analysis, evolution of major crop plants, induction and characterization of trisomics and monosomics.

Molecular cytogenetics : Nuclear DNA content, C-value, paradox, cot curve and its significance, restriction mapping - concept and techniques, multigene families and their evolution, in situ hybridization - concept and techniques, physical mapping of

genes of chromosomes, computer assisted chromosome analysis, chromosome microdissection and microcloning, flow cytometry and confocal microscopy in karyotype analysis.

Plant Breeding

Genetic system and breeding methods: Reproduction and breeding systems in plants. Recombination, genetic control and manipulation of breeding systems including male sterility and apomixis. Selection and breeding strategies for self-pollinated, cross-pollinated and clonally propagated crop plants, breeding for crop quality, biotic and abiotic stresses, gene pyramiding for multi-trait incorporation.

Suggested Readings:

1. Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999. The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
2. Burnham, C.R. 1962. Discussions in Cytogenetics. Burgess Publishing Co. Minnesota.
3. Busch, H. and Rothblum, L. 1982. Volume X. The Cell Nucleus rDNA Part A. Academic Press.
4. Hartl, D.L. and Jones, E.W. 1998. Genetics : Principles and Analysis (4th edition). Jones & Bartlett Publishers, Massachusetts, USA.
5. Khush,G.S. 1973. Cytogenetics of Aneuploids. Academic Press, New York, London.
6. Lewis, R. 1997. Human Genetics : Concepts and Applications (2nd editions). WCB McGraw Hill, USA.
7. Russel, P.J. 1998. Genetics (5th edition). The Benjamin/Cummings Publishing Company INd., USA.
8. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics (2nd edition). John Wiley & Sons Inc., USA.
9. Fukui, K. and Nakayama, S. 1996. Plant Chromosomes: laboratory Methods. CRC Press, Boca ratan, Florida.
10. Sharma, A.K. and Sharma, A. 1999. Plant Chromosome Analysis, Manipulation and Engineering. Hoarwood Academic Publisher, Australia.

11. Acquaah, G. (2007). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd.,USA.
12. Allard RW (1999). Principles of Plant Breeding (2nd Edition), John Wiley and Sons, ISBN 0471023094, 9780471023098.

Suggested Laboratory Exercises:

1. Working out the effect of mono- and tri-somy on plant phenotype, fertility and meiotic behavior.
2. Induction of polyploidy using colchicines, different methods of the application of Colchicines.
3. Effect of induced and spontaneous polyploidy on plant phenotype, meiosis, pollen and seed fertility and fruit set.
4. Effect of translocation heterozygosity on plant phenotype. Chromosome pairing and chromosome disjunction and pollen and seed fertility.
5. Meiosis of comp1ex translocation heterozygotes.
6. Isolation of chlorophyll mutants. following irradiation and treatment With chemical mutagens.
7. Estimation of nuclear DNA content through micro densitometry and flow cytometry.
8. Fractionation and estimation of repetitive and unique DNA sequences in nuclear DNA.
9. Analysis of morphological and molecular diversity in different cultivars/varieties of a crop plant.

BOT 104 : ALGAE, FUNGI AND BRYOPHYTA

Algae: Algae in diversified habitats (terrestrial, fresh water and marine), thallus organization; cell ultra-structure; reproduction (Vegetative asexual and sexual); classifications of algae based on pigments, cell wall composition, reserved food material and flagellation; salient features of cyanophyta, chlorophyta, bacillariophyta, xanthophyta, pyrrhophyta , phaeophyta and rhodophyta with special reference to *Spirullina, Gelidium* , ***Nitella*** , *Pinnularia* , *Gonyaulax* , *Laminaria, Gelidium* and *Batrachospermum* ;

Economic importance of algae specially in industries, food, fodder, biofertilizers and algal blooms. Isolation and culture of algae.

Fungi: General characters; substrate relationship; cell ultra-structure; thallus organization; cell wall composition; nutrition (saprobic, biotropic and symbiotic); reproduction (vegetative, asexual and sexual),

Heterothallism; heterokaryosis; parasexuality; sex hormones. and recent trends in classification of fungi; Phylogeny of fungi.

General account of mastigomycotina, zygomycotina, ascomycotina, basidiomycotina and deuteromycotina with special reference to *Rhizopus, erenospora, Neurospora, Polyporus , Drechslera* and *Colletotrichum.*

Economic importance of fungi in industries, medicines and as food. Fungal diseases in plants and animals including humans; Mycorrhizae; fungi as biocontrol agents.

Bryophyta: Morphology, structure, distribution, reproduction and classification of bryophytes.

General account of marchantiales, jungermaniales, anthocerotales, sphagnales, funariales and polytrichales with special reference to *Plasiochasma, Notothylus* and *Polytrichum* .

Economic and ecological importance of bryophytes.

Suggested Practical exercises :

Morphological study of representative members of algae, fungi and bryophytes present in your locality in their natural habitat with special reference to:

Algae: *Microcystis* , *Spirullina* , *Duniella*, *Aulosira* ,*Oocystis*, *Spirogyra* , *Pediastrum*, *Hydrodictyon*, *Ulva*, *Pithophora*, *Stigeoclonium*, *Drapanaldiopsis*, *Closterium*, *Cosmarium*, *Nitella*, *Pinnularia*, *Laminaria*, *Gelidium* and *Batrachospermum* ; Isolation and culture of algae.

Fungi: *Stemonites*, *Peronospora*, *Pythium*, *Albugo*, *Rhizopus*, *Pilobolus*, *Yeast*, *Emericella*, *Chaetomium*, *Pleospora*, *Morchella*, *Melampsora*, *Phallus*, *Polyporus*, *Drechslera*, *Curvularia*, *Phoma* ,*Penicillium* , *Aspergilluus* ,*Colletotrichum*, *Fusarium* and *Alternaria;*

Isolation and culture of fungi using moistened blotters, PDA and Sabouraud's Dextrose Agar media.

Laboratory diagnosis of fungal diseases.

Bryophytes: *Plasiochasma* , *Pellia* , *Notothyllus*, *Andreaea* and *Polytrichum* .

Suggested Readings:

1. Alexopoulus, C.J., Mims, C.W. and Blackwel, M. 1996. Introductory Mycology, John Wiley & Sons Ind.
2. Anderson RA (2005) Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press, USA.
3. Bhatnagar SP and Moitra A (1996) Gymnosperms. New Age International (P) Limited, Publishers, New Delhi
4. Clifton, A. 1958. Introduction to the Bacteria. McGraw-Hill Book Co., New York.
5. Cole KM and Sheath RG (1990). Biology of the Red Algae. Cambridge Univ. Press, Cambridge.
6. Fritsch FE (1935, 1945). The Structure and Reproduction of Algae Vols. I and II. Cambridge University Press, Cambridge, UK.
7. Fritsch FE (1945). The Structure and Reproduction of Algae. Vol. II. Cambridge Univ. Press, Cambridge, UK.

8. Geissler and Greene SW (1982) Bryophyte Taxonomy, methods, practices and floristic exploration. J Cramer, Germany.
9. Isabella A. Abbott, George J and Hollenberg (1993). Marine Algae of California. Stanford University Press. USA.
10. Kumar, H.D. 1988. Introductory Phycology. Affiliated East-West Press Ltd., New Delhi.
11. Lee RE (1989). Phycology. Vol. II. Cambridge Univ. Press. Cambridge, USA.
12. Mehrotra, R.S. and Aneja, R.S. 1998. An Introduction to Mycology, New Age Intermediate Press.
13. Morris, I. 1986. An Introduction to the Algae. Cambridge University Press, U.K.
14. Parihar, NS (1993) An Introduction to Embryophyta: Vol I – Bryophyta, Vol II – Pteridophyta, Central Book Dept. Allahabad.
15. Parihar, N.S, 1991. Bryophyta. Central Book Depot, Allahabad.
16. Puri, P. 1980. Bryophytes. Atma Ram & Sons, Delhi.
17. Rangaswami, G. and Mahadevan, A. 1999. Diseases of Crop Plants in India (4th edition). Prentice Hall of India Pvt. Ltd., New Delhi.
18. Richardson DHS (1981) The Biology of mosses. John Wiley & Sons, Inc New York.
19. Round, F.E. 1986. The Biology of Algae. Cambridge University Press, Cambridge.
20. Sahoo D & Qasim SZ (Eds), (2002). "Sustainable Aquaculture". APH Publishing Corporation, New Delhi, India.
21. Shaw AJ and B Goffinet (2000) Bryophyte Biology. Cambridge University Press, Cambridge
22. South GR and Whittick A. (1987). Introduction to Phycology. Blackwell Scientific Publications. London.
23. Webster, J. 1985. Introduction to Fungi. Cambridge University Press.

(15)

Semester II

BOT 201: PTERIDOPHYTES, GYMNOSPERMS & PALEOBOTANY

Pteridophytes; Morphology, anatomy, reproduction; Remier's classification, distribution life history and general account of fossil Pteridophytes , Psilopsida , Lycopsida, Sphenopsida and Pteropsida classes with special reference to *Tmesipteris*. Economic importance of Pteridophytes

Morphology, anatomy, reproduction; Tippo and Chamberlain's classification, distribution life history of: *Lycopodium* ,*Gleichenia* ,*Dryopteris* ,*Isoetes* and *Ophioglossum*.

Origin and evolution of stele, heterospory and seed habit.

Gymnosperms; Morphology, anatomy, reproduction; classification, distribution, life history, evolution and economic importance.

Brief account of families of **Cycadeoidales** (*Cycadeoidea*) **Cordaitales** (*Cordaites*) and living Gymnosperms, Ginkgoales (*Ginkgo*), Coniferales (*Taxus, Araucaria, Pinus* and *Biota*.), Welwitschiales (*Welwitschia*), Gnetales (*Gnetum*).

Paleobotany; History of Paleobotany, Formation and types of fossils, techniques of study of fossils, Geological time scale. Pteridospermales (*Lygenopteris*, *Medullosa, Caytonia* and *Glossopteris*).

Paloeobotany and the evolution of vascular plants.

Applied aspects of Paleobotany; use in coal and petroleum exploration.

Suggested Laboratory Exercises:

Morphological and anatomical study of representative members of Pteridophytes and Gymnosperms in their natural habitat found in your locality with special reference to *Psilotum, Lycopodium* ,*Selaginella, Isoetes, Equisetum, Gleichenia, Pteris, Dryopteris, Adiantum* , *Ophioglossum* and *Marsilea* in Pteridophytes and *Pinus, Ginkgo, Araucaria, Taxus, Biota, Gnetum* in Gymnosperms.

Study of fossils

Suggested Readings :

1. ParihaR, N.S. 1996. Biology & Morphology of Pteridophytes Central Book Depot, Allahabad.
2. Sporne, K.K. 1991. The Morphology of Pteridophytes. B.I. Publishing Pvt. Ltd., Bombay.
3. Stewart, W.N. and Rathwell, G.W. 1993. Paleobotany and the Evolution of Plants. Cambridge University Press.
4. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms. New Age International Pvt. Ltd., New Delhi.
5. Singh, H. 1978, Embryology of Gymnosperms, Encyclopaedia of Plant Anatomy X. Gebruder Bortraeger, Berlin.
6. Smith, G.M. 1955. Cryptogamic Botany Vol. II. McGrow Hill Book Co., NY.
7. Pandey, B.P. 1993. College Botany. Vol II S. Chand and Company Ltd, New Delhi.
8. Arnold, Chester A. 2000. An Introduction to Paleobotany, Agrobios (India).

17

BOT 202: TAXONOMY OF ANGIOSPERMS

Origin of intrapopulation variation :Population and the environment, ecads and ecotypes, evolution and differentiation of species - various models. (10 hrs)

Taxonomic concepts: Taxonomic hierarchy, species, genus, family and other categories, principles used in assessing relationship, delimitation of taxa and attribution of rank. Salient features of the International Code of Botanical nomenclature. (14hrs)

Taxonomic tools : Herbarium, floras, histochemical, cytological, serological, biochemical and molecular techniques, GIS and mapping biodiversity. (14hrs)

Taxonomic evidences : Morphology, anatomy, palynology, embryology, cytology, phytochemistry, genome analysis and nucleic acid hybridization. (12hrs)

Systems of angiosperm classification : Phenetic , phylogenetic systems, salient features of the orders Helobiales and Centrospermales, cladistics in taxonomy, relative merits and demerits of major systems of classification— Cronquist, Dahlgren,Thorne, APG-II. (24 hrs)

Concepts of phytogeography : Endemism, hotspots and hottest hotspots, plant explorations, invasions and introductions with emphasis on aquatic and terrestrial systems, local plant diversity and its socio-economic importance. (8 hrs)

Phylogeny of Angiosperms : Ancestors of Angiosperms, time and place of origin of Angiosperms, Habit of Angiosperm, Primitive living Angiosperms, Inter relationship among the major groups of Angiosperms. (8 hrs)

Suggested Readings :

1. Cole, A.J. 1969. Numerical Taxonomy, Academic Press, London

2. Davis, P.H. and Heywood, V.H. 1973, Principles of Angiosperms Taxonomy, Robert E. Kreiger Pub. Co., New York.

3. Grant, V. 1971. Plant Speciation. Columbia University Press, New York.

4. Grant, W.E. 1984 Plant Biosystematics. Academic Press London.

5. Harrison, H.J. 1971 New Concepts in Flowering Plant Taxonomy. Rieman Educational Book Ltd., London.

6. Heslop-Harrison, J. 1967. Plant Taxonomy -English Language Book Soc. & Edward Arnold Pub. Ltd. U.K.

7. Heywood, V.H. and Moore, D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.

8. Jones, A.D. and Wilbins, A.D. 1971. Variations and Adaptations in Plant Species.

Hiemand & Co. Educational Books Ltd. London.

9. Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematics (2nd edition). McGraw-Hill Book Co., New York.

10. Nordenstam, B., El Gazaly, G. and Kassas, M. 2000 Plant Systematics for 21st Century. Portlant Press Ltd., London.

11. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper & Row Publications, USA.

12. Singh, H. 1978, Embryology of Gymnosperms, Encyclopaedia of Plant Anatomy X. Gebruder Bortraeger, Berlin.

13. Solbrig, O.T. 1970. Principles and Methods of Plant Biosystematics. The MacMillan Cocollier- MacMillan Ltd., London.

14. Solbrig, O.T. and Solbrig, D.J. 1979. Population Biology and Evolution, Addison-Weslley Publicating Co. Ind USA.

15. Stebbings, G.L. 1974. Flowering Plant - Evolution Above Species Level. Edward Arnold Ltd. London.

16. Stace, C.A. 1989. Plant Taxonomy and Biosysteinatics (2nd edition) Edward Arnold Ltd., London.

17. Takhtajan, A.L. 1997. Diversity and Classification of Flowering Plants. Columbia

University Press, New York.

18. Woodland, D.W. 1991. Contemporary Plant Systematics. Prentice Hall. New Jersey.

Suggested Laboratory Exercises :

1. Description of a specimen from representative, locally available families.

List of Locally Available Families :

(1) Ranunculaceae, (2) Capparidaceae, (3) Portulacaceae. (4) Caryophyllaceae, (5)

Malvaceae, (6) Tiliaceae , (7) Sterculiaceae, (8) Zygophyllaceae, (9) Rhamnaceae. (10) Sapindaceae, (11) Leguminosae, (12) Combretaceae, (13) Myrtaceae, (14)

Cucurbitaceae, (15) Umbelliferae- Apiaceae, (16) Rubiaceae, (17) Asteraceae, (18) Primulaceae, (19) Plumbaginaceae, (20) Asclepiadaceae, (21) Convolvulaceae, (22)

Solanaceae, (23) Boraginaceae, (24) Polemoniaceae, (25) Acanthaceae, (26) Pedaliaceae, (27) Martyniaceae, (28) Bignoniaceae, (29) Labiatae, (30) Nyctaginaceae, (31) Polygonaceae, (32) Chenopodiaceae, (33)Amaranthaceae, (34) Aizoaceae, (35) Molluginaceae, (36) Euphorbiaceae, (37) Commelinaceae and (38) Cyperaceae.

2. Description of a species based on various specimens to study intraspecific variation : a collective exercise.

3. Description of various species of a genus, location of key characters and preparation of keys at generic level.

4. Location of key characters and use of keys at family level.

5. Field trips within and around the campus, compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated, as are abundant.

6. Training in using floras and herbaria for identification of specimens described in the class.

7. Demonstration of the utility of secondary metabolites in the taxonomy of some

appropriate genera.

8. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.

UNIVERSITY OF RAJASTHAN

20

BOT 203- MICROBIOLOGY

1. **Introduction:** History and development of microbiology, General characteristics of microorganisms, scope, contribution of Van Leeuwenhoek- Joseph Lister, Pasteur, Koch, Jenner and Alexander Fleming. 3

2. **Classification of microorganisms:** Hackel's three kingdom concept, Whittaker's five kingdom concept. Salient features of Bergey's manual of systemic Bacteriology.Modern trends in classification (ribotyping, nucleic acid hybridization, RNA fingerprinting, molecular chronometer). 9

3. **Microbial diversity:** Occurrence, salient features and designation of following- Gram Negative bacteria, Spirochaetes, Aerobic or microaerophilic, Anaerobic bacteria Rickettsias and Anoxygenic phototrophs, Oxygenic phototrophs, Mycobacteria, Actinomycetes. Chlamydias, Archaebacteria: Methanotrophs, Halophiles and Sulfur dependent archaebacteria. 9

4. **Microbial toxins**: Pathogenic types of toxins (exotoxin, endotoxin and entrotoxin), nonspecific and specific defense mechanisms. 3

5. **Morphology, Ultra structure and Cultivation of Bacteria**:
   Morphology and ultra structure of bacteria. Anaerobic, aerobic culture media, growth curve, growth kinetics, batch, continuous culture, growth measurements, Pure culture techniques , preservation methods. 12

6. **General account of Mycoplasma-** Characteristics, cell morphology, diseases caused in plants by mycoplasma (sesame phyllody, sandal spike). 3

7. **Viruses**- Nomenclature, classification, properties and structure of viruses Life cycle and pathogenesis of following: RNA virus- Rabdo, Hepatitis, swine flu virus; DNA viruses- Pox, herpes, Measles; Plant viruses: TMV, Turnip yellow mosaic. 12

8. **Physiology and Metabolic Diversity among Microorganisms**-Nutritional classification of microorganisms- chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. Photosynthesis in microorganisms; Nitrite oxidizing bacteria; Nitrate and sulfate reduction; Syntrophy; Nitrogen metabolism; Nitrogen fixation; Hydrocarbon transformation. Motility and bioluminescence. 9
9. **Immunology:** General account of immunity, properties of antigens and antibodies. Antibody structure and function, affinity and antibody specificity, Monoclonal antibodies and their uses, antibody engineering, serology. vaccination and vaccines, Interferon. 9
10. **Application of Microbiology:** application of microbiology in industrial, agriculture and waste management: symbiotic nitrogen fixation, Mycorriza and VAM fungi, Siderophores and other PGRs. 6
11. **Food Microbiology:** Contamination and spoilage of food products, Food preservation methods. Application of microbial enzymes in food industry, Microbiology of fermented milk products. 6
12. **Industrial Microbiology:** Industrial production of alcohol, citric, acid, solvents, amino acids, enzyme, antibiotics. Microorganism in mineral recovery; microbial degradation of petroleum and hydrocarbons. Pesticides and other recalcitrant chemicals (Xenobiotics), preliminary account of Biofilms, biochips, biosensors and biosurfactants. 9

Suggested Practicals:

1. Preparation of culture media -Liquid & Solid media, Enrichment, Selective & Differential mediums. Preparation of slant, deep tube and plate culture.
2. Isolation of pure culture by Pour plate, Serial dilution and Streak plate method.
3. Study of Growth curve.
4. Effect of pH, temp, Osmolarity and Oxygen, UV, Dessication on growth of bacteria.
5. Sterilization methods.
6. Methods of quantitative estimation of Microorganisms.

7. -Total counts (haemocytometer)-Viable counts (Plate count), WBC counts. RBC counts
8. Methods of staining bacteria (Simple staining, Gram's staining, Negative staining)
9. Endospore staining
10. Fermentative production of ethyl alcohol by Yeast.
11. Extraction and detection of aflatoxin for infected foods.
12. Serological tests - Widal test, VDRL test,
13. Blood grouping, Rh factor,
14. Haemoglobin estimation
15. To study spontaneous mutations by replica plating.
16. To study induced mutations in bacteria.
17. Antibiotic bioassay: by gradient plate technique and disc method.
18. Testing of milk by MBRT, Turbidity Test for Milk,
19. Qualitative estimation of Phosphorus and calcium in milk.
20. Most probable number (MPN)
21. Coliform Test for milk/ water
22. Isolation of micro-organisms from air, water, soil and rhizosphere microflora

Suggested Readings:

1. Frazier WC and Westhoff DC (1998). Food Microbiology. Tata McGraw Hill Publishing Company Ltd, New Delhi
2. Industrial Microbiology, G. Reed (editor), CBS Publishers (AVI Publishing Company)
3. Biology of industrial microorganisms. A.L.Demain
4. Genetics and biotechnology of industrial microorganisms, C.L. Hershnergev, S.W. Queener and Q. Hegeman. Publisher: American Society of Microbiology. Ewesis. et.al. 1998. Bioremediation principles. McGraw Hill.
5. General Microbiology by R.Y. Stanier, John L. Ingraham and Mark L. Wheelis pagex, Mc Millian Press.
6. Principles of Microbiology by Ronald M. Atlas, Mc Graw Hill.
7. Microbiology by Michael J. Pcleczar, Chan and Krieg, Mac Graw Hill.
8. Fundamentals of Microbiology by Edward Alcamo, Jones and Bariett Publishers.

9. Brock- Biology of Microorganisms by Madigan, Martina and Parker. Prentice Hall.
10. Microbiology principles & Applications - J.J. Black, John Wiley, Prentice Hall
11. An introduction to Fungi - H.C. Dube: Vikas Publishing House Pvt. Ltd.
12. Introductory Mycology - C.J. Alexopoules
13. Products & Properties of Algae by Zizac Adams M.R. and Moss M.O. (1995) Food Microbiology. Royal Society of Chemistry Publication, Cambridge.
14. Michel. R. Introduction of Environmental Microbiology. 1999. ASM book.

BOT 204: PRINCIPLES OF PLANT PATHOLOGY

1. **Scope of Plant Pathology**: General account of diseases caused by plant pathogens.
2. **Pathogen attack and defense mechanisms**: Physical, physiological, biochemical and molecular aspects.
3. **Plant disease management**: Chemical, biological, IPM systems, development of transgenics, biopesticides, plant disease clinics.
4. **Information technology in plant pathology**: Preliminary account of application of information technology in plant pathology.
5. **Symptomology, identification and control of following plant diseases**:

Fungal diseases:

Wheat – Rusts, loose smut, flag smut, Karnal bunt

Barley – Covered smut

Pearl millet - Green ear, ergot and smut

Crucifers – rust, Alternaria blight

Paddy- Paddy blast

Cotton - Wilt

Grapes -Downy mildew and powdery mildew

Bacterial diseases: Tundu disease of wheat, Citrus canker, black rot of crucifers

Viral diseases: Tobacco mosaic, Bhindi yellow mosaic.

Phytoplasma disease: Little leaf of brinjal, sesame phyllody, sandal spike

Nematode diseases: Root-knot of vegetables, Ear-cockle of wheat.

Suggested Readings

1. Alexopoulus, C.J., Mims, C.W. and Blackwel, M. 1996. Introductory Mycology. John Wiley & Sons Inc.
2. Agrios, G.N. 1997. Plant Pathology. Academic Press, London.
3. Albajes, R., Gullino, M.L., Van Lenteren, J.C. and Elad, Y. 2000. Integrated Pest and Disease management in Greenhouse Crops. Kiuwel Academic Publishers.

4. Bridge, P., Moore, D.R. & Scott, P.R. 1998. Information Technology Plant Pathology and Biodiversity. CAB International, U.K.
5. Cliffton, A. 1958. Introduction to the Bacteria. McGraw Hill Book Co. New York.
6. Mandahar, C.L. 1978. Introduction to plant viruses. Chand & Co. Ltd., Delhi.
7. Mehrotra, R.S. Plant Pathology, Tata McGraw Hill.
8. Rangaswamy, G. & Mahadevan, A. 1999. Diseases of crop plants in India (4th edition) Prentice Hill of India, Pvt. New Delhi.
9. Horsfall, J.G. & A.E. Dimond. Plant Pathology Vol. 1,2 & 3. Academic Press, New York, London.
10. Trivedi, P.C. I998. Nematode Diseases in Plants. CBS Publisher & Distributor, New Delhi.

Suggested laboratory Exercises

Exercises and Plant diseases as per theory syllabus.

Field visits to show diseases in crop plants.

26

SEMESTER- III

BOT 301: PLANT PHYSIOLOGY AND METABOLISM

Plant Physiology

Water relations of plants: Unique physiochemical properties of water Chemical potential, Water potential, apparent free space, Bulk movement of water. Soil plant atmosphere continuum(SPAC/ absorption, ascent of sap, transpiration), Stomatal regulation of transpiration. Membrane transport: Passive nonmediated transport. Nernst equation. Passive mediated transport. ATP driven active transport. Uniport, Symport , Antiport, Ion Channels. 24

Biomolecules: General Structure, Classsification, Properties and Functions of Primary metabolites (Carbohydrates, Proteins , amino acids, enzymes and Lipids) and Secondary metabolites (Alkaloides, Flavanoides and Steroides). Ramachandran Plot for amino acids . 18

Photosynthesis: Photosynthetic pigments, absorption and transformation of radiant energy, photo-oxidation, : photosystem I, & II, non cyclic and cyclic transportation of electrons (photophosphorylation), Calvin cycle and its control regulation of RUBP carboxylase activity. C4 pathway, CAM pathway. Differences b\w c3 and c4 plants. Glycolate pathway and photorespiration, chlororespiration .

Respiration: Anaerobic and aerobic respiration. Amphibolic nature of TCA cycle, Pentose phosphate pathway, Glyoxylate pathway, oxidative phosphorylation, Gluconeogenesis, High energy compounds: their synthesis and utilization.

Fat metabolism: Synthesis of long chain fatty acids, lipid biosynthesis, α-and β – oxidation. 24

Plant growth regulators:

Auxins - chemical nature, bioassay, physiological effects and mode of action.

Gibberellins - chemical nature, bioassay, physiological effects and mode of action.

Cytokinins - chemical nature, bioassay, physiological effects and mode of action.

Abscisic acid - chemical nature, bioassay, physiological effects and mode of action.

Ethylene - chemical nature, bioassay, physiological effects and mode of action. 24

Suggested Readings:

1. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2000. Biochemistry and Molecular

Biology of Plants, American Society of Plant Physiologists, Maryland, USA.

2. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. (Eds) 1997. Plant Metabolism (second edition). Longman Essex, England.

3. Galston, A.W. 1989. Life Processes in Plants. Scientific American Library, Springer-Verlag, New York, USA.

4. Hooykaas, P.J.J., Hall M.A. and Libbenga, K.R. (eds) 1999. Biochemistry and Molecular Biology of Plant Hormones, Elsevier, Amsterdam, The Netherlands.

5. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA.

Suggested Laboratory Exercises:

1. Effect of time and enzyme concentration on the rate of reaction of enzyme (e.g. acid phosphatase nitrate reductase).

2. Effect of substrate concentration on activity of any enzyme and determination of it Km value.

3. Demonstration of the substrate inducibility of the enzyme nitrate reductase.

4. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids.

5. To determine the chlorophyll a/ chlorophyll b ratio in C3and C4 plants.

6. Isolation of intact chloroplasts and estimation of chloroplast proteins by spot protein assay.

7.To demonstrate photophosphorylation in intact chloroplasts, resolve the phosphoprotecins by SDS-PAGE and perform autoradiography.

8. Extraction of seed proteins depending upon the solubility.

9. Determination of succinate dehydrogenase activity, its kinetics and sensitivity to inhibitors.

10. Desalting of proteins by gel filtration chromatography employing Sephadex G-25.

11. Preparation of the standard curve of protein (BSA) and estimation of the protein content in extracts of plant material by Lowry's or Bradford's method.

12. Fractionation of proteins using gel filtration chromatography by Sephadex G100 or Sephadex G200.

13. SDS-PAGE for soluble proteins extracted from the given plant materials and comparison of their profile by staining with Coomassie Brilliant Blue or silver nitrate.

14. Separation of isozymes of esterases, peroxidases by native polyacrylamide gel electrophoresis.

15. Radioisotope methodology, autoradiography, instrumentation (GM count and Scintillation counter) and principles involved.

Suggested Readings (for laboratory exercises)

1. Bajracharya, D. 1999. Experiments in Plant Physiology : A Laboratory Manual, Narosa Publishing House, New Delhi.

2. Cooper, T.G. 1977. Tools in Biochemistry. John Willey, New York,USA

3. Copeland, R.A. 1996. Enzymes: A Practical introduction to Structure, Mechanism and data Analysis. VCH Publishers, New York.

4. Dennison, C. 1999. A Guide to Protein Isolation. Kluwer Academic Publishers, Dordrecht, The Netherland.

5. Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India.

6. Dryer, R.L. and Lata, G.F 1989. Experimental Biochemistry. Oxford University Press, New York.

7. Hames B.D. (Ed.) 1998. Gel Electrophoresis of Proteins : A Practical Approach, 3rd edition. PAS, Oxford University Press, Oxford, U.K.

8. Harbome, T.C. 1981. Phytochemical Methods : A Guid to Modern Techniques of Plant Analysis. Chapman & Hall, London.

9. Moore, T.C. 1974. Research Experiences in Plant Physiology : A Laboratory Manual, Springer-Verlag, Berlin.

10. Ninfa, A.J. and Ballou, D.P. 1998 Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Fitzgerald Science Press, Inc, Maryland. USA.

11. Piummer, D.T. 1998. An Introduction to Practical Biochemistry. Tata McGraw-Hill- Publishing Co. Ltd, New Delhi.

12. Scott, R.P.W. 1995. Techniqucs and Practice of Chromatography. Marcel Dekkkcr, Inc. New York.

13. Wilson, K. and Goulding, K.H.(Eds), 1986. A biologists Guide to Principles and

Techniques of Practical Biochemistry. Edyward Arnold, London, UK.

14. Wiison, K. and Walker, J. 1994. Practical Biochemistry : Principles and Techniques. 4th edition, Cambridge University Press, Cambridge, UK.

BOT 302 : PLANT MORPHOLOGY & DEVELOPMENTAL ANATOMY

Introduction: Unique features of plant development (open form of growth; strategies for survival; growth, differentiation and morphogenesis; organization of plant body; commitments for development; reversal of established commitments) , differences between animal and plant development. 5

Seed germination and seedling growth: Metabolism of nucleic acids, proteins and mobilization of food reserves, tropisms during seed germination and seedling growth, hormonal control of seedling growth, gene expression, use of mutants in understanding seedling development. 20

Shoot development: Organization of the shoot apical meristem (SAM), cytological and molecular analysis of SAM, control of cell division and cell to cell communication, Primary and secondary tissue differentiation, control of tissue differentiation (especially xylem and phloem), secretory ducts and laticifers, wood development in relation to environmental factors. 25

Leaf growth and differentiation: Determination, phyllotaxy, control of leaf form, differentiation of epidemis (with special reference to stomata and trichomes) and mesophyll , kranz anatomy, leaf traces and leaf gaps, transfer cells, petiolar anatomy. 15

Root development: Organization of root apical meristem (RAM), cell fates and lineages, vascular tissue differentiation, lateral roots, root hairs, root-microbe interactions. 20

Seed development: External and internal morphology of seed , seed appendages, Ontogeny of seed coat in various families, mature structure, spermoderm patterns.15

Suggested Readings:

1. Atwll, B.J. Kriedcrmann, P.E. and Jumbull, C.G.N. (eds). 1999. Plants in Action : Adaption in Nature Performance, in Cultivation, MacMillan Education. Sydney, Australia.

2. Bewley. J.D. and Black, M. 1994. Seeds: Physiology of Development and Germination, Plenum Press. New York.

3. Burgess, J. 1985. An Introduction to Plant Cell Development. Cambridge University Press, Cambridge.

4. Fahn, A. 1982. Plant Anatomy. (3rd edition). Pergamon Press, Oxford.

5. Fosker, D.E. 1994. Plant Growth and Development. A Molecular Approach. Academic Press, San Diego.

6. Howell, S.H. 1998. Molecular Genetics of Plant Development. Cambridge University press, Cambridge.

7. Lyndon, R.F. 1990. Plant Development. The Cellular Basis, Unnin Byman, London.

8. Murphy, T.M. and Thompson, W.E, 1988. Molecular Plant Development. Prentice Hall, New Jersey.

9. Raghavan, V. 1999. Developmental Biology of Flowering Plants. Springer-Verlag, New York.

10. Raven, P.H., Evrt, R.F and Eichhorn, S. 1992. Biology of Plants (5th edition). Worth, New York.

11. Salisbury, P.B. and Ross, C.W. 1992. Plant Physiology (4th edition). Wadsworth Publishing, Belmont, California.

12. Steeves, T.A. and Sussex, I.M., 1989. Patterns in Plant Development (2nd edition). Cambridge University Press, Cambridge.

13. Waisel, Y., Eshel, A. and Kafkaki, U. (eds.). 1996. Plant Roots : The Hidden Hall (2nd edition). Marcel Dekker, New York.

Suggested Laboratory/Field Exercises

1. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla*.

2. Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and double-stained permanent slides of a suitable plant such as *Coleus, Kalanchoe, tobacco*. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.

3. Study of alternate and distichous, alternate and superposed, opposite and superposed, opposite and decussate leaf arrangement. Examination of rosette plants (*Launaea, Mollugo, Raphanus, Hyoscyamus etc.*) and induction of bolting under natural conditions as well as by GA treatment.

4. Microscopic examination of vertical sections of leaves such as *Cannabis*, tobacco, *Nerium*, maize and wheat to understand the internal structure of leaf tissues and trichomes, glands etc. Also study the C3 and C4 leaf anatomy of plants.

5. Study of epidermal peels of leaves such as *Coccinia, Gaillardia, Tradescantia, Notonea*. etc. to study the development and final structure of stomata and prepare stomatal index. Demonstration of the effect of ABA on stomatal closure.

6. Study of whole roots in monocots and dicots. Examinatian of L.S. of root from a permanent preparation to understand the organization of root apical meristem and its derivatives. (use maize, aerial roots of banyan, *Pistia*, *Jussieua* etc.) Origin of lateral roots. Study of leguminous roots with different types of nodules.

7. Study of primary and secondary tissue differentiation in stem.

BOT 303 - PLANT ECOLOGY

Science of Ecology: Introduction to ecology, evolutionary ecology, ecological models; **Population**: Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure, population growth. Competition and coexistence, intra-specific interactions, interspecific interactions, scramble and contest competition model, mutualism, commensalism and allelopathy, prey-predator interactions. **21hours**

Vegetation organization: Concepts of community and continuum, community coefficients, interspecific associations, ordination, species diversity and pattern diversity in community, concept of habitat and ecotone, ecological niche.

Vegetation development: Temporal changes (cyclic and non-cyclic), mechanism of ecological succession (relay floristic and initial floristic composition), succession models (facilitation, tolerance and inhibition models), Changes in ecosystem properties during succession, concept of climax. **21 hours**

Ecosystems: Nature and size of ecosystem, components of an ecosystem (producers, consumers and decomposers), Grazing (grassland) and Detritus food chain in freshwater ecosystems, food webs, Ecological energetic: Solar radiation and energy intakes at the earth's surface, energy flow models, Productivity of various ecosystems of the world and global biogeochemical cycles of carbon and nitrogen, Ecosystem Management: Homeostasis and cybernetics of ecosystem, Resilience of ecosystem, Restoration of degraded ecosystems. **24 hours**

Biomes, Biodiversity & Conservation: Major biomes of the world and Impact of changing climate on biomes, Biodiversity assessment (local, national and global), loss of diversity, conservation (ex-situ and in situ) and management, International Conservational organizations, biodiversity act of India and related international conventions. diversity indices, sustainable development, natural resource management in changing environment, molecular ecology, genetic analysis of single and multiple population, molecular approach to behavioural ecology, conservation genetics. **24hours**

Suggested Readings :

1. Smith, R.L. 1996. Ecology and Field Biology, Harper Collins, New York.
2. Muller-Dombois, D. and Ellenberg, H., 1974. Aims and Methods of Vegetation Ecology, Wiley, New York.
3. Begon, M. Harper, J.L. and Townsend, C.R. 1996. Ecology, Blackwell Science, Cambridge, U.S.A.
4. Ludwig, J. and Reynolds, J.F. 1988. Statistical Ecology. John Wiley & Sons.
5. Odum, E.P. 1971. Fundamentals of Ecology, Saunders, Philadelphia.
6. Odum, E.P. 1983. Basic Ecology, Saunders, Philadelphia.
7. Barbour, M.G., Burk, J.H. and Pitts, W.D. 1987. Terrestrial Plant Ecology, Benjamin/Cummings Publication Company, California.
8. Kormondy, E.J., 1996. Concepts of ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.
9. Chapman, J.L. and Reiss, M.J. 1988. Ecology, Principles and Applications. Cambridge University Press, Cambridge, U.K.
10. Molan, B. and Billharz, S. 1997. Sustainability Indicators, John Wily Sons, New York.
11. Heywood, V.H. and Watson, R.T. 1985. Global Biodiversity Assessment. Cambridge University Press.
12. N.S. Subrahmanyam and A.V. S.S. Sambamurty. 2000. Ecology. Narosa Publishing House, Delhi
13. S.K. Maiti. 2004. Handbook of Methods in Environmental Studies Vol. 1 &2. ABD Publisher, Jaipur.
14. J. L. Chapman and M. J. Reiss. 1995. Ecology principles and applications. Cambridge University Press.
15. C. Faurie, C. Ferra, P. Medori and J. Devaux. 2001. Ecology Science & Practice. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
16. G.T. Miller Jr. 2005. Essentials of Ecology. III Edition, Thomson, Brooks/Cole

Suggested Laboratory Exercises

1. To determine minimum size and number of quadrat required for reliable estimate of biomass in grasslands.

2. To compare protected and unprotected grassland stands using community coefficients (similarity indices).
3. To estimate IVI of the species in a grassland/woodland using quadrat method.
4. To determine gross and net phytoplankton productivity by light and dark bottle method.
5. To determine soil moisture content, porosity and bulk density of soils collected from varying depths at different locations.
6. To determine the Water holding capacity of soils collected from different locations.
7. To determine percent organic carbon and organic matter in the soils of cropland, grassland and forest.
8. To estimate the dissolved oxygen content in eutrophic and oligotrophic water samples by azide modification of Wrinkler's method.
9. To estimate chlorophyll content in SO_2 fumigated and unfumigated plants leaves.
10. To estimate rate of carbon dioxide evolution from different soils using soda lime or alkali absorption method.
11. To study environmental impact of a given developmental activity using checklist as a EIA method.

Elective papers: BOT 304 (A- F):

BOT 304 (A) : ADVANCED PLANT PATHOLOGY-I

Plant Pathology : History & Scope. Nature, Origin. & Evolution of parasitism. Biotic and abiotic pathogens, Pathogen factors in disease development. Penetration, infection and pathogenesis. Physiological specialisation in phytopathogenic microbes.

Host factors in disease development. Inoculum Potential, Phenomena of resistance and susceptibility. Protective and defense mechanisms in plants, Phytoalexins. Breeding for disease resistance plants.

Environmental factors in disease development. Epiphytotics and plant disease forecasting.

Principles of plant protection. Physical, chemical and biological control of plant diseases, IPM, Application of biotechnology and information technology in pest management.

Molecular Plant Pathology : Molecular diagnosis, identification of genes and specific molecules in disease development molecular mechanism of resistance. Non-parasitic diseases and control measures.

Classification and anatomy of galls : Some insect induced plant galls (*Pongamia, Cordia, Prosopis*) of Rajasthan. Mechanism and physiology of insect galls.

BOT 304 (B) : SEED SCIENCE &TECHNOLOGY -I

History of seed testing and its importance to agriculture, aims of seed testing, International Seed Testing Association (I.S.T.A.) – rules and recommendations. 6

Sampling of seeds, purity analysis (physical and genetical), seed moisture content, germination test, rapid test of viability, seedling evaluation and various methods of seed separation, cleaning and drying. 12

Gross architecture of seed structure of angiosperms, identification and structure of seeds of important crop plants with special reference to Rajasthan (wheat , pearl millet, mustard, gram, pea) and their weeds (*Amaranthus* and *Cynodon*) 18

Principles of seed production, seed production in self and cross pollinated plants; hybrid seed production. Physiology of seed germination; seed and seedling vigour. Seed dormancy and longevity. 18

Seed storage methods, principles for safe seed storage, effects of storage, mycotoxins, Deterioration of seeds in storage by micro-organisms, insects and rodents; detoxification, control of seed deterioration. 18

Seed certification standards and quarantine regulations. International cooperations, International Seed Testing Association - Certificates, other seed certificates; Indian Seeds Act and National and Regional Seed Corporations of India - their organisation, aims and functions. National and International Co-operation in Seed Pathology. Sanitary and phytosanitary (SPS) agreements of WTO. 18

List of suggested Practical exercises:

1. Structure of seeds of some crop plants (wheat, pearl millet, mustard, gram, pea)
2. Common weed seeds in crop seed lots and their identification (*Amaranthus* and *Cynodon* .
3. Study of purity of seed sample.
4. Study of seed germination, seedling abnormality and seedling index.
5. Determination of moisture content of seeds.
6. TZ test for seed viability
7. Assay of enzymes in crop seeds.
8. Biochemical testing of starch, protein, lipids, tannins, phenols and lignin in seed
9. Localization of starch, protein, lipids, tannins, phenols and lignin in seed sections.

10. Isolaton and identification of storage fungi.
11. Preparation of phytosanitary certificate etc. of seed lot.

Suggested Readings:

1. Agarwal, V.K. and Sinclair, J.B. (1987).Principles of Seed-pathology, II edition CRC Lewis Publishers, Boca Raton, New York, London.
2. Agrawal, R.L. 1980. Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
3. Anonymous (1985). International rules for seed testing. International Seed Testing Association (ISTA). Seed Sci, & Tech.
4. Bewley, J.D. and Black, M. 1983. Physiology and Biochemistry of Seeds in Relation to Germination. Volume I & II. Springer-Verlag, Berlin, Heidelberg, New York.
5. Copeland, L.O. 1976. Principles of Seed Sci. and Technology Minnesota, USA.
6. Kulkarni, G.N. 2002. Principles of Seed Technology. Kalyani Publishers, New Delhi.
7. Neergaard, P. 1986. Seed- A horse of hunger or a source of life. Revised print of Danish Government Institute of Seed Pathology for Developing Countries. Hellerup, Denmark.
8. Winton, A. L. and Winton, K. B. (1932-1939): The structure and composition of foods. Vol I and II: John Wiley and Sons, Inc., New York.

BOT 304 (C): ENVIRONMENTAL BIOLOGY & ARID ZONE ECOLOGY-I

Grassland Ecosystems - Characteristics of grasslands, stratification, grasslands and grazing, grasslands and drought, grassland and animal life, Grasslands types with special reference to Prairie and Savannah, Indian grasslands. **8hours.**

Freshwater Ecosystems –Classification of Freshwater Habitats, Lentic: Lakes & Ponds: Temperature and Oxygen stratification, Zonation based on light penetration, Flora and fauna, Productivity classes of lakes, Marshes and Swamps, Bogs, Lotic: Springs, Streams and Rivers. **12 hours**

Marine and Estuarine Ecosystems - Characteristics of marine environment: Salinity, Temperature and pressure, Zonation and Stratification, Tides, Estuarine ecosystem: Types of Estuaries, Flora and fauna, Estuarine productivity, Coral reef ecosystem **12hours**

Forest Ecosystems - Stratification of the forest, Forest types -Boreal, Temperate and Tropical forests, Forest animal life **7 hours**

Urban Ecosystem -Urban environment and Climatic conditions, additional physical complexes (modified surfaces including parking lots, roofs, and landscaping, buildings, transportation networks, infrastructure and public amenities), flora and fauna (human beings as largest macro consumer), Implications of urbanization: problems of air pollutants, drinking water supply, floods, waste disposal. **6 hours**

Rural ecosystems: Rural environment and climate, physical complexes (fields, agricultural implements and machines), Flora and fauna, Problems of discharge of chemical fertilizers, pesticides and drinking water. Management of waste, Principle; Social Forestry. **6hours**

Pollution: Air, water, soil & noise, Kinds, sources, quality parameters, effects on plants and ecosystems **5hours**

Climate Issues: Greenhouse gases (CO_2, CH_4, N_2O, CFCs: sources, trends and role) and consequence of greenhouse effects (CO_2 fertilization, global warming, sea level rise, Biodiversity erosion), Carbon footprints, ozone layer depletion and its consequences, Applications of GIS and Remote Sensing technology in environmental studies, the future of planet earth. **6 hours**

Remediation: Definition, remediation of soil, water (municipal) and air pollution, Bioremediation, Green belt, Carbon sequestration. **6hours**

Solid waste management: Solid wastes, Types, collection and methods of disposal and their management, recycling and resource recovery (Reduction, Recycle & Reuse), briquetting. 4hours

Policies, Regulations & related issues: Water (Prevention and Control of Pollution) Act 1974; Air (Prevention and Control of Pollution) Act 1981; Environment (Protection) Act 1986, Wild Life Protection) Act 1972, Forest (Conservation) Act 1980, Biodiversity Act 2002. 4hours

Environmental concerns: Environment auditing, Ecological footprints, Environment Impact Assessment, Bioindicator and biomarkers of environmental health; Environmental economics, Ecopolitics and green policies; Ecolabel 4hours.

Suggested Readings

1. Treshow, M. 1985. Air Pollution and Plant Life. Wiley Interscience.
2. Mason, C.F. 1991. Biology of Freshwater Pollution. Longman.
3. Hill, M.K. 1997. Understanding Environmental Pollution. Cambridge University Press.
4. Brij Gopal, P.S.Pathak and K.G. Saxena (Eds.). 1998. Ecology Today: An anthology of Contemporary Ecological Research. International Scientific Publications, New Delhi.
5. P. K. Goel. 1997. Water Pollution: Causes, Effects and Control. New Age international Ltd., Publishers, New Delhi.
6. P.L.Jaiswal, A.M. Wadhwani and N.N. Chhabra (Eds.). 1983. Desertification and its Control. ICAR, New Delhi.
7. R.K.Trivedy and P.K.Goel. 1998. An Introduction to Air Pollution. Technoscience Publications, Jaipur
8. S.K. Maiti. 2004. Handbook of Methods in Environmental Studies Vol. 1 &2. ABD Publisher, Jaipur.
9. I.P.Abrol amd V.V. Dhruva Narayana (Editors) 1990. Technologies for Wasteland Development. ICAR, New Delhi.
10. Smith, R.L. 1996. Ecology and Field Biology, Harper Collins, New York.
11. Subrahmanyam, N.S. and A.V.S.S. Sambamurty 2000. Ecology. Narosa Publishing House, New Delhi.

Suggested Laboratory Exercises:

1. To estimate pH, EC and Secchi Disc transparency for polluted and unpolluted water bodies.
2. To estimate Chemical Oxygen Demand of polluted water sample.
3. To estimate Biological Oxygen Demand of polluted water sample.
4. To estimate inorganic phosphorus content in water samples collected from polluted and unpolluted water bodies.

5. To estimate Total hardness, calcium and magnesium content in water samples collected from polluted and unpolluted water bodies.
6. To determine diversity indices (Shannon-Wiener, concentration of dominance, species richness, equitability and β-diversity) for polluted and unpolluted water bodies.
7. Find out stomatal index of plant species growing in your locality.
8. Study of trichomes of selective plant species growing in your locality.
9. Study spread of root system of a perennial species in the soil
10. Study ecological adaptations of halophytes in your nearby area.

BOT 304 (D): ADVANCED PLANT PHYSIOLOGY-I

Proteins and Enzymes :Techniques of protein purification, protein sequencing and proteomics, enzyme kinetics, Michaelis -Menten equation and significance of Km value, negative and positive cooperativity, enzyme nomenclature and EC number, catalytic mechanisms; acid-base catalysis, covalent catalysis, metal ion catalysis, electrostatic, catalysis, catalysis through proximity-orientation effect and catalysis through transition state bonding, lysozyme as model enzyme for catalytic mechanism, regulation of enzyme activity; feed back and allosteric regulation, active sites, coenzymes, activators and inhibitors, isoenzymes, ribozymes and abzymes 23.

Nucleotides : Biosynthesis of ribonucleotides (purines and pyrimidines), formation of deoxyribonucleotides, salvage purines, nucleotide degradation.

Vitamins : Water and fat-soluble vitamins, biochemical function of thiamine, riboflavin, nicotinic acid, pantothenic acid, pyridoxin, biotin, folic acid, vitamin B12, ascorbic acid, vitamin A and vitamin D. 22.

Secondary metabolites : Coumarins and lignins : structure and synthesis. Insecticides: : (pyrethrins and rotenoides) distribution, chemistry and function

Tannins : distribution synthesis and function.

Flavonoids and water-soluble pigments: synthesis and function.

Hallucinogens: distribution, chemistry and function .

Alkaloids : pyrrole, pyrrolidine, pyridine, polyacetyl isoquinoline, tropane and indole alkaloids - their distribution, synthesis and function.

Saponins and sapogenins : sterols, steroids, steroidal alkaloids - their distribution, synthesis and function.

Cardiac glycosides : their distribution, structure and function 23

BOT 304 (E): ADVANCED MORPHOLOGY & MORPHOGENESIS-I

Floral anatomy- Its role in explaining the morphology of the Stamen and Carpel, Placentation, Inferior ovary, taxonomic significance of floral anatomy. Anatomy of the seed and pericarp and their taxonomic significance. 20

Anther-organizational relationship of anther tissues : ultrastructure aspects of microsporogenesis: Pollen-sporoderm pattern. Pollen analysis, pollen fertility and sterility, allergy due to pollen. Viability, storage and germination of pollen. 15

Embryosac - basic types and their inter-relationships, ultrastructural aspects of embryosac development. Pollen pistil interaction, cytomorphology of style and stigma, role of pollen ultrastructural studies on pollen tube growth in the pistil, chemotropism, fertilization. 15

Endosperm – Major types and their interrelationship, cytology and role in embryo development, 10

Embryo- Embryogenic laws, major types, ultrastructure and cytology, cell Lineages, gene action during embryogenesis Apomixis - gynogenesis, androgenesis. agri-horticultural importance. 15

Embryological features of the following families : Santalaceae, Loranthaceae, Podostemaceae, Cucurbitaceae, Magnoliaceae, Boraginaceae, campanulaceae, Tropeolaceae. 15

BOT 304 (F): BIOSYSTEMATICS OF ANGIOSPERMS-I

Aims, components and principles of taxonomy, Alpha and Omega taxonomy, documentation and scope. (12 hrs)

Evolutionary taxonomic classification...System of Hutchinson, Takhtajan, Cronquist, Dahlgren, Thorne, APG-II. (15 hrs)

International and national botanical gardens , plant geography, Indian plant geographical regions, Role of Herbaria in taxonomy, Taxonomic literature-- Flora, Library, Icones, Index (10 hrs)

ICBN - Principles and important rules, type method, Principle of priority and its limitation, Name of hybrids and cultivars, Concept of Biocode. (15 hrs)

Biosystematics Procedures, --Serum diagnosis, Palynology- pollen morphology, polarity, symmetry, NPC, exine stratification, Cytology—chromosome morphology and number, polyploidy,aneuploidy,chromosome bands, G,C, bands, Embryology—embryological characters of taxonomic importance, Anatomy—wood and floral anatomy, anatomical characters of taxonomic importance, Histochemistry--lipids, starch, ascorbic acid, tannins, phenols, proteins, Molecular systematics (RAPD, PFLP analysis) (28 hrs)

Numerical taxonomy - Principles, Concepts, Operational taxonomic units (OTU), Data processing and taxonomic studies, Taxometric methods for study of Population variation and similarity - Coding, Cluster analysis, cladistics, cladogram. (10 hrs)

Practical work will be based on theory syllabus.

SEMESTER- IV

BOT 401: PLANT REPRODUCTIVE BIOLOGY

Reproduction : Vegetative options and sexual reproduction, flower development, genetics of floral organ differentiation, homeotic mutants in ***Arabidopsis*** and ***Antirrhinum***, sex determination. 15

Male gametophyte : Structure of anthers, microsporogenesis, role of tapetum, pollen development and gene expression, male sterility, sperm dimorphism and hybrid seed Production, pollen germination, pollen tube growth and guidance, pollen storage, pollen allergy, pollen embryos. 15

Female gametophyte : Ovule development, megasporogenesis, organization of the embryo sac, structure of the embryo sac cells 10.

Pollination, pollen-pistil interaction and fertilization : Floral characteristics, pollination mechanisms and vectors, breeding systems, commercial considerations, structure of the pistil, pollen-stigma interactions, sporophytic and gametophytic self-incompatibility (cytological, biochemical and molecular aspects), double fertilization, in vitro fertilization. 15.

Seed development and fruit growth : Endosperm development during early maturation and desiccation stages, embryogenesis,' ultrastructure and cytology, cell lineages during late embryo development, 'storage proteins of endosperm and embryo, polyembryony, apomixis, embryo culture, dynamics of fruit growth, biochemistry and molecular biology of fruit maturation, role of ethylene in fruit ripening. 15

Latent life – Seed dormancy: Importance and types,development, role of ABA in seed desiccation and dormancy, gene expression during seed dormancy, overcoming seed dormancy; bud dormancy 10.

Senescence and programmed cell death (PCD) : Basic concepts, types of cell death, PCD in the life cycle of plants; metabolic changes associated with senescence and its regulation, influence of hormones and environmental factors on senescence. 10

Suggested practical/Field exercises;

1. Study of microsporogenesis and gametogenesis in sections of anthers.
2. Examinatian of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Cannabis sativa, Crotoloria, Tradescantia, Brassica. Petunia, Solanum melongena*, etc.)
3. Tests for pollen viability using stains and in vitro germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
4. Estimating percentage and average pollen tube length in vitro.
5. Role of transcription and translation inhibitors on pollen germination and pallen tube growth.
6. Pollen storage, pollen-pistil interaction, self-incompatibility, in vitro pollination.
7. Study of ovules in cleared preparations, study of monosporic, bisporic and tetrasporic types of embryo sac development thorough examination of permanent, stained serial sections.
8. Field study of several types of flower with different pollination mechanisms (Wind pollination, thrips pollination, bee/butterfly pollination, bird pollination).
9. Emasculation, bagging and hand pollination to study pollen germination, seed set and fruit development using self compatible and obligate outcrossing systems. Study of cleistogamous flowers and their adaptations.
10. Study of nuclear and cellular endosperm through dissections and staining.
11. Isolalion of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun (*Syzygium cumini*) etc. by dissections.
12. Study of seed dormancy and methods to break dormancy.

Suggested Readings

1. Atwll, B.J. Kriedcrmann, P.E. and Jumbull, C.G.N. (eds). 1999. Plants in Action : Adaption in Nature Performance, in Cultivation, MacMillan Education. Sydney, Australia.
2. Bewley. J.D. and Black, M. 1994. Seeds: Physiology of Development and Germination, Plenum Press. New York.
3. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Deihi.
4. Burgess, J. 1985. An Introduction to Plant Cell Development. Cambridge University Press, Cambridge.
5. Fageri, K. and Van der Pijl, L. 1979. The Principle of Pollination Ecology. Pergamon Press, Oxford.
6. Fahn, A. 1982. Plant Anatomy. (3rd edition). Pergamon Press, Oxford.
7. Fosker, D.E. 1994. Plant Growth and Development. A Molecular Approach. Academic Press, San Diego.
8. Howell, S.H. 1998. Molecular Genetics of Plant Developmem. Cambridge University press, Cambridge.
9. Leins, P., TucKer, S.C. and Endress, P.K. 1988. Aspects of Floral Development, J. Cramer, Germany.
10. Lyndon, R.F. 1990. Plant Development. The Cellular Basis, Unnin Byman, London.
11. Murphy, T.M. and Thompson, W.E, 1988. Molecular Plant Development. Prentice Hall, New Jersey.
12. Proctor, M. and Yeo, P. 1973. The Pollination of Flowers. William Collins Sons, London.
13. Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
14. Raghavan, V. 1999. Developmental Biology of Flowering Plants. Springer-Verlag, New York.
15. Raven, P.H., Evrt, R.F. and Eichhorn, S. 1992. Biology of Plants (5th edition). Worth, New York.
16. Salisbury, P.B. and Ross, C.W. 1992. Plant Physiology (4th edition). Wadsworth Publishing, Belmont, California.

17. Steeves, T.A. and Sussex, I.M., 1989. Patterns in Plant Development (2nd edition). Cambridge University Press, Cambridge.
18. Sdgely, M. and Griffin, A.R. 1989. Sexual Reproduction to Tree Crops. Academic Press, London
19. Shivanna, K.R. and Sawhney, VK. (eds.) 1997. Pollen Biotechnology for Crop Production and Improvement. Cambridge University Press, Cambridge.
20. Shivanna, K.R. and Rangaswamy, N.S. 1992. Pollen Biology : A Laboratory Manual. Springer-Verlag. Berlin.
21. Shivanna, K.R. and Johri, B.M. 19R5. The Angiosperm Pollen : Structure and Function. Wiley Eastern Ltd.. New York.
22. The Plant Cell Special Issue on Reproductive Biology of Plants. Vol. 5(10) 1993. The American Society of Plant Physiologists, Rockville, Maryland. USA.

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1. Study of microsporogenesis and gametogenesis in sections of anthers.
2. Examinatian of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Cannabis sativa, Crotoloria, Tradescantia, Brassica. Petunia, Solanum melongena*, etc.)
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7. Study of ovules in cleared preparations, study of monosporic, bisporic and tetrasporic types of embryo sac development thorough examination of permanent, stained serial sections.
8. Field study of several types of flower with different pollination mechanisms (Wind pollination, thrips pollination, bee/butterfly pollination, bird pollination).

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11. Isolalion of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun (*Syzygium cumini*) etc. by dissections.
12. Study of seed dormancy and methods to break dormancy.

Suggested Readings. (for Laboratory Exercises)

1. Shivanna, K.R. and Rangaswamy, N.S. 1992. Pollen Biology : A Laboratory Mannual, Springer-Verlag, Berlin-Heidelberg (and references therein).
2. Chopra, V.L. 2001. Plant Breeding : Theory and Practice. Oxford IBH Pvt. Ltd., New Delhi.
3. Chopra, y.L. 2001. Plant Breeding: Field Crops. Oxford IBH Pvt. Ltd., New Delhi.

BOT-402: PLANT RESOURCE UTILIZATION & ETHNOBOTANY

World centres of primary diversity of domesticated plants : Vavilov's primary centres of origin, plant introductions and secondary centres. (8 hrs)

Origin, evolution, botany, cultivation and uses of (i) Food, forage and fodder crops, (ii) fibre crops, (iii) medicinal and aromatic plants and (iv) vegetable oil-yielding crops. (10 hrs)

Important fire-wood and timber-yielding plants and non-wood forest products

(NWFPs) such as bamboos, rattans. raw materials for paper making, gums, tannins, dyes, resins and fruits. (10 hrs)

Green revolution : Benefits and adverse consequences. Innovations for meeting world food demands...GM crops, hydroponics, terrace gardens, dryland agriculture, deficit water farming, Plants used as avenue trees for shade, pollution control and aesthetics. (14 hrs)

Plant Biodiversity : Concept, status in India, utilization and concerns

Sustainable development : Basic Concepts. Origins of agriculture. (8 hrs)

Principles of conservation: Extinctions, Threatened plants—categories, Red data book, environmental status of plants based on International Union for Conservation of Nature. (10 hrs)

Strategies for conservation - *in situ* conservation : International efforts and Indian initiatives, protected areas in India – sacred groves,sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs conservation of wild biodiversity. (14 hrs)

Strategies for conservation - *ex situ* conservation : Principles and practices, botanical gardens. field gene banks, Seed banks, in vitro repositories, cryobanks, general account of the activities of Botanical Survey of India (BSI), National Bureau of plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR), and the Department of Biotechnology (DBT) for conservation, non formal conservation efforts. (16 hrs)

Suggested Readings

1. Anonymous 1997. National Gene Bank : Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New Delhi.

2. Arora, R.K. and Nayar, E.R. 1984. Wild Relatives of Crop Plants in India. NBPGR

Science Monograph No.-7.

3. Baker, H.G. 1978. Plants and Civilization (3rd edn.) C.A. Wadsworth, Belmont.41

4. Bole, P.V. and Vaghani, Y. 1986. Field Guide to Common Indian Trees. Oxford University Press, Mumbai.

5. Chandel, K.P.S., Shukla, G. and Sharma, N. 1996. Biodiversity in Medicinal and Aromatic Plans in India : Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.

6. Chrispeels, M.J. and Sadava, D. 1977. Plants, Food and People, W.H. Freeman and Co., San Francisco.

7. Cristi, B.R. (ed.) 1999. CRC Handbook of Plant Sciences and Agriculture. Vol. I. Insitu conservation. CRC Press, Boca Raton, Florida, USA.

8. Conway, G. 1999. The Doubly Green Revolution : Food for All in the 21st Century. Penguin Books.

9. Conway, G. and Barbier, E. 1990. After the Green Revolution. Earthscan Press, London.

10. Conway, G. and Barbief, E. 1994. Plant. Genes and Agriculture. Jones and Bartlett Publishers, Boston.

11. Council of Scienfific and Industrial Research 1986. The Useful Plants of India. Publications and Information Directorate, CSIR, New Delhi.

12. Council of Scientific and Industrial Research (1948 - 1976). The Wealth of India. A Dictionary of Indian Raw Materials and Industrial Products. New Delhi. Raw Materials I-XII, Revised Vol. I-III (1985-1992) Supplement (200).

13. Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York, USA.

14. Directory of Indian Wetlands, 1993. WWF INDIA, New Delhi and AWB, Kuala Lumpur.

15. Falk, D.A., Olwel, M. and Millan C. 1996. Restoring Diversity, Island Press. Columbia, USA.

16. FAO/IBPGR 1989. Technical Guidelines for the Safe Movement of Germp1asm.

FAO/IBPGR, Rome.

17. Frankel, O.H., Brown, A.H.D. and Burdon, J.J. 1995. The Conservation of Plant Diversity. Cambridge University Press, Cambridge, U.K.

18. Gadgil, M. and Guha, R. 1996. Ecology and Equity : Use and Abuse of Nature in Contemporary India. Penguin, New Delhi.

19. Gaston, K.J. (Ed.) Biodiversity : a Biology of Numbers and Differences. Blackwell Science Ltd., Oxford, U.K.

20. Heywood, V. (Ed). 1995 Global Biodiversity Assessment. United Nations Environment Programme. Cambridge University Press, Cambridge, U.K.

21. Heywood, V.H, and Wyse lackn, P.S. (Eds) 1991. Tropical Botanical Gardens. Their Role in Conservation and Development. Academic Press, San Diego.

22. Kocchar, S.L. 1998. Economic Botany of the Tropics, 2nd edition. Macmillian India Ltd., Delhi.

23. Kothari, A. 1997. Understanding Biodiversity: Life Sustainability and Equity. Orient Longman.

24. Kohli, R., Arya, K.S., Singh, P.H. and Dhillon, H.S. 1994. Tree Directory of Chandigarh. Lovdale Educational, New Delhi.

25. Nair, M.N.B. et. al. (Eds.) 1988. Sustainable Management of Nonwood Forest Products. Faculty of Forestry, University Putra Malaysia. 43004 PM Serdong. Selangor, Malaysia.

26. Paroda, R.S. and Arora, R.K. 1991. Plant Genetic Resources Conservation and Management. IPGRI (Pubiication) South Asia Office, C/o NBPGR. Pusa Campus, New Delhi.

27. Pimentel, D. and Hall, C.W. (Eds.) 1989. Food and Natural Resources, Academic Press, London, New York.

28. Pinstrup-Anderson, P. et. al. 1999. World Food Prospects :Critical Issues for the Early 21st Century. International Food Policy Research Institute. Washington, D.C., USA.

29. Plant Wealth of India 1997. Special Issue of Proceedings Indian National Science Academy B-63.

30. Plucknett, D.L., Smith, N.J.H., William, J.T. and Murti Annishetty, N. 1987. Gene Banks and Worlds Food. Princeton Univrersity Press, Princeton, New Jersey, USA.

31. Rodgrs, N.A. and Panwar, H.S. 1988. Planning a Wildlife Protected Area Network in India. Vol. I. The Report. Wildlife Institute of India, Dehradun.

32. Sahni, K.C. 2900. The Book of Indian Trees. 2nd edition. Oxford University Press, Mumbai.

33. Schery, R.W. 1972. Plants for Man. 2nd ed. Englewood Cliffs, New Jersey. Prentice Hall.

34. Sharma, O.P. 1996. Hill's Economic Botany (Late Dr. A.F. Hill, adapted by O.P. Sharma). Tata McGraw Hill Co. Ltd., New Delhi.

35. Swaminathan, M.S. and Kocchar, S.L. (Eds.) 1989. Plants and Society. Macmillan Publication Ltd., London.

36. Thakur, R.S., Puri, H.S.and Husain, A. 1989. Major Medicinal Plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.

37. Thomas, P. 2000. Trees: Their National History. Cambridge University Press, Cambridge.

38. Wanger, H., Hikino, H. and Farnswarth, N. 1989. Economic and Medicinal Plant Research. Vols. 1-3. Academic Press, London.

39. Walter, K.S. and Gillett, H.J. 1998. 1997 IUCN Red List of Threatened Plants. IUCN, the World Conservation Union. IUCN, Gland, Switzerland and Cambridge,U.K.

Suggested Laboratory Exercises The Practical course is divided into three units:

(I) Laboratory work, (2) Field survey and (3) Scientific visits.

Laboratory Work

1. Food crops: Wheat, rice, maize, chickpea (Bengal gram), potato, tapioca, sweet potato, sugarcane. Morphology, anatomy, microchemical tests for stored food materials.

2. Forage/fodder crops : Study of any five important crops of the locality (for example fodder sorghum, bajra, berseem, clove, guar bean, gram, Ficus sp.)

3. Plant fibers :(a) Textile fibres : cotton, jute, linen, sunn hemp, *Cannabis*.

(b) Cordage fibres: coir (c) Fibres for stuffing: silk cotton or kapok

Morphology, anatomy, (microscopic) study of whole fibres using -appropriate staining procedures.

4. Medicinal and aromatic plants: Depending on the geographical location college/university select five medicinal and aromatic plants each from a garden crop field (or from the wild only if they are abundantly available).

Papaver somniferum, Atropa belladonna, Catharanthus roseus, Adhatoda cylanica (syn A. vasica) Allium sativum, Rauwolffia serpentina, Withania somnifera, Phyllanthus amarus, (P. fratermus), Andrographis paniculata, Aloe barbadens, Mentha arvensis, Rosa sp., Pogostemon cablin, Origanum vulgare, Vetiveria zizanioides. Jasminum grandiflorum, Cymbopogon sp., Pandanus odoratissimus.

Study of live or herbarium specimens or other visual materials. to become familiar with these resources.

5. Vegetaible oils : Mustard, groundnut, soybean, coconut, sunflower, castor,

Morphology, microscopic structure of the oil-yielding tissues, tests for oil and iodine number.

6. Gums, resins, tannins, dyes : Perform simple tests for gums and resins. Prepare a water extract of vegetable tannins *(Acacia, Terminalia, mangroves, tea, Cassia spp., myrobalans)* and dyes (turmeric, *Bixa orellana*, indigo, *Butea monosperma, Lawsonia inermis*) and perform tests to understand their chemical nature.

Field Surveys

7. **Firewood and timber yielding plants and NWF's :**

a. Prepare a short list of 10 most important sources of firewood and timber in your locality. Give their local names, scientific names, and families to which they belong. Mention, their properties.

b. Prepare an inventory of the bamboos and rattans of your area giving their scientific and local names and their various uses with aprropriate illustrations.

c. A survey of a part of the town or city should be carried out by the entire class, In batches. Individual students will select one avenue/road and locate the trees planted on a graph paper. They will identify the trees, mention their size, canopy shape, blossoming and fruiting period and their status (healthy, diseased, infested, mutilated, misused or dying) and report whether or not the conditions in which they are surviving are satisfactory. The individual reports will be combined to prepare a larger map of the area, which can be used for subsequent monitoring either by the next batch of students/teachers/local communities/NGOs/ or civic authorities. The purpose of exercise in item C above is to make the students aware of the kinds of trees and value in urban ecosystems and ecological services.

Scientific Visits*

The students should be taken to one of the following:

i. A protected area (biosphere reserve, national park, or a sanctuary)

ii. A wetland

iii. A mangrove

iv. National Bureau of Plant Genetic Resources, New Delhi-I10012 or one of its field stations.

v. Head Quarters of the Botanical Survey of India or one of its Regional Circles.

vi. A CSIR Laboratory doing research on plants and their utilization.

vii. An ICAR Research Institute or a field station dealing with one major crop or crops.

viii. A recognized botanical garden or a museum (such as those at the Forest Research Institute, dehradun, National Botanical Institute, Lucknow, Tropical Botanical Garden and Research Institute, Trivendram), which has collection of plant products.

Note : The students are expected to prepare a brief illustrated narrative of the field survey and scientific Visits. After evaluation, the grades awarded to the students by the teachers should be added to the field assessment of the practical examination.

55

BOT 403: PLANT BIOTECHNOLOGY & GENETIC ENGINEERING

Plant Tissue culture: Principles, Concept, History. General methodology, culture media ingredients, preparation, methods of sterilization and disinfestations, aseptic techniques and preparation of explants, histological and photographic techniques for plant tissue culture. Micropropagation in plants, Shoot morphogenesis and organogenesis, callus and suspension cultures, microspore culture and its importance. Somatic embryogenesis: Principles, concepts and applications. Protoplast technology: Isolation methods, purification, viability tests, culture, plating efficiency, Somatic cell hybridization, selection of protoplast fusion hybrids, Applications. Somaclonal Variation. Plant tissue culture and Secondary metabolite production. Overview of Plant Tissue Culture Applications.

Recombinant DNA Technology: tools and techniques, construction of genomic/cDNA libraries, polymerase chain reaction, DNA fingerprinting

Vectors for plant transformation: Basic features of vectors (Promoters and terminators, selectable markers, reporter genes, origin of replication, Co-integrative and binary vectors), Optimization, clean gene technology. Techniques for plant transformation: *Agrobacterium*-mediated gene transfer, process of T-DNA transfer and integration, practical applications of *Agrobacterium*-mediated gene transfer, Direct gene transfer methods. The genetic manipulation of Herbicide tolerance, pest tolerance, plant disease resistance. Reducing the effects of viral disease, Strategies for engineering stress tolerance, Improvement of crop yield and quality, Molecular farming of carbohydrate &lipids(Starch, polyfructans, bioplastics),proteins(custom made antibodies, edible vaccines, oleosin system).

Metabolic Engineering and industrial Products: control mechanisms and manipulation of phenylpropanoid pathway, alkaloids, industrial enzymes, biodegradable plastics, polyhydroxybutyrate, therapeutic proteins, Antibiotics, ethanol, Polyketides, Vitamins, Biopolymers , Biological Pigments , Amino acids, solvents.

Science and society: Public acceptance of genetically modified crops(Public concerns, current status of transgenic crops, concerns about GM crops, regulation of GM crops and products),Introduction to Intellectual property, Biosafety guidelines ,Environmental release of GMO's,Risk analysis, Risk Assessment, Risk management.

Suggested Practicals:

1. Preparation of media.
2. Surface sterilization
3. Micro propagation technique
4. Organ culture.
5. Callus propagation, organogenesis, transfer of plants to soil.
6. Anther culture, production of Haploids.
7. Preparation of synthetic seeds
8. Cytological examination of regenerated plants.
9. Isolation of protoplasts from various plant tissues and testing their viability
10. Agrobacterium culture, selection of transformants, reporter gene (GUS) assays.
11. PCR
12. Techniques: Biolistics, Membrane Filtration, Cell Counting
13. Restriction digestion of plant DNA, its separation by agarose gel electrophoresis and visualization by ethidium bromide staining.

Books:

1. J.Hammond,P. McGarvey and V. Yusibov (Eds.):Plant Biotechnology.Springer Verlag,2000.
2. T-J.Fu,G. Singh,and W.R. Curtis(Eds):Plant Cell and Tissue Culture for the Production of Food ingredients.Kluwer Academic/Plenum Press.1999.
3. H.S.Chawla:Biotechnology in Crop improvement. International Book Distributing Company,1998.
4. R.J.Henry: Practical Application of plant Molecular Biology.Chapman and hall.1997.
5. P.K.Gupta:Plant Biotechnology.Rastogi and Co.Meerut,2010

6. Bhojwani, S.S. and Razdan, M.K. 1996. Plant Tissue Culture : Theory and Practice (a revised edition). Elsevier Science Publishers, New York. USA.
7. Slater A, Scott N, Fowler M: Plant biotechnology: the genetic manipulation of plants. Oxford: Oxford University Press.2010

BOT 404 (A-F): Elective Papers

BOT 404 (A): ADVANCED PLANT PATHOLOGY-II

Fungal diseases : Symptomatology, disease identification and control of flag smut wheat, covered smut of barley, blast of paddy, smut of Jowar, red root of sugarcane, flax rust, early blight of potato.

Bacteria : Classification and nomenclature of bacterial plant pathogens. Methods of identification of bacterial diseases using molecular diagnostics. Bacterial diseases : Brown rot of potato, blight of rice, soft rot of vegetables, Crown gall disease, angular leaf spot of cotton.

Virus, viroid and phytoplasma disease : Symptomatology and transmission of viral diseases; Potato virus X & Y, Tomato ring mosaic, bunchy top of banana; viroids and important viroid diseases. Phytoplasma General account; Sesame phyllody, Spike disease of sandal.

Nematology : Brief history, classification and identification of plant pathogenic nematodes. Morphology and anatomy of nematodes. Methods used in Nematology. Control of plant parasitic nematodes. Nematode Disease : Molya disease of wheat & barley, ear cockle of wheat, root-knot disease.

BOT 404 (B): SEED SCIENCE & TECHNOLOGY –II

Introduction and importance of Seed Pathology in modern agriculture. History of Seed Pathology. Kinds and various method for testing seed borne fungi, bacteria and viruses (cultural, biochemical, serological, nucleic acid based methods). 18

Avenues of seed infection, environment influencing seed infection, infected/contaminated part of seed, morphology and anatomy of seeds in relation to invasion and location of inoculum of the pathogen in seed. 12

Seed-borne diseases of some important crops with particular reference to the state of Rajasthan and India. Typical case of infection by:
fungi (Wheat- smuts and bunts, Sesame-charcoal rot; bacteria (Brassicas- black rot, Cluster bean- bacterial blight); viruses (tomato mosaic virus, pea seed-borne mosaic virus,) and nematodes (Wheat- ear cockle). 18

Seed-borne inoculum, inoculum density and assessment of seed-borne inoculum in relation to plant infection, epiphytotics due to seed-borne inoculum, disease forecast based on infected seed samples : Tolerance limits of seed borne pathogens. 12

Transmission of disease: types of disease transmission, mode of establishment and course of disease from seed to plant and factors affecting them. 12

Control of seed-borne disease, principles of control, seed treatments (physical, chemical and biological), mechanism of action of seed treatment, major seed treatments for important seed pathogens. 18

List of suggested Practical exercises:

1. Dry seed examination of seed lots.
2. Isolation and identification of seed-borne mycoflora by standard blotter method (ISTA, 1976).
3. Preparation of media (PDA and NA).
4. Plating seeds on PDA/NA and identification of micro flora.
5. Other methods of plating e.g. deep freezing, 2,4D- blotter method.

6. Water agar seedling symptom test.
7. Study of any seed borne nematode disease.
8. Detection of bacterial and viral pathogens in seeds.
9. LOPAT tests for detection of seed- borne bacteria.
10. Histopathology of infected seed samples.
11. Physical control of seed-borne pathogens.
12. Antibiotic/fungicidal assay against seed-borne pathogens.
13. Field visits: Crop fields, FCI, NSC, Seed testing Labs., quarantine station (e.g. NBPGR) etc.

Suggested Readings:

1. Agarwal, V.K. and Sinclair, J.B. (1987).Principles of Seed-pathology, II edition CRC Lewis Publishers, Boca Raton, New York, London.
2. Agarwal, P. C., Mortensen, C. N. and Mathur, S. B. (1989). Seed-borne diseases and seed health testing of rice. Technical Bull. No.3, Danish government institute of seed Pathology for Developing Countries (DGISP), Copenhagen and CAB International Mycological Institute, (CMI) UK.
3. Agarwal, V.K. 2006. Seed Health. International Book Distributing Company. Charbagh, Lucknow, India.
4. Agrios, G.N. 2005. Plant Pathology. Academic Press, London., New York
5. Cliffton, A. 1958. Introduction to the Bacteria. McGraw Hill Book Co., New York.
6. Mandahar, C.L. 1978. Introduction to plant viruses. S. Chand & Co. Ltd., Delhi.
7. Mathur, S.B. and Cunfer, B.M. 1993. Seed-borne diseases and Seed health Testing of Wheat. Danish Government Institute of Seed Pathology for Developing Countries. Hellerup, Denmark.
8. Neergaard, P. (1977). Seed Pathology. Vol. I & II. The Mac Millan Press Ltd., London.
9. Rangaswamy, G. & Mahadevan, A. 1999. Diseases of crop plants in India (4th edition). Prentice Hill of India, Pvt. New Delhi.
10. Richardson, M. J. (1990). An annotated list of seed borne diseases 4th edn. Proc. Int Seed Test Assoc. Zurich, Switzerland.

11. Schaad, N. W. (1980). Laboratory guide for identification of plant pathogenic bacteria (edt.). Bacteriology Committee of American Phytopathological Society, St. Paul, Minnesota.
12. Schaad, N. W. (1988). Laboratory guide for identification of plant pathogenic bacteria (2nd eds.). APS Press (The American Phytopathological Society), St. Paul, Minnesota.
13. Singh, D. and Mathur, S. B. (2004). Histopathology of seed-borne infections. CRC Press, Boca Raton, London, New York, Washington DC.
14. Singh, K.G. and Manalo, P.L. 1986. Plant Quarantine and Phytosanitary Barriers in the Asean. Asean Plant Quarantine Centre and Training Institute, Malaysia.

BOT 404 (C): ENVIRONMENTAL BIOLOGY & ARID ZONE ECOLOGY-II

Desert: Definition, classification (hot and cold), physiography, desert features, flora, fauna and water, formation, topography, distribution and characteristics of world deserts

Hot deserts: Hot deserts of the world, Global distribution of hot deserts, Formation and topography, climatic conditions, characteristic features of each desert, flora and fauna.

Cold deserts: Cold deserts of the world, global distribution of cold deserts, formation and topography, climatic conditions, characteristic features of each desert, flora and fauna. **24hours**

Indian Arid Zones: State wise description of arid regions of India, Hot arid zones-West Rajasthan, Punjab-Haryana, Gujarat, Andhra Pradesh, Karnataka, Maharashtra. Cold arid zones-Jammu and Kashmir state, Aridity index in different arid zones of India.

Desert Ecosystem (Thar desert): Climatic conditions, temperature and rainfall, high speed wind, cyclones, sand dunes, thunder storms, characteristic features of desert soil, topography, organic matter and nutrients, food chain and food web in desert

ecosystems, Vegetation types (Rajasthan desert) and plant communities, plant life forms, plant processes (seed viability, dormancy, phenology, and rhizology of desert plants), biological production in deserts, conservation of flora and fauna, agroforestry, wild life, Succession in vegetation of western Rajasthan and coastal sand dunes, economic importance of desert plants (general economic plants, medicinal, famine food plants and crops) **24 hours**

Saline Arid zones: Saline tracts of Rajasthan and plants of saline arid zones (Halophytes), Economic and social considerations in the management of salt affected soils, afforestation in salt affected soils, Importance of halophytes.

Mangrove vegetation: Definition, Distribution of mangrove vegetation in India, habitat of mangrove plants, biological and ecological characteristic features of mangrove plants. Role of mangroves plants in conservation and ecological significance.

Sand dunes: Definition, processes for transportation of dune sands, types of sand dunes, origin and morphology of sand dunes **21 hours**.

Stabilization of sand dunes; Principles of sand dune stabilization, Techniques for stabilization of inland and coastal dunes, management of sand dunes, wind breaks and shelter belts, afforestation and desert control measures.

Water crises in desert: Water problems in Rajasthan particularly underground water resources and its change, rain water harvesting, Orans, dry land farming, arid lands and horticultural crops, Indira Gandhi Canal and its ecological implication, water logging & salinity problems- The management alternatives **21hours**.

BOT 404 (D) - ADVANCED PLANT PHYSIOLOGY-II

Plant growth regulators : Natural and synthetic, biochemistry and physiological effects of brassinosteroids, jasmonic acid; salicylic acid, polyamines, morphactins and cyanogenic compounds. 10.

Signal transduction in plants : Receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity of protein kinases and phosphatases, signal transduction mechanisms with special reference to : actin-cytoskeleton signal transduction, sugar induced signal transduction, Gibberellin induced signal transduction, auxin induced signal transduction and cytokinin induced signal transduction. 13

Stress physiology : Plant responses to biotic and abiotic stresses, mechanism of biotic and abiotic stress resistance, plant defense mechanisms against water stress, salinity stress, metal toxicity, freezing and heat stress and oxidative stress. Role of Sec. metabolites in defence mechanism, 22

Photobiology - Photoreceptors, Phytochrome : history, discovery, physiological properties, interaction between hormones, and phytochrome, role of different phytochromes in plant development and flowering, mechanism of phytochrome signal transduction. Cryptochromes and phototropins. Physiology of flowering: Photoperiodism and Vernalization. 13.

Circadian rhythms in plants - nature of oscillator, rhythmic outputs, entrainments

(inputs)and adaptive significance 10.

Tools and Techniques : Principles and application of spectrophotometry, Principles of chromatography, partition chromatography, thin layer chromatography, ion-exchange chromatography, gas-liquid chromatography, high performance liquid chromatography, gel filtration, electrophoresis, isoelectric focusing, immobilized pH gradient, ultra centrifugation(velocity and density gradient), ELISA and RIA 22.

BOT 404 (E): ADVANCED MORPHOLOGY & MORPHOGENESIS-II

Development and morphogenesis - shoot apex, the apical cell, meristem, the subcellular and biochemical struture of the meristem. the mechanism of primordium initaition, transition to flowering, growth and formation of organs, experimental work on apical meristem, meristem culture and virus free plant, histochemical studies on apical meristems. 20

The phenomenon of morphogenesis - correlation, polarity, symmetry, differentiation, regeneration 15

Morphogenetic factors - Physical, mechanical, chemical and genetic factors. molecular basis of morphogenesis in plants with special reference to work done in **Arabidopsis.** 15

Somatic embryogenesis - survey of somatic embryogenesis in angiosperms, direct somatic embryogenesis and embryogenesis from callus and protoplasts, cytology, physiology and genesis of somatic embryogenesis nutritional factors, hormonal factors and embryo rescue in wide hybridization.Endosperm and embryo culture.

Micropropagation advances and synthetic seeds. Cell plating technique and isolation of mutant cell lines, auxotrophic mutants. Mechanism involved in cell culture mutants. Suspension culture and growth studies. 22

Microtechniques. Fixation (FAA and gluteraldehyde), dehydration, clearing, embedding in paraffin and GMA, microtomy ,equipment and histological staining \procedures, histochemistry. Transmission and scanning electron microscopy for internal structure and morphologica development of plant organs and tissues. 18

BOT 404 (F): BIOSYSTEMECS OF ANGIOSPERMS-II

Experimental taxonomy - Scope and significance, Synthetic theory of evolution, study of major families belonging to monocotyledons and dicotyledons. (20 hrs)

Concept of species- speciation, species classification, Concept of characters-analytic versus synthetic character, qualitative versus quantitative characters, good and bad characters. (10 hrs)

Concept of population- its significance, pattern of phenetic variabi1ity, Geographical Variability. (10 hrs)

Variation - causes of variation in population, Range of tolerance and phenotypic plasticity. (14 hrs)

Ecotypes - origin and differentiation, Taxonomic significance of ecotypes, vicarians. (12 hrs)

Experimental taxonomy and hybridization, Role of hybridization in evolution, amphidiploidy. Breeding barriers, epistasis pleiotropy. (10 hrs)

Biochemical systematics – method and principles. Systematic markers, PCR analysis, chemotaxonomy, seed proteins, techniques of protein electrophoresis, chemical protein analysis procedures—Lowry and Bradford methods.genome analysis and nucleic acid hybridization. (14 hrs)

Practical work will be based on theory syllabus.

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