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SANT GADGE BABA AMRAVATI UNIVERSITY

विज्ञान विद्याशाखा
(FACULTY OF SCIENCE)

अभ्यासक्रमिका
विज्ञान पारंगत परिक्षा (वनस्पतीशास्त्र)
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PROSPECTUS

OF
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IN
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SYLLABUS PRESCRIBED FOR M.Sc. PART-I BOTANY
SEMESTER – I

PAPER- I: CELL BIOLOGY, CYTOLOGY AND GENETICS

Unit-I 1.1 Cell wall and Plasma membrane: Structural organization and function.

1.2 Cell organelles: Golgi bodies, Lysosomes, Endoplasmic Reticulum and Ribosomes: Structural organization and their functions

1.3 Techniques in Cell Biology: Confocal microscopy, Phase Contrast microscopy, Flow Cytometry: Principle and working.

Unit-II 2.1 Cell Cycle and Apoptosis: Mechanism of Cell division; Regulation, Roles of Cyclins and Cyclin dependent kinases, Cell Plate formation, PCD.

2.2 Cell to cell Interaction and Signal transduction : Intercellular junctures, Harmones and neurotransmitter signalling, receptors, G-proteins, kinases and messengers.

2.3 Protein sorting: Targeting of proteins to nucleus, chloroplasts and secretary pathways of leader polypeptides.

Unit-III 3.1 Chromosome Organisation : Eukaryotic chromosome structure and DNA packaging, Nucleoproteins, Organisation of centromeres and telomeres, nucleolus and r-RNA Genes, Euchromatin and heterochromatin..

3.2 Specialised Chromosomes: Polytene, Lampbrush, B-Chromosomes, Sex Chromosomes.

3.3 Structural aberrations of Chromosomes: Origin, Meiosis and breeding behaviour of duplication, deficiency, inversions and translocation- Heterozygosity.

3.4 Karyotype and Banding Patterns: Types, Evolution of Karyotype, Analysis and its significance. Application of banding techniques.

Unit-IV 4.1 Genetics of Mitochondria and Chloroplast: Semi autonomous, Genome character, size and regulation, cytoplasmic male sterility.

4.2 Mutations: Origin, Physical and Chemical mutagenic agents, Molecular basis and mutational breeding.

4.3 Transposable elements in Prokaryotes: IS elements, Composite transposons, transposition mechanisms and their effect on phenotype and genotype

4.4 Physiology of Cancer; Genetics of Cancer: C-Oncogenes, V-Oncogenes, Tumor Suppressor genes.

Unit-V 5.1 Genetic Code: Triplet nature of code, Breaking of code, Wobble Hypothesis, Properties, Evolution and Central dogma - transcription, types of RNAs, Initiation and termination signals, differences between eukaryotic and prokaryotic transcription (promoters, caps and tails, Introns, RNA editing).

5.2 Regulation of gene expression in Prokaryotes: Gene structure, Lac - operon, Trp-operon, Phage operon, transcriptional-control systems, translational control and post translational control.

5.3 Genetics of Nitrogen fixation: Organization, function and regulation of nitrogen fixing genes in klebsiella, hup genes.

Suggested Readings:

1. Lewin, B. 2000. Genes VII, Oxford University Press, New York.
2. Rost, T. et al.. 1998. Plant Biology. Wadsworth Publishing Co., California, USA.
3. Krishnamurthy, K.V.2000. Methods in Cell wall Cytochemistry, CRC Press, Boca Raton, Florida.
4. De, D.N. 2000. Plant Cell Vacuoles: An introduction. CSIRO Publication, Collingwood, Australia.
5. Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999. The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
6. Burnham, C.R. 1962. Discussions in Cytogenetics. Burgess Publishing Co., Minnesota.
7. Busch, H. and Rothblum, L. 1982. Volume X. The Cell Nucleus & DNA Part A. Academic Press.
8. Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4th Edition). Jones and Bartlett Publishers, Massachusetts, USA.
9. Khush, G.S. 1973. Cytogenetics of Aneuploids. Academic Press, New York, London.
10. Lewin B., 2000. Gene VII. Oxford University Press, New York, USA.
11. Lewis R., 1997. Human Genetics: Concepts and Applications (2nd Edition). WCB McGraw Hill, USA.
12. Russel, P.J. 1998. Genetics (5th Edition). The Benjamin/ cummings Publishing Company Inc., USA.
13. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics (2nd Edition). John Wiley and Sons Inc., U.S.A.
14. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function. Jones and Barlett Publishers, Boston, Massachusetts.
15. Hall, J.L. and Moore, A.L. 1983. Isolation of Membranes and

Organelles from Plant Cells. Academic Press, London, U.K.

16. Harris, N. and Oparka, K.J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, U.K.
17. Fukui, K. and Nakayama, S.1996. Plant Chromosomes: Laboratory Methods. CRC Press, Boca Raton, Florida.
18. Sharma, A.K. and Sharma, A. 1999. Plant Chromosomes: Analysis, Manipulation and Engineering. Harwood Academic Publishers, Australia.
19. R.S.Shukla and P.S.Chandel, 3rd Edition, 2004. Cytogenetics, Evolution and Plant Breeding.

Laboratory Exercises:

1. Squash and smear preparation; mateirals; ***Tradescantia, Colix, Allium cepa, Allium sativum; Barley, Vicia faba, Wheat, Rhoeo discolor, Aloe vera*** or any other ideal material
2. Isolation of chloroplast.
3. Demonstration of SEM and TEM.
4. Linear Differentiation of chromosomes through banding techniques, such as C-banding, O-banding and Q-banding.
5. Orcein and Feulgen staining of the salivary gland chromosomes of ***Chironomous*** and ***Drosophila.***
6. Characteristics and behaviour of B-chromosomes using maize or any other appropriate material.
7. Working out the effect of monosomy and trisomy on plant phenotype, fertility and meiotic behaviour.
8. Induction of polyploidy using colchicine; different methods of the application of colchicine.
9. Effect of induced and spontaneous polyploidy on plant phenotype, meiosis, pollen and seed fertility and fruit set.
10. Meiosis of complex translocation heterozygotes.
11. Isolation of chlorophyll mutants following irradiation and treatment with chemical mutagens.
12. Estimation of nuclear DNA content through microdensitometry and flow cytometry.
13. Isolation of mitochondria. .
14. Comparative study of normal and banded karyotype.
15. Determination of chaisma frequency in any plant species
16. Incompatibility studies in ideal plant material.
17. Problems on interaction of genes; linkage and crossing over.
18. Determination of mitotic index in any plant species.

PAPER- II: RESOURCE UTILIZATION AND CONSERVATION

UNIT I : 1.1 Concept of Biodiversity; Species diversity; Genetic diversity; Ecosystem diversity.

1.2 Origin of Biodiversity; values of Biodiversity; loss of Biodiversity.

1.3 Biodiversity and agriculture; Biodiversity and food diversity; Bioprospecting; commercial values of Biodiversity.

1.4 Conservation of Biodiversity; Implementation process in India CBD.

UNIT II: 2.1 World centers of primary diversity of domesticated plants; Indo Burmese centers.

2.2 Plant introduction and secondary centers.

2.3 Origin, evolution, botany, cultivation and uses of:

i. Food, Forage and Fodder crops.
ii. Fibre crops.
iii. Medicinal and Aromatic plants.
iv. Vegetable and Oil yielding plants.

UNIT III: 3.1 Important fire wood and timber yielding plants and non wood forest products (NWFPS) such as Bamboo, Rattam raw materials for paper making, gums, resins, tannins, dyes, fruits

3.2 Green revolution; Benefits and adverse consequences, sustainable agriculture, agroecosystem approach.

3.3 Innnovative approaches for meeting world food demands; modern agricultural approach.

3.4 Plants used as Avenue trees' for shade, pollution control and aesthetics.

UNIT IV: 4.1 Strategies for conservation of Biodiversity, global scenario, decline of bioresources.

4.2 Protected areas concept: Sanctuaries, National parks, Biosphere reserves (Tiger reserves with reference to Melghat Tiger Project) Wildlife Management and Sacred groves.

4.3 Conservation of wild germplasm with reference to threatened species.

UNIT V : 5.1 Principles and practices for *Ex- situ* conservation, Botanical gardens, Field Gene Banks, Seed Banks.

5.2 *In-vitro* repositories, Cryobanks, Legal aspects of conservation of Biodiversity in India.

5.3 General accounts and activities of national institutes like 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), Department of Biotechnology (DBT), Non formal efforts, Medicinal Plant Board, Ministry of Environment and Forests.

SUGGESTED READINGS :

1. Atwell, B.J., Kriedermann, P.E. and Jurnbull, C.G.N. (eds) 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. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4th Edition). Wadsworth Publishing, Belmont, California.
5. Anonymous 1997. National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources. New Delhi.
6. Arora, R.K. and Nayar, E.R. 1984. Wild Relatives of Crop Plants in India. NBPGR Science Monograph No.7.
7. Baker H.G. 1978. Plants and Civilization (3rd ed). C.A. Wadsworth, Belmont.
8. Chandel, K.P.S., Shukla, G. and Sharma, N. 1996. Biodiversity in Medicinal and Aromatic Plants in India : Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.
9. Chrispeels, M.J. and Sadava, D. 1977. Plants, Food and People, W.H. Freeman and Co., San Francisco.
10. Cristi, B.R. (ed.) 1999. CRC Handbook of Plant Sciences and Agriculture. Vol.I, In-situ conservation. CRC Press, Boca Raton, Florida, USA.
11. Conway, G. 1999. The Doubly Green Revolution: Food for all in the 21st Century. Penguin Books. Earthscan Press, London.
12. Conway, G. and Barbier E., 1994. Plant, Genes and Agriculture. Jones and Bartlett Publishers, Boston.
13. Council of Scientific & Industrial Research 1986. The Useful Plants of India. Publications and Information Directorate, CSIR, New Delhi.
14. Council of Scientific & Industrial Research (1948-1976). The Wealth of India. A Dictionary of Indian Raw Materials and Industrial Products. New Delhi. Raw Materials I-XI, Revised Vol. I-III (1985-1992) Supplement (2000).
15. Cronquist, A. 1981. An integrated System of Classification of Flowering Plants. Columbia University Press, New York, USA.
16. Directory of Indian Wetlands, 1993. WWF INDIA, New Delhi and AWB, Kuala Lumpur.

17. Falk, D.A., Olwell, M. and Millan C., 1996. Restoring Diversity. Island Press, Columbia, USA.
18. FAO/IBPGR 1989. Technical Guidelines for the Safe Movement of Germplasm. FAO/IBPGR, Rome.
19. Frankel, O.H., Brown, A.H.D. & Burdon, J.J. 1995. The Conservation of Plant Diversity. Cambridge University Press, Cambridge, U.K.
20. Gadgil M., and Guha, R. 1996. Ecology and Equity: Use and Abuse of Nature in Contemporary India. Penguin, New Delhi.
21. Gaston, K.J. (Ed), Biodiversity: a Biology of Numbers and Differences. Blackwell Science Ltd., Oxford, U.K.
22. Heywood, V. (Ed), 1995. Global Biodiversity Assessment. United Nations Environment Programme. Cambridge University Press. Cambridge, U.K.
23. Heywood, V.H. and Wyse Jackon, P.S. (Eds) 1991. Tropical Botanical Gardens. Their Role in Conservation and Development. Academic Press. San Diego.
24. Kocchar, S.L. 1998. Economic Botany of the Tropics, 2nd edition. Macmillan India Ltd., Delhi.
25. Kothari, A. 1997. Understanding Biodiversity : Life Sustainability and Equity. Orient Longman.
26. Kohli, R., Arya, K.S., Singh, P.H. and Dhillon, H.S. 1994. Tree Directory of Chandigarh. Lovedale Educational, New Delhi.
27. Nair, M.N.B. etal (Eds) 1998. Sustainable Management of Non-wood Forest Products. Faculty of Forestry, University Putra Malaysia, 434004 PM Serdong, Selangor, Malaysia.
28. Paroda, R.S. and Arora, R.K. 1991. Plant Genetic Resources Conservation and Management. IPGRI (Publication) South Asia Office, C/o NBPGR, Pusa Campus, New Delhi.
29. Pimentel, D. and Hall, C.W. (Eds) 1989. Food and Natural Resources. Academic Press, London-New York.
30. Pinstrup-Anderson, P. 1999. World Food Prospects : Critical issues for the Early 21st Century. International Food Policy Research Institute, Washington, D.C., USA.
31. Plant Welath of India 1997. Special issue of Proceedings Indian National Science Academy B-63.
32. Plucknett, D.L., Smith, N.J.H., William, J.T. and Murti Annishetty, N. 1987. Gene Banks and Worlds Food. Princeton, University Press, Princeton, New Jersey, USA.
33. Rodgers, N.A. and Panwar, H.S. 1988. Planning a Wildlife Protected Area Network In India. Vol.1. The Report Wildlife Institute of India, Dehradun.

34. Sahni, K.C. 2000. the Book of Indian Trees, 2nd edition. Oxford University Press, Mumbai.
35. Schery, R.W. 1972. Plant for Man. 2nd Ed. Englewood Cliffs, New Jersey. Prentice Hall.
36. 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.
37. Swaminathan, M.S. and Kocchar, S.L. (Eds) 1989. Plants and Society. Macmillan Publication Ltd., London.
38. Thakur, R.S., Puri, H.S. and Husain, A. 1989. Major and Aromatic Plants, CSIR, Lucknow.
39. Thomas, P. 2000. Trees : Their National History, Cambridge University Press, Cambridge.
40. Wagner, H., Hikino, H. and Farnswarth, N. 1989. Economic and Medicinal Plant Research, Vols. 1-3. Academic Press, London.
41. Walter, K.S. and Gillett, H.J. 1998. 1997 IUCN Red List of Threatned Plants. IUCN, the World Conservation Union, IUCN, Gland, Switzerland, and Cambridge, U.K.

Suggested laboratory Exercises:

The Practical course is divided into three units: (1) 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 fibres :
   (a) Textile fibres : Cotton, Jute, Linen, Sunn hemp, Cannabis.
   (b) Cordage fibres : Coir.
   (d) Fibres for stuffing: Silk cotton or kapok
   Morphology, anatomy, microscopic study of whole fibers using appropriate staining procedures.
4. Medicinal and aromatic plants: Depending on the geographical location of 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 zeylanica (Syn A. vasica), Allium sativum, Rauvolffia serpentina, Withania somnifera, Phyllanthus amarus, (P. fraternus), Andrographis paniculata, Aloe barbadense, Mentha arvensis, Rosa sp., Pogostemon cablin, Origanum vulgare,

Vetiveria zizanioides, Jasminum grandiflorum, Cymbopogon sp., Pandanus odoratissimus,Abrus precatorius, Asparagus racemosus, Melia azhadirac, Dioscorea pentaphylla, Vitex negundo, Oscimum sanctum.

Study of live or herbarium specimens or other visual materials to become familar with these sources. (Identification, uses and products like oils).

5. Vegetable Oils: Mustard, Groundnut, Soyabean, Coconut, Sunflower and Castor. Morphology, microscopic structure of the oil-yielding tissues, tests for oil and Iodine number. (Any three)
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. (One from each category)
7. To prepare ombrothermic diagrams for different sites on the basis of given data and comment on climate.
8. To find out association between grassland species using chi square test.
9. To analyse plant community using Bra-curtis ordination method.
10. To determine diversity indices for protected and unprotected cropland stands.
11. To determine IVI of grassland.
12. To prove the biological spectrum of vegetation under study using Raunkiar's life forms classification.

SEMESTER – I

PRACTICAL I: CELL BIOLOGY, CYTOLOGY, GENETICS, RESOURCE UTILIZATION & CONSERVATION.

PRACTICAL SCHEDULE

Time: 6 hrs. **Marks - 40**

Q.1	Karyotype Analysis	06
Q.2	Isolation of any cell organelle	05
Q.3	Smear/Squash Technique/ Specialized Chromosome	04
Q.4	Problem on interaction of genes	04
Q.5	Identification and morphological description of given economically important plant	05
Q.6	Chemical Characterization of tannins, resins, dyes, fibers (any –2)	05

Q.7 Spotting 06

Q.8 Viva-Voce 05

PAPER – III: BIOLOGY AND DIVERSITY OF ALGAE AND BRYOPHYTES

Unit -I: General account and reproduction.

1.1 : Range of habitat and thallus organization in Algae.

1.2 : Cell structure;

i) Ultrastructure

ii) Pigments in Algae

iii) Reserve food material

iv) Flagella.

1.3 Classification by F.E. Fritsch (1935), G.M. Smith; Chapman (1938); Round (1965)

1.4 : Cyanophyta- Ultrastructure of cell,heterocyst, reproduction and affinities.

1.5 : Reproduction in Algae and alternation of generations.

Unit -II : Diversity and Phylogenenetic considerations

2.1 : Chlorophyta: Volvocales, Chlorococcales, Ulotricales, Cladophorales,Cheatophorales,Oedogoniales, Conjugales, Siphonales, Charales.

2.2 Chrysophyta: Chrysophyceae, Xanthophyceae, Bacillariophyceae

2.3 Cryptophyta:Cryptophyceae

2.4 Dinophyta: Dinophyceae

Unit- III :Diversity; Phylogeny and Importance of Algae

3.1 : Range of thallus , reproduction and life-cycle in i)Phaeophyta, ii)Rhodophyta

3.2 : Economic importance of Algae as biofertilizer; food; feed; and use in industry.

3.3 : Algae in Symbiotic association, as pollution indicator; phytoplanktons and water blooms.

3.4 : Fossil Algae

Unit- IV: Bryophyta : General account and significance.

4.1 : Classification and distribution of Bryophytes.

4.2 : Vegetative propagation in Bryophytes.

4.3 : Fossil Bryophytes.

4.4 : Economic and ecological importance of Bryophytes.

Unit -V : Morphotaxonomy and Phylogeny of Bryophytes.

5.1 : Thallus Organization; internal structure and reproduction in

i) Sphaerocarpales, ii)Marchantiales, iii)Anthocerotales,

iv) Jungermanniales.

5.2 : Thallus organization; internal structure and reproduction in

i) Sphagnales, ii)Andreales, iii) Bryales

5.3 : Progressive and retrogressive evolution in Gametophytes and Sporophytes.

Suggested Readings:

1. Kumar, H.D. 1988, Introductory Phycology. Affiliated East- West Press Ltd., New Delhi.
2. Morris, I.1986. An Introduction to the Algae, Cambridge University Press, U.K.
3. Parihar, N.S. 1991, Bryophyta, Central Book Depot, Allahabad.
4. Parihar, N.S. 1996, Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
5. Puri, P. 1980, Bryophytes. Atma Ram and Sons, Delhi.
6. Round, F.E. 1986. The Biology of Algae, Cambridge University Press, Cambridge.
7. Stewart, W.N. and Rothwell, G.W. 1993. Paleobotany and the Evolution of Plants. Cambridge University Press.
8. Prescott G.W. (1969) The Algae: A Review, Thomas Nelson and sons, London.
9. Lee,R.E. (1980) Phycology, Cambridge University Press, Cambridge.
10. Kumar, H.D. (1990) Introductory Phycology, East west Press , New Delhi.
11. Misra, J.N. (! 966) Pheaeophyceae of India, ICAR, New Delhi.
12. Kumar , H.D.(1989) Algal Cell Biology, 2nd Edition, East west Press , New Delhi.
13. Desikachary, T.V. (1959) , Cyanophyta , ICAR, New Delhi.
14. Round , F.E. (1981) The Ecology of Algae. Cambridge University Press, Cambridge.
15. Round , F.E. (1973) The Biology of Algae. 2nd Edition, Edward and Arnold , London.
16. Campbell, D.H. (1961) The evolution of Land Plants. Central Book Depot, Allahabad.
17. Smith G.M (1955) Cryptogamic Botany Vol-II. Bryophyta and Pteridophyta McGraw Hill.Book Co., New York
18. Watson, E.V. (1967) The structure and Life of Bryophytes , 2nd Edition. London, Hutchinson.
19. Ram Udar (1970) An introduction to Bryophyta , Sadashiv Malviya Prakashan, Lucknow.
20. B.R.Vashishta (Revised by A.K.Sinha), Reprint Edition 2005.

21. B.R.Vashishta : Algae

Laboratory Exercises: -

1. Morphological study of Algae :(Any 12 of the following)
   Oscillatoria, Nostoc, Anabaena, Spirullina, Gleotricha, Chlamydomonas, Eudorina, Volvox, Closterium, Hydrodictyon, Pediastrum, Cladophora, Ulva, Pithophora, Draparnaldia, Cosmarium, Chlorella, Acetabularia, Chara, Nitella, Laminaria, Sargassum, Padina, Ectocarpus, Batrachospermum, Gracillaria, Gellidium, Polysiphonia,
2. Morphological, anatomical and reproductive studies of following members: ***Targonia, Cyathodium Marchantia, Plagiochasma, Deumortiera, Anthoceros, Notothylus; Polytrichum, Pogonatum, Sphagnum,***
3. Field study: i) Collection of Algal material from water reservoirs (ii) Collection of Bryophytic material.

   Field visits: Visits to the field to study distribution of algal flora and bryophytic forms.

PAPER – IV: PLANT DEVELOPMENT AND REPRODUCTION

UNIT I: 1.1 Unique features of plant development, differences between plant and animal development.

1.2 Structure of seed, germination of seed and seedling growth and control.

1.3 Metabolism of nucleic acids, proteins and mobilization of reserve food.

1.4 Seed dormancy: types, importance and means to break the seed dormancy.

UNIT II: 2.1 Organisations of shoot apical meristem (SAM). Cytological and molecular analysis of SAM, Root apical meristem.

2.2 Types of meristem, tissue differentiation, structures, development and importance of tissue differentiation: Vascular cambium and cork cambium, evolution of Xylem.

2.3 Wood development in relation to environmental factors, secondary growth: stem and root.

2.4 Leaf development and structure, differentiation of epidermis and mesophyll. Structure and function of secretary ducts and laticifers.

UNIT III: 3.1 Plant reproduction: Means of reproduction, flower development, homeotic mutants in *Arabidopsis* and *Antirrhinum*, sex determination.

3.2 Structure of anther, microsporogenesis, and pollen development, pollen viability, male sterility, pollen germination, pollen storage, pollen embryo.

3.3 Types of ovules, ovule development and structure, megasporogenesis, embryo sac development and structure.

UNIT IV: 4.1 Flower structure and floral characteristics, mechanism of pollination, flower vectors.

4.2 Breeding system, structure, pollen pistil - interaction, sporophytic and gametophytic self-incompatibility.

4.3 Double fertilization, development of embryo, endosperm and seed development.

4.4 Dynamics of fruit growth, biology of fruit maturation.

UNIT V: 5.1 Polyembryony, apomixis, *In-vitro* plant regeneration through embryo, pollen and anther culture.

5.2 Metabolic changes associated with senescence and its regulation.

5.3 Influence of hormones and environmental factors on senescence.

Suggested Readings:

1) Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Delhi.
2) Fageri, K. and Van der Pol, L. 1979. The Principles of Pollination Ecology. Pergamon Press, Oxford.
3) Fahn, A. 1982. Plant Anatomy, (3rd edition). Pergamon Press, Oxford.
4) Fosket, D.E. 1994. Plant Growth and Development. A molecular Approach. Academic Press, San Diego.
5) Howell, S.H. 1998, Molecular Genetics of Plant Development. Cambridge University Press, Cambridge.
6) Leins, P., Tucker, S.C. and Endress, P.K. 1988. Aspects of Floral Development. J. Cramer, Germany.
7) Lyndon, R.F., 1990. Plant Development. The Cellular Basis. Unnin Hyman, London.
8) Murphy, T.M. and Thompson, W.F. 1988. Molecular Plant Development. Prentice Hall, New Jersey.
9) Proctor, M. and Yeo, P. 1973. The Pollination of Flowers. William Collins Sons, London.
10) Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
11) Raghavan, V. 1999. Developmental Biology of Flowering Plants. Springer-Verlag, New York.

12) Raven, P.H., Evert, R.F. and Eichhorn, S.E. 1992. Biology of Plants (5th Edition). worth, New York.

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

14) Sedgely, M. and Griffin, A.R. 1989. Sexual Reproduction of Tree Crops, Academic Press, London.

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

16) Shivanna, K.R. and Sawhney, V.K. (eds) 1997. Pollen Biotechnology for Crop Production and Improvement, Cambridge University Press, Cambridge.

17) Shivana, K.R. and Rangaswamy, N.S. 1992. Pollen Biology: A Laboratory Manual. Springer-Verlag, Berlin.

18) Shivana, K.R. and Johri, B.M. 1985. The Angiosperm Pollen: Structure and Function. Wiley Eastern Ltd., New York.

19) The Plant Cell. Special issue on Reproductive Biology of Plants, Vol. 5(10) 1993. The American Society of Plant Physiologists, Rockville, Maryland, USA.

Suggested Laboratory / Field Exercises (Any 10):

1. Effect of gravity, unilateral light and plant growth regulators on the growth of young seedlings.
2. Role of dark and red light / far-red light on the expansion of cotyledons and epicotylar hook opening in pea.
3. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla*.
4. 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.
5. 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.
6. 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 plant.
7. Study of epidermal peels of leaves such as *Coccinia, Gallardia, 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.

8. Study of whole roots in monocots and dicots. Examination of L.S. of root. from 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.
9. Study of microsporogenesis and gametogenesis in sections of anthers.
10. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (Maize, Grasses, *Cannabis sativa, Crotolaria, Tradescantia, Brassica, Petunia, Solanum melongena*, etc.)
11. Tests for pollen viability using stains and *in vitro* germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
12. Estimating percentage and average pollen tube length *in vitro.*
13. Role of transcription and translation inhibitors on pollen germination and pollen tube growth.
14. Pollen storage, pollen-pistil interaction, self-incompatibilty, *in vitro* pollination.
15. Study of ovules in cleared preparations; study of monosporic, bisporic and tetrasporic types of embryo sac development through examination of permanent stained serial sections.
16. Field study of several types of flower with different pollination mechanisms (wind pollination, thrips pollination, bee/butterfly pollination, bird pollination).
17. 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.
18. Study of nuclear and cellular endosperm through dissections and staining.
19. Isolation of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun (*Syzygium cumini*) etc. by dissections.
20. Study of seed dormancy and methods to break dormancy.

Semester – I

PRACTICAL –II: BIOLOGY AND DIVERSITY OF ALGAE AND BRYOPHYTES AND PLANT DEVELOPMENT AND REPRODUCTION

Practical schedule

Time 6 hrs. Marks: 40

Q. 1	:	Isolation and identification of any two algal forms	06
Q.2	:	Characterization and identification of given Bryophytic material.	06
Q.3	:	Setting and working of any experiment based on plant development	10
Q.4	:	Microtomy	05
Q.5	:	Spotting algal, bryophyte Plant DW; flower	08
Q.6	:	Viva-voce	05

Semester – II

PAPER –V: CYTOGENETICS AND MOLECULAR BIOLOGY

Unit I : 1.1 Cytogenetics of polyploids: Types, origin and production of polyploids; genome constitution, meiotic behaviour, analysis and evolution in major crop plants; induction and characterization of trisomics; significance in crop improvement.

1.2 Breeding of polyploids: heterosis and inbreeding depression.

1.3 Plant Breeding: Methods of breeding in self-pollinated and cross-pollinated crops, genetic variability, male sterility in plant breeding.

Unit II : 2.1 Molecular Cytogenetics: Nuclear DNA content, C-value paradox; cot curve and *in-situ* hybridization.

2.2 Physical mapping of genes on chromosomes and their analysis, problems on linkage and crossing over, single nucleotide polymorphism (SNP).

2.3 Multigene families evolution, types of multigene families and the proteins produced, chaperones.

Unit III: 3.1 Gene expression and its regulation in Eukaryotes: fine structure of gene, cis-trans test, introns, mRNA splicing, RNA editing, CAAT BOX, TATA BOX, Homeo box, role of transcription factors.

3.2 Genetic Recombinations: Molecular mechanism of crossing over, role of Rec- A, B, C, D enzymes site specific recombination, independent assortment and crossing over.

3.3 Genetics of Yeast: Yeast genome, yeast genome characterization, Yeast artificial chromosome.

Unit IV: 4.1 Genetic and Restriction Mapping: Restriction digestion of DNA, single and double digest, restriction map construction.

4.2 Molecular markers: Isozymes, proteins, RAPD, AFLP.

4.3 Techniques in genetic engineering: DNA finger printing, Southern blotting and Electrophoresis.

Unit V: 5.1 Methods of DNA sequencing: Maxam and Gilbert technique, Sanger's Dideoxy nucleotide method, application of sequencing.

5.2 Biostatistics: Mean, mode, central tendency, standard deviation, variance, covariance, correlation, regression; sampling, chi-square test and its significance.

5.3 Molecular Biology and Bioinformatics: Overview, scope, development, introduction to databases, computers in bioinformatics, applications.

Suggested Reading:

1. 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.
2. Wolfe, S.L. 1993, Molecular and Cellular Biology. Wadsworth Publishing Co., California, USA.
3. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2000.Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
4. Kleinsmith, L.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology (2nd Edition). Harper Collins College Publishers, New York, USA.
5. 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.
6. Alberts, B., Bray, D., Lewis, J., RAff, M., Roberts, K. and Watson, J.D. 1989. Molecular Biology of the Cell (2nd Edition). Garland Publishing Inc., New York.
7. Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999. The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
8. Burnham, C.R. 1962. Discussions in Cytogenetics. Burgess Publishing Co., Minnesota.
9. Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4th Edition). Jones and Bartlett Publishers, Massachusetts, USA.

10. Khush, G.S. 1973. Cytogenetics of Aneuploids. Academic Press, New York, London.
11. Karp G 1999. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons, Inc., U.S.A.
12. Lewin B., 2000. Gene VII. Oxford University Press, New York, USA.
13. Lewis R., 1997. Human Genetics: Concepts and Applications (2nd Edition). WCB McGraw Hill, USA.
14. Malacinski, G.M. and Freifelder, D., 1998. Essentials of Molecular Biology (3rd Edition). Jones and Barlet Publishers, Inc., London.
15. Russel, P.J. 1998. Genetics (5th Edition). The Benjamin/ cummings Publishing Company Inc., USA.
16. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics (2nd Edition). John Wiley and Sons Inc., U.S.A.
17. Glick, B.R. and Thompson, J.E. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
18. 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.
19. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function. Jones and Barlett Publishers, Boston, Massachusetts.
20. 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.
21. Harris, N. and Oparka, K.J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, U.K.
22. Shaw, C.H. (Ed.), 1988. Plant Molecular Biology: A Practical Approach, IRL Press, Oxford.
23. Fukui, K. and Nakayama, S.1996. Plant Chromosomes: Laboratory Methods. CRC Press, Boca Raton, Florida.
24. Sharma, A.K. and Sharma, A. 1999. Plant Chromosomes: Analysis, Manipulation and Engineering. Harwood Academic Publishers, Australia.

Laboratory Exercises:

1] Isolation of mitochondria and the activity of its marker enzyme, succinate dehydrogenase (SDH).
2] Isolation of chloroplasts and SDS-PAGE profile of proteins to demarcate the two subunits of Rubisco.
3] Isolation of nuclei and identification of histones by SDS-PAGE.
4] Isolation of Plant DNA and its quantitation by a spectrophotometric method.

5] Isolation of DNA and preparation of "cot" curve.
6] Restriction digestion of plant DNA, its separation by agarose gel electrophoresis and visualization by ethidium bromide staining.
7] Isolation of RNA and quantitative estimation by a spectrophotometric method.
8] Separation of Plant RNA by agarose gel electrophoresis and visualization by EtBr staining.
9] Southern blot analysis using a gene specific probe.
10] Fluorescence staining with FDA for cell viability and cell wall staining with calcofluor.
11] Silver banding for staining nucleolus-organizing region, where 18S and 28S rDNA are transcribed.
12] To perform plant hybridization
13] Estimation of nuclear DNA content through microdensitometry and flow cytometry.
14] Fractionation and estimation of repetitive and unique DNA sequences in nuclear DNA.
15] Study of protein profile by gel electrophoresis.
16] Determination of pollen sterility with staining techniques.
17] Statistical Analysis (standard error, standard deviation, variance, significance) of the given data.

Semester – II

PAPER –VI: BIOLOGY AND DIVERSITY OF MICROBES AND FUNGI

UNIT I: 1.1 Archaebacteria and Eubacteria- General account, nutrition, reproduction and economic importance.
1.2 Ultrastructure of Eubacteria.
1.3 Important bacterial diseases of regional crops.

UNIT II: 2.1 Viruses: characteristics and ultrastructure of Virions, chemical nature, replication, transmission of viruses.
2.2 Important viral disease of regional crops.
2.3 Phytoplasma: General account and important plant disease.

Unit III: 3.1 Classification of Fungi proposed by Ainsworth (1971)
3.2 Economic importance of Fungi.
3.3 Myxomycotina: General account.
3.4 Mastigomycotina: General account of Chytridiomycetes, Oomycetes, Plasmodiophoromycetes.
3.5 Zygomycotina: General account (studies up to order level and their respective genera.)

UNIT IV: 4.1 Ascomycotina: General, vegetative and reproductive

characters of Hemiascomycetes, Plectomycetes and Discomycetes.

4.2 Basidiomycotina: General vegetative and reproductive characters of Teliomycetes, Hymenomycetes and Gastromycetes.

4.3 Deuteromycotina: General account and importance.

UNIT V: 5.1 Heterothallism and Parasexuality in Fungi.

5.2 Mycorrhiza: Ectomycorrhizae and Endomycorrhizae, general account and VAM Fungi.

5.3 Fungi as Biological Agent.

Suggested Readings:

1) Agrios, G.N. (1980) Plant Pathology, academic Press, INC, New York.
2) Ainsworth, G.C. and A.S.Sussman (eds). The Fungi, An advance Treatise Vol.I, II, III & IV Academic Press, New York.
3) Alexopoulos, C.J. (1962). Introductory Mycology John Wiley Eastern Pvt.Ltd.
4) Alexopoulos, C.J. and Mims C.W. (1979). Introductory Mycology 3rd Edition, John Wiley and Sons, Inc. Wiley, New York.
5) Alexopoulos, C.J., Mims and Black well (1996) 4th ed. John Wiley and Sons, Inc. Wiley, New York.
6) Aneja, K.R. (1993) Experimental in Microbiology, Plant Pathology & Tissue Culture, Wiswa Prakashan, New Delhi.
7) Bessey, E.A. (1950) Morphology and Taxonomy of Fungi. The Blakiston co. Philadelphia.
8) Bharat Rai, D.K.Arora, N.K.Dube and P.D.Sharma (1994) : Fungal Ecology and Biotechnology, Rastogi Publication.
9) Bilgrami, K.S. and H.C.Dube (1985) A text Book of Modern Plant Pathology, Vikas Publication House, New Delhi.
10) Balkhande L.D. & L.V. Gangawane (2000) Production of auxins Phyollosphere mycoflora and wheat plant resource development, Saraswati Prakashan Aurangabad, P.160-165.
11) Barnett, J.H. (1968) Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.
12) Butler E.J. and S.J.Jones (1949) Plant Pathology, Macmillan & Co. New York.
13) Buckyng Pugh G.J.F. (1971) Auxin productions by phyllosphere fungi Nature Vol. 231 P.332.
14) Dickenson and Preece Micrology of arial plant surfaces, Academic Press, New York,
15) Dube, R.C. and D.K.Maheshwari (1999) A.Text Book of microbiology, S.Chand & Co. Ltd.

16) Dube, R.C. and D.K.Maheshwari (2000) Practical Microbiology - S.Chand & Co. Ltd.
17) Gruen, H.E. (1959) The production of IAA by *Phycomyces blakesleanus* Mycol.57 683-694.
18) Gupta, V.K. and M.K.Behl (1994) Indian Plant Viruses and Mycoplasma Kalyani Publishers, 1/1, Rejinder Nagar, Ludhiana.
19) Jha, D.K. (1993) A Text Book of Seed Pathology, Vikas Publication House.
20) Manibhushan Rao, K. and A.Mahadevan - Recent Development in biocontrol of plant pathogenes. Today and Tomorrow publishers, New Delhi.
21) Mehrotra, R.S. and Aneja, K.R. (1990) An Introduction to Mycology, Willey Eastern Private Limited.
22) Mehrotra, R.S. (1989) Plant Pathology, Tata McGraw Hill.
23) Mehrotra, R.S. and K.R.Aneja (1998) An Introduction to Mycology, New Age Intermidiate Press.
24) Mukadam, D.S. (1997) The Illustrated Kingdom of fungi, Akshar Ganga Prakashan, Aurangabad.
25) Mukadam, D.S. and L.V.Gangawane (1978) Experimental Plant Pathology (edited) Marathwada University Aurangabad.
26) Pande, P.B. (1997) Plant Pathology, S.Chand & Co. New Delhi.
27) Pelzer, M.J. , Jr.Cahn, E.C.S. and N.R.Krieg (1993) Microbiology, Tata McGraw Hill.
28) Preece and Dickeson. Ecology of leaf surface microorganism Academic Press, New York.
29) Rangaswamy, G. and A.Mahadevan (1999) Diseases of Crop Plant in India, Prentice Hall of India.
30) Raychoudhari, S.P. and Nariani, T.K. (1977) Virus and Mycoplasma Diseases of Plant in India, Oxford and IBH Publication Co.
31) Reddy, S.M. *et al* (1997) Microbial Biotechnology, Scientific publishers, Jodhpur.
32) Schlegel, H.G. (1996) General Microbiology, 7th Edition, Cambridge University Press.
33) Snowdon, A.L. (1991) A colour Atlas of Post harvest diseases & disorders of fruits & vegetables Vol.I & II Wolfe Scientific, London.
34) Sing, R.S. (1994) Plant Pathology, Oxford and IBH Publication Co. New Delhi.
35) Sunder Rajan, S. (2001) Tools and Techniques of Microbiology, Anmol Publ.New Delhi.
36) Thind, T.S. (1998) Diseases of field crops and their management, National Agricultural Technology, Information Centre Ludhiana.
37) Vaidya, J.G. (1995) Biology of the fungi, Satyajeet Prakashan, Pune.

38) Walker, J.G. (1952) Diseases of Vegetables Crops. McGraw Hill, New York.

39) Walker, J.C. (1968) Plant Pathology, McGraw Hill, New York.

Laboratory Exercises:

1. Morphological Studies of Fungi (any 15 of the following)
   Stemonities, Perenospora, Phytopthora, Albugo, Mucor, Rhizopus, Yeast, Aspergillus, Penicillium, Chaetomium, Taphrina, Peziza, Erisyphe, Phyllactenia, Uncinula, , Melamosora, Uromyces, Drechslera,Ravenallia, Ustilago, Polyporus, Morchella, Cyathus, , Alternaria, Helminthosporium, Curvularia, Colletotrichum, Phoma, Plasmodiophora, Cercospora, Fusarium, Claviceps.
2. Symptomology of some diseased plants (any 10 of the following).
   White rust of Crucifers, Downy mildew, powdery mildew, Rusts, Smuts, Ergot, Groundnut leaf spot (Tikka disease), False smut of paddy, red rot of Sugarcane, Wilt disease, Citrus canker, Angular leaf spot of cotton, Leaf mosaic of bhindi/ papaya, Leaf curl of tomato/Potato/Papaya, Little leaf of brinjal.
3. Identification of Fungal cultures (Any 5)
   Rhizopus, Mucor, Aspergillus, Penicillum, Drechslera, Curvularia. Phoma, Colletotrichum, Alternaria, Helminthosporium.

Semester-II

PRACTICAL – III

(CYTOGENETICS, MOLECULAR BIOLOGY, BIOLOGY & DIVERSITY OF MICROBES AND FUNGI)

Time : 6 hrs. Marks : 40

Q. 1.	Isolation and Estimation of DNA by UV-VIS spectrophotometry.	08
Q. 2.	Experiment on Plant Breeding/Polyploids.	05
Q. 3.	Biostatistical analysis of given data	04
Q.4	Identification of given Fungal culture and plant disease material with its diagnostic characters and classification	08
Q.5.	Identify the given plant disease as per its symptoms	05
Q. 6.	Spotting.	05
Q. 7.	Viva-voce	05

Semester- II

PAPER VII: PLANT PHYSIOLOGY

Unit-I : 1.1 Energy flow: Principle of thermodynamics, kinetics, dissociation and association constants; Gibb's free energy,

redox reactions, structure and function of ATP.

1.2 Enzymology: Allosteric mechanisms, regulatory and active sites; isozymes; Michaelis- Menton Equation and its significance.

Unit-II: 2.1 Transport of water through xylem; plant water relations, SPAC.

2.2 Translocation of solutes in phloem transport, passive & active, transport; nutrient uptake through root microbe interaction; membrane transport proteins.

2.3 Stress physiology: Overview; types of stresses and plant responses, mechanism for tolerance of biotic and abiotic stresses. (Water, temperature, salinity and metal)

Unit-III: 3.1 Photochemistry: Light energy, components of electromagnetic radiation, photons, absorption spectrum, action spectrum, light harvesting complexes.

3.2 Photosynthesis: Evolution of photosynthetic apparatus, photoxidation of water, Hills reaction, two-pigment system, mechanism of electron and proton H+ transport, carbon assimilation pathways in C3, C4 and CAM plants. Photosynthetic productivity in these plants. Physiological, ecological consideration and significance.

3.3 Photobiology: Discovery, structure and properties (biochemical and photochemical) of photochromes and cryptochromes, photomorphogenesis, G-proteins, signaling.

Unit-IV: 4.1 Respiration: Mitochondrial electron transport; Glycolysis; synthesis of ATP, respiratory pathways- PPP; regulation of respiration.

4.2 Photorespiration: Glyoxylate pathway, biochemical basis of photorespiration, photorespiration and crop productivity and significance.

4.3 Senescence and PCD; Mechanism, physiology of senescence; role of hormones, biochemical aspects, significance in fruit ripening

Unit-V: 5.1 Growth Regulators and Elicitors: Physiological effect and mechanism of action of Auxins Gibberellins, Cytokinins, Ethylene, Abscissic acid, Brassinosteriods, Jasmonic acids, Polyamines, salicylic acid; receptors and expression.

5.2 Flowering Process: Photoperiodism and significance of Florigen in floral induction, development, genetic analysis, vernalization and its role in flowering.

5.3 Plant Movements: Classifications of plant movements, physiological basis of plant movements.

Suggested Reading:

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. Galston, A.W. 1989. Life Processes in Plants. Scientific American Libray, Springer-Verlag, New York,USA.
3. Hooykaas, P.J.J., Hall, M.A. and Libbenga, K.R. (eds) 1999. Biochemistry and Molecular Biology of Plant Hormones, Elsevier, Amesterdam, The Netherilands.
4. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA.
5. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D., and Darnell, J. 2000. Molecular Cell Biology (fourth edition). W.H. Freeman and Company, New York, USA.
6. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones (second edition). Springer-Verlag, New York, USA.
7. Nobel, P.S., 1999. Physiochemical and Environmental Plant Physiology (second edition), Academic Press, San Diego, USA.
8. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4th edition). Wadsworth Publishing Co., California, USA.
9. Singhal, G.S., Renger, G., Sopory. S.K., Irrgang, K.D. and Govindejee 1999. Concepts in Photobiology. Photosynthesis and Photomorphogenesis, Narosa Publishing House, New Delhi.
10. Taiz, L. and Zeiger, E. 1998. Plant Physiology (2nd edition). Academic Press, San Diego, U.S.A. Westhoff, P. (1998) Molecular Plant Development: from Gene to Plant. OxfordUniversity Press, Oxford, UK.
11. Plummer, D.T. 1988. An Introduction to practical Biochemistry. Tata McGraw Hill Publishing Co.Ltd.New Delhi.
12. Wilson,K. and Goulding, K.H. (Eds), 1992. A Biologist Guide to Principles and Techniques
13. Practical Biochemistry (3rd Edition). Manas Saikia for Foundation Books, New Delhi.
14. Sadasivam, S. and Manickam A., 1996. Biochemical methods (2nd Edition). New Age International Publishers New Delhi
15. Sharma, J.R. 1994. Principles and Practice of Plant Breeding. Tata McGraw Hill Publishing Company Ltd. New Delhi.
16. Rubenstein, I. Gengen bach, B.Phillips, R.L. and Green C.E. (Eds), 1980. Genetic improvement of crops. University of Minnesota Press. U.S.A.
17. Chaudhary, R.C. 1986. Introduction to Plant breeding, Oxford & IBH Publishing Co., New Delhi.

18. Gupta, S.K.2000. Plant Breeding. Theory and Techniques. Agrobios (India) Jodhpur
19. Singh, P. 2001. Essentials of Plant Breeding (2nd Edition). Kalyani Publishers, New Delhi.

Laboratory Exercises:

1. Extraction of chloroplast pigments from leaves and preparation of absorption spectrum of chlorophylls and cardtenoids.
2. To determine chlorophyll a, chlorophyll b and total chlorophyll ratio in C3 & C4 plants.
3. Estimation of sodium and potassium in plant material by flame photometry.
4. Determination of Ca: Mg ratio by spectrophotometry in plant tissue.
5. Preparation of the standard curve of proteins (BSA) by Biurette method.
6. Determination of Isoelectric point of Legumin.
7. Effect of GA/IAA on plant growth.
8. Isolation of intact chloroplasts and estimation of chloroplast proteins by spot protein assay.
9. To demonstrate photophosphorylation in intact chloroplasts, resolve the phosphoproteins by SDS-PAGE & performs Western blotting.
10. Estimation of protein content in extracts of plant material by Lowry's or Bradford's method.
11. Assay of the enzyme Phosphatases.
12. Assay of the enzyme nitrate reductase.
13. Principles of colorometry, spectrophotometry and fluorimetry.
14. Demonstration of an electron transport system.
15. Estimation of carbon dioxide liberated during respiration.
16. To demonstrate the process of antagonism.
17. To demonstrate the process of fermentation by Kunhe's vessel.
18. To demonstrate the process of tissue tension.
19. Detection of amino acids by chromatography.
20. Effect of various salts on the permeability of the plasma membrane.
21. Estimation of Ascorbic Acid in the given material.
22. Estimation of reducing, Non-reducing and total sugars.

Semester-II

PAPER – VIII: PLANT METABOLISM.

Unit-I : 1.1 Carbohydrates in Biosphere, properties, functions and importance

1.2 Carbohydrate Metabolism: - Biosynthesis of starch and sugars, catabolic pathways, interaction between Hexose Pentose Phosphate and Triose phosphate pools.

Unit-II : 2.1 Amino Acid Metabolism: Assimilation of inorganic nitrogen in amino acids, Biosynthesis of amino acids in plants, Proline metabolism– a target for metabolic engineering of stress tolerance.

2.2 Protein: Regulation of cystolic protein biosynthesis in eukaryotes, post-translational modification of proteins; storage proteins, degradation of proteins.

Unit-III: 3.1 Lipid Metabolism: Classification, structure and function of lipids, biosynthesis of fatty acids, membrane lipids, structural lipids and storage lipids.

3.2 Catabolism of storage lipids, phospholipids and derived lipids (steroids).

Unit-IV: 4.1 Nitrogen Metabolism: Overview of nitrogen fixation, ammonia uptake and reduction, nitrite reduction.

4.2 Sulphur Metabolism: Sulphur chemistry and fixation, uptake and transport, reductive sulphate assimilation pathways, synthesis and function of glutathione and its derivatives.

Unit-V : 5.1 Metabolism Biochemistry: Primary and secondary metabolites in plants as important natural products; types of alkaloids, phenols, flavonoids, glycosides, and their applications; distribution and localization.

5.2 Phosphate Metabolism.

5.3 Phytochemical Techniques: Quantitative and Qualitative analysis methods; TLC, HPLC, HPTLC principle and techniques.

Suggested Readings:

1. Brachet J. & Mirshy, A.E., ed., The Cell Biochemistry, Physiology, Morphology, Vol.II. Academic Press Inc. London LTD. 1961.
2. Buchanan, B.B.; Gruissem, W.; Jones, R.L.; Biochemistry & Molecular Biology of Plants, American Society of Plant Physiologists, Rockville, Maryland, 2000.
3. Daniel,M. and R.P.Purkayastha Ed., Handbook of Phytoalexin metabolism & action, Marcel Dekker, Inc., New York, 1995.
4. Davies, D.D., ed., The Biochemistry of Plants, Vol.II, Academic Press, London, 1987.
5. Duke, J.A. CRC Handbook of Phytochemical Constituents of GRAS Herbs, Foods & other Economic Plants. CRC Press, Boca Raton, FL, 1992.
6. Epstein, E., Mineral Nutrition of Plants: Principles & Perspectives. John Wiley & Sons, New York, 1972.

7. Kaufman, P.B.; L.J.Cseke; S.Warber; J.A.Duke & H.L.Brielmann. Natural products from plants. CRC Press LLC New York, 1999.
8. Marchner, H. Mineral Nutrition of Higher Plants, 2nd ed. Academic Press,, London, 1995.
9. Nishimura, S.; C.d.Vance & N.Doke, Eds. Molecular determinants of Plant diseases. Japan Scientific Press, Tokyo / Springer Verlag, Berlin, 1987.
10. Staples, R.C. Ed. Plant Disease Control, John Wiley & Sons, New York, 1981.
11. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. (eds) 1997. Plant Metabolism (second edition), Longman, and Essex, England.
12. Hooykaas, P.J.J., Hall, M.A. and Libbenga, K.R. (eds) 1999. Biochemistry and Molecular Biology of Plant Hormones, Elsevier, Amesterdam, The Netherlands.
13. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D., and Darnell, J. 2000. Molecular Cell Biology (fourth edition). W.H. Freeman and Company, New York, USA.
14. Alice Kurian and M. Asha, 2007. Medicinal plants. New India Publishing House, New Delhi.
15. Raaman N., 2006 Phytochemical techniques. New India Publishing House, New Delhi.
16. Van Damme J.M., Willey J. Penmans, Arpad Pustazi and Susan Bardocz Hand Book of Plant Lectins: Properties and Biomedical Applications. Jain Boooks and Pub. Distributers.

LABORATORY EXERCISES:

1. Effect of time and enzyme concentration on the rate of enzyme action (e.g. acid phosphatase, nitrate reductase).
2. Estimation of stress induced amino acid (Proline)
3. Determination of total carbohydrates by Anthrone method.
4. Extraction of seed proteins depending upon solubility.
5. Determination of succinate dehydrogenase activity, its kinetics, & sensitivity to inhibitors.
6. Separation of isozymes of esterases, peroxidases by native polyacrylamide gel electrophoresis.
7. Estimation of total fats in fatty seeds.
8. Separation of Alkaloids/Phenols by TLC.
9. Estimation of Phenols by chemical method.
10. Extraction of secondary metabolites from callus tissue.
11. Qualitative analysis of secondary metabolites.
12. Detection of secondary metabolites by TLC (any one)
13. Profile study of secondary metabolites by TLC (any one)

14. Separation of Amino acids by chromatographic techniques
15 Spectrophotometer estimation of secondary metabolites.
16 Estimation of phytoalexins.

Semester – II

PRACTICAL – IV: PLANT PHYSIOLOGY AND PLANT METABOLISM PRACTICAL SCHEDULE

Time: 6 Hours. Marks: 40

Q. 1:	Setting and working of any one major physiology experiment.	08
Q. 2:	Setting and working of one major Plant Metabolism experiment.	08
Q.3	Comment on any one minor physiology experiment.	05
Q. 4	Comment on any one minor Metabolism experiment	05
Q. 5	To perform Phytochemical tests.	04
Q. 6	Principle and working of instrument.	05
Q. 7	Viva Voce	05

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Syllabus for M.Sc. Part-II Botany

Semester – III

PAPER-IX: BIOLOGY AND DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERMS.

Unit-I : General account of Pteridophyta.
- 1.1 Geological Time Scale & Fossilization process.
- 1.2 Steler organization and evolution.
- 1.3 Origin of leaf and telome concept.
- 1.4 Heterospory and seed habit.
- 1.5 Classification of Pteridophyta – G.M. Smith.

Unit-II : Morphology, anatomy and reproduction.
- 2.1 Psilopsida : Psilophytales and Psilotales.
- 2.2 Lycopsida : Lycopodiales, Selaginellales, Isoetales.
- 2.3 Sphenopsida : Calamitales, Equisetales.
- 2.4 Pteropsida : Filicales.
- 2.5 Evolutionary trends among Pteridophytes.

Unit-III: General account of Gymnosperms.
- 3.1 Characteristic features of gymnosperms. Distribution and economic importance of gymnosperms.
- 3.2 Variations in structure of pollen grains, pollen germination.
- 3.3 Evolutionary trends in female gametophyte.
- 3.4 Classification of gymnosperms: D.D.Pant and S.V.Meyen

- 3.5 Contributions of Professors Birbal Sahni, D.D. Pant, K.R. Surange etc.

Unit-IV : Morphology, anatomy, reproduction and evolutionary tendencies
- 4.1 Pteridospermales: Lyginopteridaceae, Medullosaceac, Glossopteridales, Caytoniales.
- 4.2 Bennittitales: Cycadeoidaceae and Williamsoniaceae.
- 4.3 Cycadales: Nilssoniaceae and Cycadaceae.
- 4.4 Pentoxylales: Pentoxylaceae.
- 4.5 Cordaitales: Cordaitaceae.

Unit-V: Morphology, anatomy, reproduction and affinities:
- 5.1 Ginkgoales: Ginkgoaceae.
- 5.2 Coniferales: Araucariaceae, Podocarpaceae, Cupressaceae and Cephalotaxaceae.
- 5.3 Taxales: Taxaceae.
- 5.4 Ephedrales; Gnetales; Welwitschiales

Suggested Readings:

1. Sporne, K.R.(1976) : Morphology of Pteridophytes.
2. Stewart, W.N. and Rothwell G.W. (1993), Palaeobotany and the Evolution of Plants, Cambridge University Press.
3. Smith, G.M. (1976): Cryptogamic Botany Vol.II, Tata Mc-Graw Hill Publishing Co. Ltd., New Delhi.
4. Rashid,A (1976): An introduction to Pteridophyta, Vikas Publishing House, New Delhi.
5. Parihar N.S. (1976): The biology and morphology of the Pteridophyta, Central Book Depot, Allahabad.
6. Foster A.S. & Gifford F.M. (1967): Comparative morphology of vascular plants, Freeman Publishers, San Fransisco.
7. Eames, A.J.(1974): Morphology of Vascular Plants- lower groups, Tata Mc-Graw Hill publishing Co., New Delhi.
8. Arnold, C.A. (1947): Introduction to Palaeobotany, Mc-Graw Hill Book Co. Inc., New York and London.
9. Kubitzki K. (1990), The families and genera of vascular plants Pteridophytes and Gymnosperms, springer Verlag, New York
10. Agashe, S.N. (1995), Palaeobotany, Oxford & IBH, New Delhi.
11. Biswas, C & Johri, B.N. (2004), The Gymnosperms, Narosa Publishing House, New Delhi.
12. Coulter J.M. & Chamberlain C.J.(1978): Morphology of Gymnosperms, Central Book Depot, Allahabad.
13. Kakkar, R.K.and Kakkar, B.R. (1995), The Gymnosperms (Fossils & Living), Central Publishing House, Allahabad.
14. Sharma O.P. (2002) Gymnosperms, Pragati Prakashan, Meerut.

15. Siddiqui, K.A. (2002) Elements of Palaeobotany, Kitab Mahal, Allahabad.
16. Bhatnagar, S.P. and Moitra A. (1996), Gymnosperms, New Age International Pvt. Ltd., New Delhi.
17. Singh, H. (1978), Embryology of Gymnosperms, Encyclopedia of Plant Anatomy X, Gebryder, Bortragear, Berlin.
18. Stace, C.A. (1989) Plant Taxonomy and Biosystematics (2nd Edition) Edward Arnold Ltd., London.
19. Takhtajan, A.L.(1997): Diversity and Classification of flowering Plants. Columbia University Press, New York.
20. Woodland, D.W. (1991), Contemporary Plant Systematcs, Prentice Hall, New Jersey.
21. Khullar, S.P. (1994), An illustrated Fern Hora of west Himalayas Vol. II, International Book distributors, Rajpur Road, Dehradun
22. Pant, D.D. (2003): Cycas and allied Cycadophytes, BSIP, Publications.
23. Bierhorst D.W. (1971): Morphology of vascular plants McMillan, New York.
24. Thomas, B.A. & Spicer R.A. (1987): The Evolution and Palaeobiology of land plants. Discordies Press, Fortland, USA.
25. Spicer, R.A. & Thomas, B.A. (1986) Systematic and taxonomic approaches in Palaeobotany. Systematic Association Special Volume.
26. Chamberlain C.J. (1986); Gymnosperms, structure and Evolution, CBS publishers and distributors, New Delhi.

Laboratory Exercises:

A. Study of morphology, anatomy and reproductive structure of Pteridophytic forms.
   i.) ***Psilotum, Lycopodium, Selaginella. Isoetes, Equisetum, Gleichenia, Pteris, Ophioglossum, Azolla, Salvinia, Adiantum, Angiospteris*.**
   ii) Study of fossil forms:
   Rhynia, Calamites, Calamostachys, Lepidodendron, Psaronius, Zygopteris, Stauropteris.

B. Comparative Study of vegetative and reproductive parts of – ***Cycas, Zamia, Cedrus, Abies, Pinus, Cupressus, Cryptomeria, Taxodium, Podocarpus, Agathis, Thuja, Gnetum, Ephedra, Juniperus, Cephalotaxus, Taxus,*** Permanent micropreparatious to be submitted by the students.

C. *Ginkgo*: Morphology to be studied from Museum specimens & anatomy from permanent slides only.

D. Study of important fossil gymnosperms from material and permanent slides.

E. Visit to palaeobotanical Institutes, localities and collection of specimens.

F. Field visits to ecologically different localities to study living gymnosperms.

Semester- III

PAPER- X: TAXONOMY OF ANGIOSPERMS.

UNIT I : Systems of Angiosperm classification: -
Phenetic verses phylogenetic systems. Relative merits and demerits of following systems of classification. Engler and Prantls system: Hutchinsons system; Bessey's system; Cronquist's system.

UNIT II : Origin of intrapopulation variation. Population and Environment. Ecads & Ecotypes. Evolution and differentiation of species. Different models.

UNIT III : Taxonomic hierarchy, concept of species, genus, families and other categories (above the family and below the species rank). Principles used in assessing relationship. Salient features of international code of Botanical nomenclature.

UNIT IV : Evolutionary trends in Angiosperms with special reference to vegetative floral anatomical and chemical characters. Systematic studies of following families with emphasis on origin, evolution and interrelationship. Magnoliaceae, Ranunculaceae; Papaveraceae; Capparidaceae; Meliaceae; Leguminoceae, Myrtaceae; Cucurbitaceae;Cactaceae.

UNIT V : Gentianaceae; Rubiaceae; Asteraceae; Apocynaceae; Asclepiadaceae; Convolvulaceae, Boraginaceae. Scrophulariaceae, Acanthaceae, Lamiaceae, Polygonaceae; Nyctaginaceae; Caryophyllaceae; Loranthaceae Podostemonaceae; Poaceae; Cyperaceae Cannaceae; Orchidaceae, Arecaceae.

Suggested Readings:

1) Bhatnagar, S.P. and Moitra, A., 1996, Gymnosperm. New Age International Pvt.Ltd.New Delhi.
2) Cole,A.J., 1969, Numerical Taxonomy, Academic Press, London.
3) Davis P.H. and Heywood, V.H. 1973, Principles of Angiosperms Taxonomy, Robert, E.Kreiger, Publishing Company, New York.
4) Grant,V. 1971. Plant Speciation, Columbia University Press, New York.
5) Grant,W.F., 1984, Plant Biosystematics, Academic Press, London.

6) Harrison,H.J. 1971. New Concepts in Flowering Plant Taxonomy. Hiemn Educational Books limited, London.

7) Hislop-Harrison,J. 1967, Plant Taxonomy. English Language Book Society and Edward Arnold, Publishing Ltd. New Delhi.

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

9) Jones,A.D. and Wilbins Lady, 1971. Variations and Acceptance in Plant Species. Heman and Co., Educational Books Ltd.London.

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

11) Nordenstam,B., El Gazaly and Kassas,M. 2000. Plants Systematics for 21st Century. Fortland Press, Ltd.London.

12) Radford,A.E. 1986. Fundamentals of Plant Systematics. Harper and Raw Publications, U.S.A.

13) Singh, H. 1978. Embryology of Gymnosperms Encyclopedia of Plant Anatomy X. Gebryder Bortraeger, Berlin.

14) Solbrig, O.T. 1970. Principles and Methods of Plant Biosystematics. A Macmillan Co.-Colliar Macmillan Ltd.London.

15) Solbrig, O.T. and Solbrig, D.J. 1979. Population Biology and Evolution Addison Wesley Publication Co., Inc, U.S.A.

16) Stebbins, G.L. 1974. Flowering Plant - Evolution above species Level. Edward Arnold Ltd. London.

17) Stace, C.A. 1989. Plant Taxonomy and Biosystematics (2nd Edition) Edward Arnold Ltd. London.

18) Takhtajan, A.L. 1997. Diversity and Classification of Flowering Platns. Columbia University Press, New York.

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

Laboratory Exercise:

Angiosperms :

1) Technical description of plant species available locally and identification upto family.

2) Study of species belonging to single genus and preparation of key at genus level.

3) Preparation of herbarium specimens following standard techniques. At least 100 specimens should be presented collectively by the class of locally abundant species.

Frequent field trips should be arranged to get acquainted with local flora. One tour within state and one outside the state should be arranged to study the biodiversity of gymnosperms and angiosperms. Field tour reports should be supported by exhaustive field notes and photographic representations of plant species studied.

SEMESTER-III

PRACTICAL – V: PTERIDOPHYTA, GYMNOSPERMS AND TAXONOMY OF ANGIOSPERMS.

PRACTICAL SCHEDULE

Time : 6 Hrs. Max. Marks: 40

Q.1. Identify and describe the given pteridophytic material 06 Marks

Q.2. Identify, describe and make a double stained permanent micropreparation of gymnosperm material 07 Marks

Q.3. Systematic description of a given angiospermic two plant species. 14 Marks

Q.4. Spotting: 08 Marks

i) Pteridophyte- 2
ii) Gymnosperm- 2
iii) Fossil Specimen- 2
iv) Angiosperm- 2

Q.5. Viva-voce 05 Marks

Semester- III (Elective)

PAPER-XI: PLANT TISSUE CULTURE-I

Unit-I : Concept and Scope

1.1 Introduction, definition and scope of plant tissue culture.

1.2 Historical Developments.

1.3 Laboratory structure, instruments, requirement and general techniques, Designing of green house, Polyhouse for hardening, maintenance and multiplication.

1.4 Cellular totipotency; role of growth hormones in differentiation.

1.5 Role of photoperiod, humidity and temperature for *in-vitro* cultures.

Unit II : Media composition and sterilization.

2.1 Media constituents (inorganic & organic); growth hormones; gelling agents, media preparation and maintenance, autoclaving of media, Different media compositions.

2.2 Sterilization: dry and wet heat sterilization, sterilization of glasswares, steel material.

2.3 Surface sterilization of explants; selection of explant, size of explant.

2.4 Differentiation: Organogenic differentiations, Cytodifferentiation.

Unit III : Cell and suspension culture

3.1 Cell culture, isolation of single cell, techniques; factors

affecting single cell culture, Induction of callus.

3.2 Cell suspension culture: techniques and maintenance of suspension culture.

3.3 Preparation of cloning of single cell and and its regeneration to whole plant

Unit IV: Variability and Micropropagation :

4.1 Nuclear and genetical variation; factors affecting variation.

4.2 Role of variability in selection and improvement of plant; somaclonal and gametoclonal variations.

4.3 Practical application of variability in tissue culture.

4.4 Techniques of micropropagation ; factors affecting *in-vitro* stages of micropropagation; technical problems in micropropagation techniques.

Unit V: *In-vitro* selection and Application.

5.1 Commercial exploitation of micropropagation technique in horticultural and agronomical crops.

5.2 In-vitro selection for abiotic and biotic stresses, Isolation of useful nutrients at cellular level,Single cell proteins.

Semester –III

PAPER XII: PLANT TISSUE CULTUR-II (Elective)

Unit I : Somatic Embryogenesis:

1.1 Concept and mechanism of somatic embryogenesis; difference in zygotic and somatic embryos.

1.2 Factors affecting somatic embryogenesis.

1.3 Production of synthetic seeds, application of synthetic seeds in cryopreservation, maintenance of germplasm in storage.

Unit II : Haploid and Triploid Culture:

2.1 Haploid production and its significance.

2.2 Anther and pollen culture technique, monoploid and polyploid culture *in-vitro*.

2.3 Factors affecting Morphogenesis, Role of haploid and polyploids in plant improvement.

2.4 Gynogenesis: Ovule and ovary culture, *in-vitro* pollination and fertilization; Embryo rescue technique, Haploid production through distant hybridization, Triploid production (Endosperm culture).

Unit III: Protoplast Culture

3.1 Isolation and purification of protoplast, culture of protoplast and regeneration of protoplast.

3.2 Somatic Hybridization; culture and selection system for hybrids.

3.3 Cybridization and production of cybrids.

3.4 Role of somatic hybrids and cybrids in plant improvement, application of protoplast culture.

Unit IV: Genetic Transformation:

4.1 Methods of genetic transformation.

i) *Agrobacterium tumefaciens* mediated gene transfer.

ii) *A. rhizogenes* mediated transformation.

iii) Virus mediated transformation.

iv) Direct Gene transfer.

4.2 Selection and identification of transformed cells. Recovery of transformed plants. Transgenic plants; its production, prospects and problems.

4.3 Production of pathogen free plants, virus- elimination through *in-vitro* technique.

Unit V : Secondary metabolites and Cryobiology.

5.1 Production of secondary metabolites from cultured cells, strategies for induction of secondary metabolite production through suspension, hairy root culture, shoot organ culture for alkaloids, pigments, perfumes, flavours, insecticides, anticancerous agents and pharmaceutically important compounds.

5.2 Germplasm Storage: Cryobiology of plant cell culture; plant banks; freeze preservation technology; Role of Cryopreservation and future prospects.

5.3 Industrial applications of plant Biotechnology.

a) Pharmaceuticals b) Food additives, c) Speciality chemicals, d) Quality oils, e) Molecular farming, f) Edible vaccines.

Suggested Readings:

1) Amirato, P.Y.D.A. Evans, W.P.Sharp and Bajaj Y.P.S. (1990) Hand book of plant cell culture volumes I-V. McGraw Hill publishing Co. New York.

2) Bhojwani S.S. and Rajdan M.K. (1983) Plant Tissue Culture, Theory and Practice.

3) Reinert J. and Bajaj Y.P.S. (1977) Applied and Fundamental aspects of plant cell, Tissue and Organ culture, by Springer Verlag, Berling.

4) Gupta P.K. (1995) Elements of Biotechnology, Rastogi and Company.

5) S.Narayan Swamy (1994) Plant Cell and tissue culture. Tata McGraw Hill Publishing Company Limited New Delhi.

6) Dr.U.Kumar (1999) Methods in Plant Tissue Culture, Agrobios (India)
7) J.Reinert and Y.P.S. Bajaj (1980) Plant Cell, Tissue, and Organ Culture, Narosa Publishing House.
8) J.Prakash and R.L.M. Pierik (1993) Plant Biotechnology. Oxford and IBH publishing Co. Pvt. Ltd.
9) Kalyan Kumar De (1992) Plant Tissue Culture. New Central Book Agency P. Ltd.
10) M.K.Razdan (1993) An Introduction to plant Tissue Culture. Oxford and IBH Publishing Co.Pvt. (LTD)
11) Surendra Prasad and L.K.Pareek (1996) Impact of Plant Biotechnology on Horticulture. Agro Botanical Publishers (India).
12) R.A.Dixon and R.A. Gonzales (1994) Plant Cell Culture. A practical approach, Oxford University Press, New York, Tokyo.
13) Philip V.Ammirato, David A.Evans, William R.Sharp, Yasuyuki Yamaha, (1984) Hand Book of Plant Cell culture. Macmillan Publishing Company, New York.
14) Dr.Ning-sun Yang, Dr.Paul Christoce, (1994) Practical Bombardment Technology for Gene Transfer. Oxford University Press.
15) S.B.Primrose (1987) Molecular Biotechnology Blackwell Scientific Publications London Edinburgh Boston.
16) Islam A.S. (1996), Plant Tissue Culture, Oxford & IBH Publishing Co.Pvt.Ltd.
17) Reinert J. and M.M.Yeoman, (1982) Narosa Publishing House.
18) Rehert D.Hall (1999) Plant Cell Culture Practicals - Humana Press.
19) Chanela, H.B. (2000), Introduction to Plant Biotechnology, Oxford & IBH Publishing Co.Pvt.Ltd.
20) Vasil I.K. and Thorpe T.A. (1994), Plant Cell and Tissue culture, Kluwer Academic Publishers, Netherland

Laboratory Exercises:

1) Preparation of media.
2) Surface sterilization.
3) Isolation of explant, induction of callus, establishment and maintenance of callus.
4) Organogenesis and plant regeneration through clonal propagation.
5) Embryogenesis in cultured cell from different explants.
6) Micropropagation of banana, citrus, papaya, sugarcane etc.
7) Cell suspension culture from different tissues.
8) Embryo culture and embryo rescue of different plant species.
9) Effect of various growth hormones on cell divisions and cell proliferation.
10) Isolation, purification and culture of protoplast.

11) Anther culture, pollen culture and production of haploids.
12) Artificial seed preparation.
13) Cytological examination of regenerated plants.
14) Agrobacterium culture and selection of transformants.
15) Selection of salt tolerance, amino acids analogous resistance through cell cultures.
16) Hardening of tissue culture raised plants.
17) Visit to forest area to study important plant species and preparation of field diary.
18) Visit to plant tissue culture laboratories in state & preparation of report.

Semester III

Plant Tissue Culture : Practical-VI (Elective)

PRACTICAL SCHEDULE

Time :	8 Hrs.	Max. Marks: 40
Q.1.	Setting and working of one major experiment	12 Marks.
Q.2.	Two Minor experiments.	08 Marks.
Q.3	Preparation of any one specific media for tissue culture.	10 Marks.
Q. 4	Comment on spots.	05 Marks.
Q. 5	Viva voce	05 Marks.

Semester- III

PAPER-XI: BIOINFORMATICS-I (Elective)

UNIT I : 1.1 Computer system: Overview functions input devices output devices, storage devices, Softwares and Hardwares.
1.2 Main circuits: Chips, Ports, Expansion slots.
1.3 Real time, offline and online processing.
1.4 Operating systems: Concepts, windows 2003/XP, VISTA, UNIX, LINUX.
1.5 Computer Virus: Overview, Transmission and Precautions.

UNIT II: 2.1 Types of computers- Latest Models.
2.2 Internet: Resources, World Wide Web, Tools associated, terminologies.
2.3 Data communication, links and Data Mining
2.4 LAN, WAN, MAN, Search Engines.
2.5 Data Models: Network and Hierarchial data model and concepts.

UNIT III: 3.1 Computer application in Bioinformatics.

3.2 Databases: Primary, Secondary; Relational and Non relational; Redundant and Non Redundant

3.3 Introduction to Oracle and Perl.

3.4 Database design and management (DBMS & RDBMS).

3.5 Bioinformatics Resources: NCBI, EBI, ExPASY, EMBL and DDBJ.

UNIT IV: 4.1 Biological Databanks: PDB, SRS, BRENDA, TREMBL, UniProt, KEGG.

4.2 Derived, Databases: PROSITE, Pfam, PRINTS, CATH, SCOP, DSSP, FSSP, DALI.

4.3 Genomic Databases.

4.4 Repositories for high throughput genomic sequences: EST, STS, GSS.

4.5 Nuclei Acid databases and Protein databases.

UNIT V: 5.1 Sequence Analysis: Overview, Concepts and tools.

5.2 Similarity Searches: BLAST, FASTA, PSI-BLAST and PHI-BLAST.

5.3 Scoring Matrices: PAM, BLOSSUM and PSSM.

5.4 Pairwise Sequence Analysis: Needleman and Wunch; Smith and Waterman.

5.5 Dynamic Programming.

Semester-III

PAPER XII : BIOINFORMATICS II (Elective)

Unit I : 1.1 Multiple sequence Alignment (MSA); Basic concepts,Progressive and Hierarchial approaches CLUSTAL-W, GENEDOC.

1.2 Sequence patterns, profiles and motifs (Profilescan) Prosite type.

1.3 Phylogenetic tree: Basic concepts, methods, types of trees, Analysis algorithm UPGMA, NJ, NR, MP and its interpretation.

1.4 Comparative genomic: Full genome alignment concepts and applications, Algorithm MUMmer, BLAST-2

Unit II: 2.1 Gene Prediction: Gen Scan and Neural Network, HMM concepts and Applications.

2.2 Genomic: Genome analysis coding region (CpG Island, GC content, SNPs, ESTs) non-coding regions: LINES, SINES, LTRs, Tandem repeats.

2.3 Structural Genomics and Primer designing

2.4 Functional genomics: DNA Microarray.

Unit III: 3.1 Protein structure Prediction: ab-initio method, GOR, Fold recognition (PHD, PSI- Prediction method)

3.2 Protein structure with respect to helix, sheets and coils, Ramchandran Plot.

3.3 Protein modelling and simulations: Techniques, MD Monte Carlo, docking strategies.

3.4 Protein optimisation techniques.

3.5 To study protein characteristics by using peptools.

Unit IV: 4.1 Protein Array: Concept tools

4.2 Protein -Protein interaction: Molecular design.

4.3 Protein Validation/Homology and Resources for virology'

4.4 Virtual Lab. concept

4.5 Allergic proteins and their studies by using bioinformatic tools.

Unit V : 5.1 Biodiversity Informatics: Overview, concept, Databases (Species 2000, tree of life, ATCC, NBTI) and Softwares (delta, Metro IS, AVIS, ICTV)

5.2 Bioinformatics in Agriculture for Crop Improvement.

5.2 Drug Design: Role of bioinformatics, target identification and Model organisms (*Arabidopsis thaliana, C. elegans, Drosophila melanogaster*)

5.4 Chemo informatics: Concepts and Dynamics of biomolecular drugs.

5.1 Emerging areas in bioinformatics: Genechip, Forest informatics, Ontology, Phylogenetic study, Drug target identification.

Suggested Readings:

1. Hanery Korth & Abraham Database system concept Tata McGraw Hill Publication.
2. Martin J.M. Database system roganisation – Prentice Hall.
3. Stephen Misener and Stephen A. Krawetz, 1999 Bioinformatics: Methods and Protocols (Methods in Molecular Biology, Vol 132), , Humana Press.
4. Stanley Letovsky, 1999 Bioinformatics: Databases and Systems, Kluwer Academic Publishers.
5. P. Green, 1998,Computational Molecular Biology, Blackwell Science Inc.
6. Introduction to Computational Molecular Biology, Joao Meidanis, Joao C. Setabal, 1997, PWS Pub. Co.
7. Dan Gusfield, 1997Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology, Cambridge University Press.
8. Simon R. Swindell, 1997 Sequence Data Analysis Guidebook, Humana Press.

9. Tieng K. Yap, Ophir Frieder, Robert L. Martino, 1996, High Performance Computational Methods for Biological Sequence Analysis, Kluwer Academic Pub.
10. Russell F. Doolittle, 1996 Computer Methods for Macromolecular Sequence Analysis, Methods in Enzymology, volume 266, , Academic Press.
11. Molecular Bioinformatics: Algorithms and Applications, Steffen Schulze-Kremer, 1995, Walter De Gruyter.
12. Michael S. Waterman, 1995, Introduction to Computational Biology – Maps, Sequences and genomes, Chapman & Hall.
13. Annette M. Griffin and Hugh G. Griffin, 1994, Human Press.Computer Analysis of Sequence Data,
14. S. G. Gindikin, 1992, Mathematical Methods of Analysis of Biopolymer Sequences (Dimacs Series in, Discrete Mathematics and Theoretical Computer Science; Volume 8), American Mathematical Society.
15. Michael S. Waterman, 1989 Mathematical Methods for DNA Sequences, CRC Press.
16. James D. Tisdall, 2003 Mastering Perl for Bioinformatics, O'Reilly.
17. Cynthia Gibas, Per Jambeck, 2001 Developing Bioinformatics Computer Skills, O'Reilly.
18. Jeffrey D. Ullman, Jennifer D. Widom, 2001,Database Systems: The Complete Book, Hector Garcia-Molina, and Prentice Hall.
19. Eric S. Roberts, 1998, Programming Abwstractions in C: A Second Course in Computer Science, Addison-Wesley.
20. Larry Wall, Tom Christiansen, Jon Orwant, 2000 Programming Perl (3rd Edition), O'Reilly.
21. Jerry Peek, Tim O'Reilly, Mike Loukide s, 2nd Edition, 1997UNIX Power Tools, 2nd Edition, O'Reilly.
22. James Callahan, Harriet Pollatsek, Lester Senechal, and 1995 Calculus in Context: The Five College Calculus Project, Freeman.
23. Gilbert Strang, 1998, Introduction to Linear Algebra, Wellesley Cambridge Press.
24. Erwin Kreyszig, 1999, Advanced Engineering Mathematics, John Wiley & Sons.
25. Christian Schlotterer, 1999, The Elements of Statistical Learning: Oxford University Press.
26. Kenneth Lange, 1997, Mathematical and Statistical Methods for Genetic Analysis, Springer Verlag.
27. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Cliff Stein, 2001,Introduction to Algorithms, 2nd Edition, MIT Press.
28. Charles Staben, 2001,Bioinformatics: A Primer, Jones & Bartlett Pub.

29. Arun Jagota, 2000 Data Analysis and Classification for Bioinformatics, AKJ Academics.
30. Stuart M. Brown, 2000, Bioinformatics: A Biologist's Guide to Biocomputing and the Internet, Eaton Pub. Co.
31. Des Higgins, Willie Taylor, 2000, Bioinformatics: Sequence, Structure and Databanks: A Practical Approach (The Practical Approach Series, 236), Oxford Univ. Press.
32. Neural Networks and Genome Informatics, Cathy H. Wu, Jerry W. McLarty, 2000, Elsevier Science.
33. Peter Clote and Rolf Backofen, 2000, Computational Molecular Biology: An Introduction (Wiley Series in Mathematical and Computational Biology), John Wiley & Sons.
34. Chrystopher L. Nehaniv, 1999, Mathematical and Computational Biology: Computational Morphogenesis, Hierarchical Complexity, and Digital Evolution American Mathematical Society.
35. Jason T.L. Wang, Bruce A. Shapiro, Dennis Elliott Shasha , 1999, Pattern Discovery in Biomolecular Data: Tools, Techniques, and Applications, Oxford Univ. Press.
36. Dan E. Krane, Michael L. Raymer, Michaeel L. Raymer, Elaine Nicpon Marieb, 2002, Fundamental Concepts of Bioinformatics, Benjamin/ Cummings.
37. Tao Jiang, Ying Xu, Michael Zhang, 2002 Current Topics in Computational Molecular Biology (Computational Molecular Biology), MIT Press.
38. Warren Ewens, Gregory Grant, 2001,Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology and Health), Springer Verlag.
39. Pierre Baldi, Soren Brunak, Sren Brunak, 2001,Bioinformatics: The Machine Learning Approach, Second Edition (Adaptive Computation and Machine Learning), MIT Press.
40. Pankhurst (1991): Practical Toxonomic Computing
41. A.R. Leach, Molecular Modelling Principles and Applications
42. Creighton T.E. Protein Folding
43. Creighton T.E. Protein Structure Prediction.
44. Brendam Wren, Nick Dorrell, 2003,Functional Microbial Genomics (Volume 33), Academic Press.
45. John E. Antonopoulos, 2000,Genomics, Xlibris Corporation
46. Sandor Suhai, 2000,Genomics and Proteomics: Functional and Computational Aspects, Plenum Pub Corp.
47. David L Spector, Robert D. Goldman, Leslie A. Leinwand, 1998, Cells: A Laboratory Manual, 3 volumes, Cold Spring Harbor Laboratory Press

48. Bruce Birren, etal., 1997, Genome Analysis: A Laboratory Manual, 4 volumes Cold Spring Harbor Laboratory Press.
49. Cecillia Sacone, Graziano Pesole, 2003, Handbook of Comparative Genomic: Principles and Methodology, Wiley-Liss
50. David Sankoff and Joseph H Nadeau, 2000,Comparative Genomics - Empirical and Analytical Approaches to Gene Order Dynamics, Map Alignment and the Evolution of Gene families, Kluwer Academic Pub
51. Melody Clark (Editor), 2000Comparative Genomics, Kluwer Academic Pub.
52. T. Rabilloud, 2000, Proteome Research: Two-Dimensional Gel Electrophoresis and Detection Methods (Principles and Practice), Springer Verlag.
53. R.M. Kamp, D. Kyriakidis, the Choli-Papadopoulou, 1999,Proteome and Protein Analysis, Springer Veriag.
54. M.R. Wilkins, et al. (Editors), 1997, Proteome Research: New Frontiers in Functional Genomics Springer Verlag.
55. I.F. Tsigelny, 2002, Protein Structure Prediction: Bioinformatic Approach, International University Line.
56. Arthur M. Lesk, 2001, Introduction to Protein Architecture: The Structural Biology of Proteins, Oxford University Press.
57. David M. Webster, 2000, Protein Structure Prediction: Methods and Protocols, Humana Press.
58. Carilvar Branden, John Tooze, 1999, Introduction to Protein Structure, Gariand Publishing.
59. Alan Fersht, 1999, Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding, Freeman
60. Mark A. Rothstein, 2003, Pharmacogenomics: Social, Ethical, and Clinical Dimensions, Wiley-Liss.
61. Meyer, Rachel Tyndale, 2001Pharmacogenomics, Werner Kalow, , Marcel Dekker.
62. Elliot S Vesell, 2000,Pharmacogenetics and Pharmcogenomics : Recent Conceptual and Technical Advances(Pharmacology, Volume 61, Number 3, 2000), S. Karger Publishing.
63. Wendell Weber, 1997, Pharmacogenetic, Oxford University Press.
64. Helen C. auston, John Quackenbush, Alvis Brazma, 2003, Microarray Gene Expression Data Analysis: A Beginner's Guide, Blackwell Publishers.
65. G. Parmigiani, E.S. Garrett, R.A. Irizarry, S. Zeger, Graeme Clark, 2003The Analysis of Gene Expression Data (Statistics for Biology and Health), Springer Verlag.

66. Daniel P. Berrar, Werner Dubitzky, Martin Granzow, 2002, A Practical Approach to Microarray Data Analysis, Kluwer Academic Publishers
67. Pierre Baldi, G. Wesley Hatfield, 2002, DNA Microarrays and Gene Expression: From Experiments to Data Analysis and Modeling, Cambridge University Press.
68. David Bowtell, Joseph Sambrook, 2002,DNA Microarrays: A Molecular Cloning Manual, Cold Spring Harbor Laboratory.
69. Steen Knudsen, 2002, A Biologist's Guide to Analysis of DNA Microarray Data, John Wiley & Sons.
70. Bertrand Jordan, 2001,DNA Microarrays: Gene Expression Applications, Springer Verlag.
71. Jang B. Rampal, 2001,DNA Arraysm: Methods and Protocols (Methods in Molecular Biology, Volume 170), Humana Press.
72. Elena V, Grigorenko, 2001,DNA Arrays: Technologies and Experimental Strategies, CRC Press.
73. Mark Schena, 2000, Microarray Biochip Technnology, Eaton Pub.
74. Mark Schjena, 1999, DNA Microarrays: A practical Approach (Practical Approach Series 205), Oxford Univ Press.
75. Eric H. Davidson, 2001, Genomic Regulatory Systems: development and Evolution, Academic Press.
76. Erica Golemis, 2001, Protein-Protein Interactions: A Molecular Cloning Manual, Cold Spring Harbor Laboratory.
77. Luke Alphey, 1997, DNA Sequencing: From Experimental Methods to Bioinformatics (Introduction to Biotechniques Series), Springer Verlag.
78. Adams M.D. Fields C., Venter J.C.), 1994, Automated DNA sequencing and analysis, Academic Press.
79. Marco Salemi, Anne-Mieke Vandamme, 2003The Phylogenetic Handbook: A Practical Approach to DNA and Protein Phylogeny, Cambridge University Press.
80. Barry G. Hall, 2001, Phylogenetics Trees Made Easy: A How- To Manual for Moleculzar Biologists, Sinauer Associates.
81. Masatoshi Nei, Sudhir Kumar, 2000Molecular Evolution and Phylogenetics, Oxford Univ Press.
82. Roderic D.M. Page, Edward C. Holmes, 1998,Molecular Evolution: A Phylogenetic Approach, Blackwell Science Inc.
83. R Scott Hawley, Michele Y Walker, 2003,Advanced Genetic Analysis: Finding Meaning in the Genome, Blackwell Publishers.
84. Pui-Yan Kwok, Carolyn T. Williford, 2003, Single Mucleotide Polymorphisms: Methods and Protocols (Methods in Molecular Biology (Clifton, N, J.), V. 212), Humana Press.

85. Daniel Sorensen, Dani Gianola, 2002, Likelihood, Bayesian and MCMC Methods in Quantitative Genetics, Springer Verlag.
86. Ali Hajeer, Jane Worthington, Sally John, 2000, Snp and Microsatellite Genotyping: Markers for Genetic Analysis Biotechniques Molecular Laboratory Methods Series Eaton Pub.
87. David B. Goldstein. Microsatellites: Evolution and Applications,

Laboratory Exercises:

1. Hands on experience and Regular Usage: Windows XP, Internet Browsers (I.E. Netscape), Search Engines, E-mail, Web, mail and ftp.
2. Downloading and installing Software/plugs in on Windows XP.
3. Spreadsheet Applications: Database Management (sorting records, Finding, adding, deleting).
4. Creation of Computer Presentations with graphics (P.P.), Slides, Wizards, inserting graphs & charts, build and animated effect.
5. Database search, NCBI, DDBJ, EMBL, BRENDA, KEGG, UniProt.
6. Pair wise Sequence Alignment-FASTA, BLAST.
7. Websites for Bioinformatics.
8. To prepare the inventory of websites.
9. To develop a phylogeny tree of at least 5 plant species.
10. To search allergic fragments of proteins in fruits / pollen grains.
11. To study Protein characteristics by using different boinformatic tools.
12. Protein database searching GCG package or EMBOSS.
13. 3D Motif recognition.
14. 3D structure viewing tools.
15. Method of gene Annotation.
16. Assembly of full genome from sequenced fragments.
17. Blast analysis of DNA sequence.
18. Blast analysis of Protein sequence.
19. Primer designing using computers.
20. Protein prediction using DNA as template.
21. RNA prediction using DNA as template.
22. Genome analysis (Prokaryotes)
23. Genome analysis (Eukaryotes)
24. Identification of MUMs (Maximum unique matches)
25. Identification of Unique Sequences for organism.
26. DNA extraction from plants.
27. Protein Molecular weight determination by electrophoresis.
28. Effect of PAM on sequence Analysis.
29. Effect of BLOSSUM on sequence Analysis.

30. Effect of PSSM on protein sequence Analysis.
31. Prediction of Function for unknown sequence.
32. CpG Island identification in Genome Sequence.
33. GC content of sequence and validation of Chargaff's rule.
34. Study of types of genome sequencing.
35. Study of sequencing techniques.
36. Phylogenetic analysis multiple sequence by root tree method.
37. Phylogenetic analysis multiple sequence by non-root tree method.
38. Calculation of distances between two sequences.
39. Study of LINES in genomes.
40. Study of SINES in genomes.
41. Study of LTRS in genomes.
42. Study of tandem repeats.
43. Study of telomeres sequences in organisms..

Semester -III

PRACTICAL -VI

ELECTIVE PAPER BIOINFORMATICS

PRACTICAL SCHEDULE

Time: 8 Hrs.		Marks: 40
Q. 1	Setting and Working of one major experiment	12 Marks
Q. 2	Perform two minor experiments	12 Marks
Q. 3	Problem on Matrices	06 Marks
Q. 4	Spotting	05 Marks
Q. 5	Viva voce	05 Marks

Semester –III

Paper-XI: Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-I (Elective)

UNIT I : Basic principles of phytochemical techniques – UV-Visible and Infra Red Spectroscopy, Nuclear Magnetic Resonance (NMR); Chromatographic techniques- Paper chromatography, Thin Layer Chromatography (TLC), High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC), Gel Electrophoresis.

UNIT II : Study of following secondary plant metabolites with respect to their chemistry and biological activity- Flavonoids, Simple Phenolics, Phenolic Glycosides, Tannins, Anthroquinones, Saponins, Steroids, Alkaloids, Pigments (anthocyanin and betacyanin), Resins, Gums and Volatile oils.

UNIT III : Basic aims and concepts of taxonomy. Principles of systematics; concept of character. Monophyly and Polyphyly, Parallelism and convergence, Homology and analogy. Taxonomic literature- keys, floras, monographs and icons.

UNIT IV : International code of Botanical Nomenclature Type method, valid publication, Rule of priority, Author citation, conservation of names and rejection of names, Time and place of origin of Angiosperms. Probable ancestors of angiosperms (different theories of origin of angiosperms).

UNIT V : Pharmacognostic studies of following drug plants:
(Nomenclature, Morphology, Anatomy, Chemistry, Uses and Adultrants)
Datura metel, Solanum surattense, Zingiber officinale, Ocimum sanctum, Swertia chirata, Asparagus racemosus Commiphora weightii, Citrulus colocynthis, Digitalis purpurea; Gloriosa superba, Withania somnifera.
Ethnobotany: Dynamism in ethnobotany.

Semester – III

Paper-XII: Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-II (Elective)

UNIT I : History of classification. Brief account of Pre-Darwinian Classification. Post-Darwinian developments in classification. Artificial, Natural, Phylogenetic and Evolutionary classification systems. Study of Modern systems – Takhtajan; Dahlgren and Thorne's system of classification, assorted Phylogenetic systems.

UNIT II : Taxonomic evidence: Vegetative and floral anatomy, palynology; embryology, cytology, Phytochemical systematics and molecular systematics. Numerical taxonomy, Biosystematics

UNIT III : Living fossils of Angiosperms: Winteraceae, Degeneriaceae, Astrobaileyaceae, Ambrorellaceae, Tetracentraceae, Trochodendraceae, Eupomatiaceae. Comparative account of vegetative and floral morphology, inter-relationships; phylogeny and distribution of plant families belonging to following subclasses as per Cronquist's system (As illustrated by following orders and families).

a) Magnoliidae: Ranunculaceae, Berberidaceae, Lardizabalaceae, Menispermaceae.

b) Hamamelideae: Urticales- Ulmaceae, Moraceae, Cannabaceae, Urticaceae.

UNIT IV: c) Caryophyllidae: Caryophyllales-Phytolaccaceae, Nyctaginaceae, Didiereaceae,Cactaceae, Aizoaceae, Molluginaceae, Chenopodiaceae, Amaranthaceae.

d) Dillenidae- Malvales- Elaeocarpaceae, Scytopetalaceae, Tiliaceae, Sterculiaceae, Bombacaceae, Malvaceae.

e) Rosidae: Geraniales- Oxalidaceae, Geraniaceae, Tropoaeolaceae, Balsaminaceae.

f) Asteridae –Asterales- Asteraceae.

UNIT V: g) Alismatidae-Alismatales-Butomaceae, Limnocharitaceae, Alismataceae.

h) Commelinidae- Zinziberales- Sterilitziaceae, Lowiaceae, Heliconiaceae, Musaceae, Zingiberaceae, Costaceae, Cannaceae, Marantaceae.

i) Liliidae- Liliales- Liliaceae, Amaryllidaceae, Iridaceae, Agavaceae, Dioscoreaceae.

Suggested Readings :

1) Comparative Phytochemistry - Swain, T., Academic Press.
2) Chemistry in Botanical classification - Nobel symposia medicine and natural science, Benz, G. and J.Santesson, Academic Press.
3) Pharmacognosy - Kokate C.K., A.P.Purohit and S.B.Gokhale, Nirali Prakashan.
4) Trease and Evan's Pharmacognosy : W.C.Evans, Saunders.
5) Plant systematics, a phylogenetic approach - Jude, Campell, Kellog & Stevans, Sionaur Association Inc.USA.
6) Biochemical systematics: Alston, R.E. & B.L.Turner, Prentice Hall.
7) Origin and Early Evolution of Angiosperms, Breek C.B. (Ed), Columbia University Press.
8) The Seeds of Dicotyledons Vols. I & II, Corner, E.J.H., Cambridge University Press.
9) Morphology of the Angiosperms, Eames, A.J., MC Graw Hill.
10) Plant Chemototaxonomy: Harborne J.B. and B.L.Turner, Academic Press.
11) Pollen Morphology & Taxonomy of Angiosperms: Eradtman, G., Almvist & Wiksei Stoekholm.
12) Taxonomy of Vascular Plants, Lawrence: H.M., MC Millan.
13) Taxonomy of Angiosperms, Naik: V.N., Tata McGraw Hill.
14) The families of flowering plants Vol. I & II: Hutchinson, J., Hutchinsu London.
15) Principles of Angiosperms Taxonomy : Davis H. & V.H, Heywood, Von Nostrand.

16) International Code of Botanical Nomenclature, Voss.E.C.(Ed.), Regnum Vegetable utrecht.
17) A Punched card key to the Dicot Families of South India: Saldhana C. & C.K.Rao, Arvind Publishers, Bangalore.
18) Phytochemistry and Angiosperm Phylogeny: Young D.J., & Siegler, Prager.
19) An Integrated System of Classification of flowering Plants: Cronguist, A., Columbia University Press.
20) Flowering Plants Origin & Dispersal: Takhtajan, A., Oliver & Boyd.
21) Evolution and Phylogeny of flowering plants: Hutchinson, J., Academic Press.
22) Evolution and Systematics: Solbrig, O.T., McMillan.
23) Morphology of Angiosperms: Sporne, K.R., Hutchinson, London.
24) Origin and Early Evolution of Angiosperms: Beck, C.G. (Ed.), Columbia University Press.
25) Palaeobiology of Angiosperms Origin: Hughes, N.H., Cambridge University Press.
26) Chromosome Atlas of the Flowering Plants of the Indian Sub-continent: Kumar, International Book.
27) Anatomy of the Dicotyledons, Second edition: Vol. I & II, Metcalfe, C.R. & L.Chalk, Oxford Science Distributors.
28) Taxonomy & Ecology: Heywood, V.H.Ed., Acadenue Press.
29) Numerical Taxonomy: Sneath, P.H.A. & R.R.Sokal, W.H.Freeman & Co.San Fransisco.
30) Manual of Cultivated Plants: 2nd Ed., Baily, L.H., Macmillan.

Laboratory Exercises :

1) Description of locally available dicot and monocot species. Identification upto species level with the help of flora.
2) Use of cytological data in Taxonomic studies - Karyotype analysis. Preparation of Karyograms; and Idiograms (to be done with the help of permanent preparation / diagram / photoplate).
3) Comparison of different species of a family to calculate similarity coefficient and preparation of dendrograms (numerical taxonomy).
4) Study of different taxonomic features like stomatal types, pollen types, trichome types, crystals etc.
5) Detection of secondary metabolites in plant material by quick tests. Detection of flavonoids, irridoids; leucoanthogenins, anthroquinones, alkaloids, saponins, differentiating anthocyanins from bactacyanins. Chemically differentiating angiosperm wood from gymnosperms wood.
6) Pharmacognostic studies of any 3 of the locally available medicinal plants.

7) Frequent field visits to study local flora are expected. One short tour within state and one long tour to other state to study the vegetation and biodiversity of angiosperms. Students should submit atleast 100 herbarium specimens (collectively) prepared according to international norms. Excursion report should be supported by field diary and photographic presentation of the flora.

Semester -III

Elective Practical VI – Angiosperm Taxonomy, Phytochemistry and Pharmacognosy.

Practical Schedule

Time : 6 Hrs Full Marks: 40

Q.1)	Systematic description of two angiospermic plants (one from dicotyledons and one from Monocotyledons)	10 Marks.
Q.2)	Preparation of artificial key	04 Marks.
Q.3)	Karyotype studies	04 Marks.
Q.4)	Detection of secondary plant metabolites of given plant material.	03 Marks.
Q.5)	Morphological and analytical characterization of given drug plant material	06 Marks.
Q.6)	Spotting	08 Marks.
Q.7)	Viva voce	05 Marks.

Semester III

ELECTIVE PAPER XI: ADVANCED PLANT PHYSIOLOGY AND BIOCHEMISTRY-I

UNIT I : 1.1 Membrane transport – Structure and organization of membrane, Glucoconjugates and protein membrane systems; Channels, pumps and carriers of membrane.

1.2 Aquaporines – Structure and functions; Model membranes.

1.3 Mineral nutrition – Deficiency symptoms in plants, Regulation of K+ Phosphoporus nutrition and transport; Micronutrient acquisition; Plant response to mineral toxicity; Nutritional status of plants.

UNIT II: 2.1 Plant movements– Overview; phototropism, phototropic signal perception, transduction of signal.

2.2 Gravitropism – signal perception and its mechanism, growth response, Role of calcium in gravitropism.

2.3 Nastic movements – Mechanism of Nyctynasty and Seismonasty.

2.4 Sensory photobiology – Phytochromes and Cryptochromes – Phytochemical and biochemical properties; Photophysiology of light induced responses; molecular mechanism of photomorphogenic receptors; signaling and gene expression.

UNIT III: 3.1 Plastids – Chemical composition, structure and transport functions of plastid membranes.

3.2 Biosynthesis of Chorophylls, Carotenoids and fatty acids.

3.3 Thylakoid membrane network; protein synthesis, nuclear proteins for photosynthesis.

3.4 Mitochondria – Chemical composition, Transport across the membrane; Proteins synthesis; nuclear proteins for respiration.

UNIT IV: 4.1 Energy Metabolism – Thermodynamic principles in biology. Artificial photosynthesis for energy harvestation; National Hydrogen Programme.

4.2 Primary and Secondary metabolites – Coordinated control of metabolism; Metabolites as important natural products.

4.3 Types, biosynthesis and applications of terpens, alkaloids, phenolic compounds, lignins, flavonoids, glycosides, caumarines, stilbenes, styrylopyrones and amylopyrones.

UNIT V: 5.1 Spectroscopy – Principles and applications of X-ray diffraction, Fluorescence, UV-visible, IR and NMR Mass spectroscopy.

5.2 Chromatography- Principle and applications of paper, ion exchange, affinity, and thin layer chromatography.

5.3 Flame photometry – Principle and its applications.

Semester III

PAPER XII: ADVANCED PLANT PHYSIOLOGY AND BIOCHEMISTRY-II (ELECTIVE)

UNIT I : 1.1 Carbohydrates- Chemical Structure, Types and functions of carbohydrates. Biosynthesis and degradation of starch and sucrose, Modulation of gene expression by carbohydrates.

1.2 Amino acid- Chemical properties; Overview of amino acid biosynthesis in plants.

1.3 Signal transduction – Overview, receptors and G-proteins, phospolipid signaling, role of cyclic nucleotides, Calcium-Calmodulin cascade, diversity in protein kinases and phosphatases, Specific signaling mechanisms- Two compartment sensor regulator system in bacteria and plants. Sucrose sensing mechanism.

UNIT II: 2.1 Plant defence systems – Overview of plant pathogens and plant diseases; Phytoalexins and their host specificity.

2.2 Molecular basis of phytoalexin elicitation; R- genes; mode of action and its role.

2.3 Post infectional compounds of some economically important plants.

2.4 Control of pathogens by Genetic Engineering.

UNIT III: 3.1 Regulation and mode of secondary metabolites – Bioseperation of compounds, Regulation of metabolite synthesis in plants, Mode of action of target sites; Synergy principle at work in plants, pathogens, insects, herbivores and humans.

3.2 Transgenic production of secondary metabolites.

UNIT IV: 4.1 Senescence and programmed cell death – Types of cell death observed in plants. Overview of senescence, pigment and protein metabolism during senescence.

4.2 Impact of senescence on Photosynthesis and oxidative metabolism.

4.3 Degradation of nucleic acid during senescence.

4.4 Endogenous plant growth regulators and senescence, Environmental influence on senescence.

UNIT V: 5.1 Stress Physiology – Plant responses to biotic and abiotic stress, Mechanism of biotic and abiotic stress tolerance, HR and SAR.

5.2 Water deficit and draught resistance; salinity stress, metal toxicity, freezing and heat stress and oxidative stress.

Suggested Readings:

1. DNA and Protein Sequence Analysis: A Practical Approach (Practical Approach Series, No. 171), 1996, M.J. Bishop and C.J. Rawlings (Editors), 1996, IRL Press.
2. Sequence Analysis Primer, Michael Gribskov and John Devereux (Editors), 1992, Oxford University Press..
3. Approaches to gene Mapping in Complex Human Diseases, Jonathan L. Haines, Margaret A. Pericak-Vance (Editors), 1998, John Wiley & Sons.
4. Essentials of Genomics and Bioinformatics, C.W. Sensen (Editor), 2002, John Wiley and Sons.
5. Hidden Markov Models for Bioinformatics, Timo Koski, Timo Koskinen, 2001, Kluwer Academic Publishers.
6. Albert, B; Bray, D; Lewin, J; Raff, M; Roberts, K; Watson, J.D.; Molecular Biology of the Cell. Garland, New York, 1994.
7. Brachet J. & Mirshy, A.E., ed., The Cell Biochemistry, Physiology, Morphology, Vol.II. Academic Press Inc. London LTD. 1961.

8. Buchanan, B.B.; Gruissem, W.; Jones, R.L.; Biochemistry & Molecular Biology of Plants, American Society of Plant Physiologists, Rockville, Maryland, 2000.
9. Charalambous, G., Ed., Spices, Herbs & Edible Fungi, Elsevier, New York 1944.
10. Clayton, R.K., Photosynthesis : Physical mechanism & Chemical patterns. Cambridge University Press, Cambridge. 1980.
11. Dangi, J.L.; Bacterial Pathogenesis of Plants & Animals, Molecular & Cellular Mechanism. Springer-Verlag, Berlin, 1995.
12. Daniel,M. and R.P.Purkayastha Ed., Handbook of Phytoalexin metabolism & action, Marcel Dekker, Inc., New York, 1995.
13. Davies, D.D., ed., The Biochemistry of Plants, Vol.II, Academic Press, London, 1987.
14. Duke, J.A. CRC Handbook of Phytochemical Constituents of GRAS Herbs, Foods & other Economic Plants. CRC Press, Boca Raton, FL, 1992.
15. Epstein, E., Mineral Nutrition of Plants : Principles & Perspectives. John Wiley & Sons, New York, 1972.
16. Hopkins, W.G. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA, 1995.
17. Jones & Bartlett, Plant Cell Biology : Structure & Function, Sudbury, M.A., 1996.
18. Kaufman, P.B.; L.J.Cseke; S.Warber; J.A.Duke & H.L.Brielmann. Natural products rom plants. CRC Press LLC New York, 1999.
19. Llyoid, C.W. ed, Plant Cell biology : Structure and function, Academic Press, London, 1982.
20. Llyoid, C.W. ed, The cytoskeletal Basis of Plant Growth & Form, Academic Press, London, 1991.
21. Lodish, H: Berk, A.; Zipursky, S.L.; Matsudaira, P. : Baltimore, D., and Damell, J. Molecular Cell biology. 4th ed. W.H.Freeman & Co., New York, USA, 2000.
22. Marchner, H. Mineral Nutrition of Higher Plants, 2nd ed. Academic Press,, London, 1995.
23. Moller, T.M.; Gardestom P., Glimelin, K.; Glaser, E. Plant Mitochondria : From Genes to function. Backhuys Publishers, 1998.
24. Nishimura, S.; C.d.Vance & N.Doke, Eds. Molecular determinants of Plant diseases. Japan Scientific Press, Tokyo / Springer Verlag, Berlin, 1987.
25. Noggle, G.R. & G.J.Fritz. Introductory Plant Physiology. 2nd ed. Prentice-Hall, Inc., Englewood cliffs, N.J. U.S.A., 1992.
26. Plummer, D.T. An Introduction to Practical Biochemistry, 3rd ed. Tata Mc Graw Hill, Delhi.

27. Rochaix, J.D. Goldschmidt-Cleronont,M., Merchant, S., Kluwer. The molecular biology of chloroplast & mitochondria in Chlamydomonas, Academic Publishers, Dordrecht, The Netherlands, 1998.
28. Staples, R.C. Ed. Plant Disease Control, John Wiley & Sons, New York, 1981.
29. Taiz, L. & Zeiger, E. Plant Physiology 2nd ed. Academic Press, Sandiago, U.S.A. 1998.
30. Tobin, A.K., ed. Plant Organelles. Cambridge University Press. Cambridge, UK, 1992.
31. Westhoff, P. Molecular Plant Development : from Gene to Plant. Oxford University Press, Oxford, UK, 1998.

Laboratory Exercies :

1) The separation of leaf pigments by adsorption chromatography.
2) The separation of amino acids by two dimensional chromatography.
3) The identification of sugar in Fruit juices by TLC.
4) Seperation of Lipids by TLC.
5) SDS - PAGE for soluble proteins extracted from given plant material.
6) Extraction of Essential oils from plant material.
7) Separation of esters and perioxidases by native PAGE.
8) Determination of Chl- a, Chl-b & total chlorophyll in C3 & C4 plants by spectrophotometry.
9) Determination of isoelectric point of legumin.
10) The quantitative estimation of amino aids by using the ninhydrin reaction.
11) Estimation of total carbohydrates by anthrone reagent.
12) The determination of acid value of fats.
13) The determination of saponification value of fats.
14) The determination of activity of enzyme a - amylase.
15) Isolation of Chloroplast from spinach leaves.
16) The evaluation of oxygen by isolated chloroplast using Hill Oxidants.
17) Preparation of absorption spectrum of chlorophylls & carotenoids.
18) Estimation of stress induced amino acids (proline)
19) Demonstration of phototropism, geotropism, hydrotropism & seismonasty.
20) Determination of water potential by tissue weight change method.
21) Estimation of Sodium, Potassium & Calcium in plant material by Flame-photometry.
22) Estimation of peroxidase activity.

23) Detection of secondary metabolites by TLC (any one)
24) Profile study of secondary metabolites by TLC (any one)
25) Spectrophotometric estimation of secondary metabolites.
26) Estimation of phytoalexins.
27) PR- protein (b - 1,3 glucanase, chitinase, PAL) assay.

Semester III

Elective Practical – VI

Advanced Plant Physiology and Biochemistry

PRACTICAL SCHEDULE

Time: 6 Hrs Full Marks: 40

Q. 1 Setting and working of any one Plant Physiology experiment. 08 Marks

Q. 2 Setting and working of any one biochemistry experiment. 08 Marks

Q. 3 Comment on two experiments based on plant physiology and biochemistry that are set up. 10 Marks

Q. 4 Comment on principle and working of analytical instrument. 04 Marks

Q. 5 Perform phytochemical / biochemical test. 05 Marks

Q. 6 Viva voce 05 Marks

Semester – III

PAPER- XI: MOLECULAR BIOLOGY, BIOTECHNOLOGY AND PLANT BREEDING-I (Elective)

UNIT I: 1.1 Chemical basis of life- Covalent bonds, Non-covalent bonds, Vander Waal's forces, Acids, Bases and Buffers.

1.2 Protein structure and function – Hierarchial; structure of protein (Primary, Secondary, Tertiary, Quaternary and domain structure).

1.3 Modification and degradation of proteins. Molecular chaperons.

1.4 Membrane proteins-Integral and peripheral membrane proteins and its Interaction.

1.5 Methods of separation of cell proteins – Detergents, Differential and Rate zonal centrifugation, SDS-Polyacrylamide gel electrophoresis and isoelectric focusing.

UNIT II: 2.1 Nuclear genome organization – Genome size, Kinetics of DNA denaturation and renaturation, the law of DNA constancy and C- value paradox.

2.2 Kinetic classes of DNA – Repetitive and Unique DNA sequences and its significance.

2.3 Transcription in prokaryotes – Transcription unit, optimal prokaryotic promoter, Bacterial RNA polymerase, Transcription process.

2.4 Transcription in eukaryotes – RNA polymerase, transcription factors, promoters, enhancer, transcription process.

2.5 Modification in RNA – 5' Cap formation, Transcription termination, 3' end processing and polyadynalation, Splicing, Editing, nuclear export of mRNA and mRNA stability.

UNIT III: 3.1 Plant tissue culture- Laboratory structure and requirements, Different types of culture media, Importance of organic, inorganic nutrients in cell differentiations. Role of growth regulators in cell differentiation.

3.2 Anther and pollen culture techniques.

3.3 Protoplast culture and somatic hybridization – Isolation of protoplasts, culture, and fusion methods.

3.4 Techniques of Bacterial culture and selection.

UNIT IV: 4.1 Cloning techniques for *E.coli.* – Mechanical shearing, Restriction endonucleases, Synthetic linkers and adapters.

4.2 Vector systems – Plasmid, Cosmid, and Bacteriophages.

4.3 Construction of gene libraries – Genomic and c-DNA libraries.

4.4 Gene Technology in plants – Agrobacterium mediated gene transfer.

4.5 Transgenic plants – Production of transgenic plants for herbicide, insect / pest tolerance through recombinant DNA technique. Production of transgenic tomato plants with longer shelf life and better taste.

UNIT V: 5.1 Plant genetic resources- Centres of origin of food plants, concept of parallel variation, Importance of genetic diversity and conservation.

5.2 Utilization of wild species in crop improvement – Tobacco, Tomato, pearlmillet, Brassica.

5.3 Techniques of producing hybrid seeds; Barriers to interspecific hybridization; Cytoplasmic basis of sterility.

5.4 Cytoplasmic and genetic male sterility systems in hybrid seed production – Methods, Sources, Advantages and difficulties and future prospects.

Semester – III

PAPER-XII: MOLECULAR BIOLOGY, BIOTECHNOLOGY AND PLANT BREEDING-II (Elective)

UNIT I : 1.1 Chemical structure and functions of Biomolecules- Nucleic acids, Carbohydrates and lipids.

1.2 Principle, working and applications of various techniques.

1.3 Gel-filtration, ion exchange and affinity chromatography.

1.4 Thin layer and gas chromatography.

1.5 High-pressure liquid chromatography.

UNIT II: 2.1 Organisation of eukaryotic genes – Features of split genes; Pseudogenes; Exons and Introns.

2.2 Genetic code – Properties of code; Biochemical elucidation of code; suppressor, non-sense, missense and frameshift mutations.

2.3 Translation in prokaryotes and eukaryotes.

2.4 Regulation of gene expression in eukaryotes – Position effect, paramutation, Genetic imprinting.

2.5 Regulation of transcription, Transcriptional and post transcriptional gene silencing.

UNIT III: 3.1 Tools in biotechnology – Principle, techniques and application of nucleic acid hybridization; Southern, Northern and Western; Microarray and PCR.

3.2 Genomic stability – Molecular characteristics, properties and significance of eukaryotic mobile genetic elements – Ty elements in Yeast; Copia elements in Drsophila, Ac-Ds, Spm – dSpm elements in maize. Role of mobile genetic elements in evolution.

UNIT IV: 4.1 Plant viruses as gene vectors – RNA viruses, DNA viruses, Gemini viruses, and caulimovirus.

4.2 Agrobacterium mediated gene transfer – Agroinfection, vectorless gene transfer.

4.3 Directed genetic engineering of plant cells – Role of antisense RNA technology and Ribozyme in inactivation of resistance gene. Role of antisense RNA in AIDS controls.

4.4 Plant as a Bioreactor – Production of High value of protein, new or modified carbohydrates in transgenic plants. Stability of proteins and RNA produced from genes introduced into transgenic plants.

UNIT V: 5.1 Molecular plant breeding – Molecular marker systems. Importance of molecular marker assisted breeding. Molecular markers in genome analysis: RFLP and RAPD.

5.2 Radiation biology –Radioactive isotopes, half-life of isotopes, Role of radiations in plant improvement.

5.3 Mutation breeding – Mutagens, treatment methods and its applications in crop Improvement.

5.4 Principle and application of Biometrical genetics in plant Breeding.

Suggested Readings :

1) Karp, G. 1999. Cell and Molecular Biology Concepts and Experiments (2nd edition). John Wiley & Sons, Inc.USA.

2) Lewin, B. 2000. Gene VII. Oxford University Press, New York, London.

3) Lewis, R. 1997. Human Genetics : Concepts and Applications (2nd edition). WCB McGraw Hill U.S.A.

4) Malacinski, G.M. and Freifelder, D. 1998. Essential of Molecular Biology (3rd edition). Jones and Bartlet, Publishers, Inc. London.

5) Russel P.J. 1998. Genetics (5th Edition). The Benjamin / cummings publishing company Inc. USA.

6) Snustad D.P. and Simmons, M.J. 2000. Principles of Genetics (2nd edition) John Wiley & Sons Inc. USA.

7) 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.

8) Buchanan, B.B., Gruissem, W., and Jones,R.L., 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

9) Lodish, H., Berk,A., Zipursky,S.L., Matsundaira,P., Baltimore,D., and Darnell, J.2000. Molecular Cell Biology (4th Edition). W.H.Freeman and Co., New York., USA.

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20) Chopra V.L.2001. Plant breeding. Theory and Practice. Oxford IBH Pvt.Ltd., New Delhi.
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24) Wilson,K. and Goulding, K.H. (Eds), 1992. A Biologist Guide to Principles and Techniques & Practical Biochemistry (3rd Edition). Manas Saikia for Foundation Books, New Delhi.
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26) Hans-Walter Heldt. 1997. Plant Biochemistry & Molecular Biology. Oxford University Press, New York.
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28) Rubenstein, I. Gengen bach, B.Phillips, R.L. and Green C.E. (Eds), 1980. Genetic improvement of crops. University of Minnesota Press. U.S.A.
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35) Gupta, S.K.2000. Plant Breeding. Theory and Techniques. Agrobios (India) Jodhpur.
36) Singh, P. 2001. Essentials of Plant Breeding (2nd Edition). Kalyani Publishers, New Delhi.

37) Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A., and Weiner, A.M. 1987. Molecular Biology of the Gene. (4th Edition). The Benjamin / cummings Publishing Company. Inc. California.
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39) De Robertis, E.D.P. and De Robertis, Jr.EM.P. 1999. Cell and Molecular Biology (8th Edition) B.I.Publication Pvt.Ltd. New Delhi.
40) Jahier, J. (Ed.) 1996. Techniques of Plant cytogenetics. Oxford & IBH Publishing Co.Pvt.Ltd. New Delhi.

Laboratory exercises:

1. To extract genomic DNA from leaves and to analyse the extracted DNA by Agarose Gel Electrophoresis.
2. Estimation of protein by Bradford's Method.
3. Western Blotting- Protein profiling.
4. SDS – PAGE.
5 Estimation of amino acids by Thin Layer Chromatography.
6 Estimation of fatty acids by paper chromatography.
7 Restriction Digestion.
8 Mechanical isolation of mesophyll protoplasts.
9 Protoplast fusion using polyethylene glycol solution.
10 DNA Fingerprinting.
11 Plasmid preparation.
12 Isolation of genomic DNA from Bacteria.
13 Establishment of callus culture from carrot cambial explant.
14 Effect of ionizing radiations/chemical mutagen on growth and mitotic Chromosome.
15 Establishment of callus from important medicinal/ ornamental/ oil yielding/ wild and endangered/ vegetatively propagated plants.
16 Detection of anomalies in chromosome pairing and disjunction caused by mutant genes and structural alteration of chromosomes.
17 Preparation of chromosome maps from Three point test cross data.
18 Identification of mutant genotype in Drosophila and Arabidopsis stocks maintained by the department.
19 Field exploration for detection of male sterile plants and estimation of their pollen fertility in locally grown plants (Tomato, Brassica, Linum).
20 Emasculation and bagging of flowers of Brasicaceae, Malvaceae, and liliaceae, pollinating them manually and estimating fruit and seed set.
21 Lay out of field experiment: Randomised block design, Latin square design.

22 Statistics:- Central value: mode median, mean; Dispersion: range, mean deviation, standard deviation; Frequency distribution: frequency curve, frequency histogram.

23 Use of different softwares for determination of chromosome length.

24 Use of CCD camera for microphotography.

25 To study the DNA denaturation and renaturation kinetic study by UV-VIS spectrophotometer.

Semester III

Elective Practical –VI: Molecular Biology, Biotechnology and Plant Breeding

PRACTICAL SCHEDULE

Time : 8 Hrs. Full Marks : 40

Q. 1. Setting and working of any one major Molecular Biology experiment. 08 Marks

Q. 2. Perform one major Biotechnology experiment. 08 Marks

Q. 3. Perform one Plant breeding experiment. 10 Marks

Q. 4. Comment on principle and working of analytical instrument. 04 Marks

Q. 5. Spotting. 05 Marks

Q. 6. Viva-Voce 05 Marks

Semester-III

PAPER –XI: PALAEOBOTANY

(EVOLUTIONARY BOTANY)-I (Elective)

Unit I : Palaeobotany as Evolutionary Science.

1.1 Basic concepts and scope of palaeobotany as evolutionary science.

1.2 Emergence of palaeobotany in world and India.

1.3 Basic principles of fossilization, fossils as an evidence of past life, methods of preservation, methods for study of different preservation types of plant fossils.

1.4 Geological time scale; stratigraphic importance of plant fossils.

1.5 Origin of life, Theory of Panspermia.

1.6 Classification of fossil plants, nomenclature and reconstruction.

Unit II : Diversification of life forms:

2.1 Algal forms like A*nimikiea, Kakabekia,Gunflintia, Eostrion* and *Stromatolite.* Dinoflagellete nano-fossils, Cyanobacteria in Archaeozoic era.

2.2 Fossil fungi.

2.3 Fossil Chlorophyta, Chrysophyta, and Phaeophyta.

2.4 Non-vascular cyrptogams like *Thallites, Marchantiolites, Naiadita, Sporogonits,* fossil mosses.

2.5 Phylogenetic significance of fossil record.

Unit III : Early Vascular land plants:

3.1 Evidence of first vascular plant.

3.2 Rhyniopsida form Rhynie chart.

3.3 Aldanophyton, Cooksonia, Baragwanathia, Rhynia, Psilophyton, Asteroxylon, Horneophyton, Yarravia, Lycopods like *Leclerquia, Lopidodendrons, Lepidophlois, Lepidostrobus.*

3.4 Origin of Isoetales, Equisetales, *Azolla, Salvinia* with special reference of Indian forms.

Unit IV: Progymnosperms: Structure and Evolution.

4.1 Aneurophytales: *Aneurophyton,Protopteridium, Tetraxylopteris*.

4.2 Archaeopteridales: *Archaeopteris.*

4.3 Origin of Progymnosperms and inter relationships.

Unit V: Fossil Gymnosperms:

5.1 Evolution of early seed.

5.2 Calamopityales: *Calamopitys, Stenomylon Chapelia*.

5.3 Callistophytales: *Callistophyton, Idanothekion, Callospermarion, Vesicaspora.*

5.4 Evolutionary significance of the order.

5.5 Cycadophyta and Coniferophyta: Past distribution and evolutionary significance of different orders.

Semester-III

PAPER –XII: PALAEOBOTANY

(EVOLUTIONARY BOTANY)-II (Elective)

Unit I : Pre-angiosperm fossil forms.

1.1 :Pre- Cretaceous angiosperms: *i) Sanmiguelia, ii) Fercula, iii) Sahanioxylon, iv) Acaciaphyllum, v) Sahanipupshpam, vi) Ficophyllum, vii) Proteaphyllum, viii) Eucomidites, ix) Rogersia.*

1.2 :Early evidence of flowers, fruits and seeds with reference to Indian flora.

1.3 :Diversification of angiosperms in Cretaceous periods.

1.4 :Modern concept of origin of Angiosperms, concept of punctuated equilibrium, cladistics concept.

Unit II : Biodiversity in Geologic past.

2.1 :Glossopteris flora; Euramerican flora, Cathyasian flora and Angara flora.

2.2 :Indian floras : Glossopteris, flora, Dicroidium flora, Ptilophyllum flora, (Rajmahal flora), Deccan Intertrappean flora.

2.3 :Palaeogeographic and palaeoecological significance of floras.

2.4 : Modern concepts of Gondwana with reference to its limits and extension, Karewa beds.

2.5 :Concept of Archeobotany, Palaeoethno and Taphonomical concepts, Mass extinction

Unit III : Microfossil Evidences:

3.1:Definition of spore, pollen, meiospores; prepollen; morphology and dispersal of important pollen types, presentation of pollen, ornamentaton of pollen wall.

3.2 :Study of pollen kit, ubisch bodies; Role of pollen and spore in stratigraphy; classification of isolated spores and pollen.

3.3:Dispersed megaspores; primitive seeds,

3.4 :Significance of palynology is coal and oil industry, Role of pollen grains in industrial honey production with reference to Indian work.

Unit - IV : Applied Palaeobotanical aspects :

4.1 :Fossil fuels; Biodiagenesis of coal, (Process of Coalification) conditions of coal formation).

4.2 :Microlithotypes found in coal viz : *Vitrinites*, *Resinites* etc.

4.3 :Coal as an indicator of palaeoclimate, Resources of coal and its present status.

4.4 :Origin of oil forming beds, source material for oil reserves of India, Formation of diatomaceous earth in marine environment, Bombay High, Present status of oil reserves.

Unit - V: Applied Aspects:

5.1 :Radiometric dating of rocks, half life period; K-Ar dating, Fission track dating.

5.2 :Continental Drift theory, plate tectonic model,

5.3 :Palaeogeographical implications, Reconstruction of past vegetation.

5.4 :Aero-allergens and its significance.

List of Books and Journals :

1. Andrews,H.N. (1961) Studies in Palaeobotany John Wiley & Sons London.

2. Darrah, W.C. (1960) Principles of Palaeobotany.
3. Delevoryas, T. (1962) Morphology & Evolution of Plants.
4. Sahni, B. (1920) Revision of Indian Fossil Plants, GSI Publication.
5. Meyen S.V. (1987) Fundamentals of Palaeobotany, Chapman & Hall, London.
6. Pant D.D. (2003) Cycas and allied cycadophytes, B.S.I.P., Publication.
7. Sporne, K.R. (1975) The Morphology of Pteridophytes, Hutchinson, London.
8. Sporne, K.R. (1965) Morphology of Gymnosperms, Hutchinson, London.
9. Sporne, K.R. (1974) Morphology of Angiosperms Hutchinson, London.
10. Seward, A.C. (1898) Fossil Plants Vol.-I-IV 1919
11. Stewart, W.N. (1983) Palaeobotany & Evolution of Plants Cambridge University Press.
12. Scott D.N. (1923) Studies in Fossil Botany
13. Taylor, T.N. (1981) Introduction to Palaeobotany; a Fossil Plant Biology McGraw Hill, New York.
14. Wadia, D.N.Geology of India
15. Tappan, H. (1980) The Palaeobiology of Plant protist Freeman, Oxford.
16. Thomas B.A. Spicer, R.A.(1987) The Evolution & Palaeobiology of land Plants. Discordies Press, Fort land U.S.A.
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18. Arnold C.A. (1947) An Introduction to Palaeobotany.
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20. Chaloner, W.G. Mac Donald 1980 Plant Invade the land. Royal Scottish Museum, Edinberg.
21. Chandra, S. & Surange, K.R.!979 Revision of sps. of Glossopteris, BSIP publication.
22. Brook, J. (1971) "Sporopollenin". Academic Press, London.
23. Bold, H.C. (1980) Morphology of Plants & Fungi. Harper & Raw, New York.
24. Chamberlain, C.J. 1935 Gymnosperms, Structure and Evolution University of .Chicago.
25. Erdtman G. Introduction to Pollen analysis.
26. Erdtman G. Pollen Morphology & Plant Taxonomy
27. Faegri, K. Vander Pijil. 1979The Principles of Pollination Ecology, Pergamon Press, Oxford

28. Harris, T.M. 1961 The Yorkshire Jurasic Flora; I, Trustees of British Museum
29. Harris, T.M. 1964 The Yorkshire Jurasic Flora; II, Trustees of British Museum
30. Harris, T.M. 1969 The Yorkshire Jurasic Flora; III & IV, Trustees of British Museum
31. Nair, P.K.K. 1969 Essential of Palynology
32. Pianka, E.R. 1978 Evolutionary Ecology Hagers, New York.
33. Cronquist, A., 1968 Evolution and Classification of Flowering plants Houghton Mifflin, Boston.
34. Bierhorst, D.W. 1971 Morphology of Vascular Plants MacMillan, New York.
35. Stanley, R.G. & Linskens, H.F. 1974 Pollen Springer Verlag, New York.
36. Becks, C.B. 1976 Origin and Early Evolution of Angiosperms Columbia University Press.
37. Takhtajan, A.L. 1969 Flowering Plants, Origin & Dispersal. Edinberg, Oliver.
38. Takhtajan, A.L. 1954 Essays on Evolutionary Morphology of Plants Lieningrad University, Leningrad.

Journals:

1. The Palaeobotanist : BSIP, Publication, Lucknow
2. Geophytology : The Palaeobotanical Soceity, Lucknow.
3. Palaeontographica : Stuttgradt, Germany.
4. Review of Palaeobotany & Palynology :Elsevier, Publication.
5. Pollen et Spores : Elsevier, Publication.
6. Palaeobiology : Elsevier, Publication.
7. Botanical Review : Elsevier, Publication.

Laboratory Exercises :

1. Study of preservation types.
2. Techniques involved in study of different preservation.
   i.) Maceration, ii) Ground sections, iii) Acetolysis etc.
3. Study of type specimens of plant fossil; with complete monograph, sketching, etc.
4. Study of Geological time scale.
5. Preparation of slides and study of cuticular characters.
6. Study of palynomorphs, typical of each age.
7. Plant life through the ages. Drawing of representative forms of geological periods.

8. Study of reconstruction of vegetation, floras.
9. Study of peat, lignite and coal samples.
10. Study of marine microfossils, especially of oil and natural gas implications.
    i) Visit to fossil localities for collection.
    ii) Visit to National Laboratories.
    iii) Submission of practical record, micropreparations, collection of fossil specimens
    iv) Field notebook, geological data.
    iv) Visit to palaeobotanical museums.

Semester – III

ELECTIVE PRACTICAL-VI: PALAEOBOTANY (EVOLUTIONARY BOTANY)-I

PRACTICAL SCHEDULE

Time: 6 hrs. Max.marks 40

1. Study of fossil specimens ..... 08 Marks
2. Application of technique for isolation..... 08 Marks
3. Identification of specimens & slides .....10 Marks
4. Study of Geological time-scale ..... 04 Marks
5. Identification of pre-angiosperm fossil forms with evolutionary Implications 05 Marks
6. Viva-voce 05 Marks

Semester – III

PAPER – XI: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS-I (Elective)

Unit-I 1.1:Means of reproduction in flowering plants, flower structure and development.

1.2 :Anther structure : Biochemical and Ultrastructural aspects, structure and function of tapetum.

1.3:Microsporogenesis : Cytoplasmic reorganization, pollen tetrad development and types, pollen wall morphogenesis, biochemical, physiological and genetic events involved in pollen development.

Unit-II : 2.1:Pollen morphology : pollen wall sculpturing, Ultra structure.

2.2:Pollen apertural types, Techniques for morphological preparations: Acetolysis, NPC.

2.3:Light and scanning election microscopic studies of pollen.

Unit-III 3.1:Pollen: Physiological and biochemical aspects, viability, assessment of pollen viability.

3.2 : Pollen germination *in-vivo* and *in-vitro*, pollen tube development and nuclear migration.

3.3 : Pollen storage, pollen bank, cryopreservation .

Unit-IV: 4.1 : Pistil : Structure and function of stigma and style.

4.2 : Types of stigma, stigma receptivity and its importance, biochemical aspects. Stylar tissue.

4.3 : Pollen adhesion and germination on stigma, molecular basis, pollen reorganization, Incompatibility and its significance.

Unit-V: 5.1 : Male sterility : genetic and cytoplasmic male sterility, male sterile lines.

5.2 : Male sterility through recombinant DNA technology.

5.3 : Sperm dimorphism and hybrid seed production.

Semester – III

PAPER – XII: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS-II (Elective)

Unit-I 1.1 : Historic review of pollination studies.

1.2 : Pollination : Pollination mechanism and syndromes, pre-pollination events: anther dehiscence and pollen release.

1.3 : Biotic and abiotic pollination, agencies concerned in pollination, Floral attractants and rewards, floral biogeny, blossom types.

Unit-II 2.1 : Fertilization : Pollen tube development through stylar tissue, biochemical events, pollen tube entry in ovule,

2.2 : Heterospermy, differential behavior of male gametes, discharge and movement of sperms.

2.3 : Syngamy and triple fission, significance of double fertilization and triple fusion.

Unit-III: 3.1 : Structure and a types of ovule.

3.2 : Megasprogenesis, structure and types of embryo sac.

3.3 : Ultra structure of zygote, embryo development and classification, polyembryony.

Unit-IV : 4.1 : Structure, development and types of endosperm.

4.2 : Ruminate endosperm, chemical composition of endosperm. Storage proteins.

4.3 : Food reserve of endosperm and endosperm culture.

Unit-V 5.1 : Anther/pollen culture, pollen embryo genesis, androgenic haploids, biochemical aspects.

5.2 : Somatic embryogonesis, biochemical aspects of somatic embryo genesis.

5.3 : Aeropalynology : Survey of air borne pollen analysis of aerospore.

5.4 : Mellitopalynology : Pollen analysis of honey, role of apiary in crop production.

Suggested readings:

1) Pande, A.K. and M.R.Dhakae (2003). Advances in Plant Reproductive Biology. Vol.II Narendra Delhi.

2) Chawhan, Y.S. and A.K.Pande (1995). Advances in plant Reproductive Biology. Vedamse Book, Pvt.Ltd. New Delhi.

3) Malik, C.P. (1996). Advances in Pollen spore Research : Emerging Strategies. VolXXI Vedamse Book (P) Ltd. New Delhi.

4) Clement, C. (1999). Anther and Pollen : From Biology to Biotechnology. Springer-Verlag New York.

5) Shukla, A.K., M.R.Vijayraghwan and B.Chaudhari (1998). Biology of pollen vedamse Book (P) Ltd. New Delhi.

6) Harley, M.M. (2003). Pollen and Spores : Morphology and Biology. Royal Botanic Garden kew.

7) Raghavan, V. (2000). Developmental Biology of Flowering Plant. Springer-Verlag.

8) Batygina, T.B. (2002) Embryology of Flowering Plants : Terminology and Concepts. Science Publishers, INC (USA)

9) Cresti,M., Cai,G., Moscatelli,A. (1999). Fertilization in higher plants : Molecular and cytological Aspects. Springer-Verlag.

10) Nattancourt, D.de (2001). Incompatibility and Incongruity in Wild and Cultivated Plants. Springer-Verlag.

11) Mahapatra, S.S. and Bruee knox (1995) Pollen Biotechnology : Gene expression and Allergen Characterization. Kluwer Academic Publishers, Boston.

12) Dafni,A., Herse,M., Pacini,E. (2000) Pollen and Pollination. Springer-Verlag Heidelburg.

13) Shivanna,K.R. (2003) Pollen Biology and Biotechnology. Science Publishers, INC (USA)

14) Hesse,M., Enrendorper, F. (1990). Morphology, Development and Systematic Relevance of Pollen and Spores. Springer-Verlag.

15) Lars Chittka and James, J. Thomson (2001) Cognitive Ecology of Pollination. Cambridge University Press.

16) Chupeau, Y., Caboche,M. Henry, Y (1998). Androgenesis and Haploid Plants. Springer-Verlag.

17) Yeo,P.F. (1993) Secondary Pollen Presentation : Form, Function and Evolution Springer-Verlag.

18) Shivanna, K.R., Johri,B.M., Sastri,D.C. (1979) : Development and Physiology of Angiosperm pollen. Today and Tomorrows printers and publishers, New Delhi.

19) Moore, P.D., Webb,J.A. and Collinson, M.E. (1991) Pollen Analysis. 2nd Ed. Blackwell Scientific Publications. Boston.

20) Barth, F.G. (1991) Insects and Flowers. Princeton University, Press, Princeton.

21) Faegri, K. and Van der Piji,L. (1979) The Principles of Pollination Ecology. Pergmon Press. Oxford.

22) Howell,S.H. (1998) Molecular Genetics of plants Development. Cambridge University Press, Cambridge.

23) Scot R.J., and Anthony D.Sted (1994) Molecular and Cellular Aspects of Plant Reproduction, Cambridge Uni. Press.

24) Shivanna, K.R. and Rangaswamy,N.S. (1992). Pollen Biology. A Laboratory mannual.

25) Bhojwani, S.S. and Batnagar, S.P. (2000). The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Delhi.

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

27) Fosket, D.E. (1994) Plant Growth and Development. A Moleclar Approach. Academic Press, San Diego.

28) Leins,P., Tucker,S.C. and Endress,P.K. (1988). Aspects of Floral Development. J.Cramer, Germany.

29) Lyndon, R.F., (1990). Plant Development. The Cellular Basis. Unnin Hyman, London.

30) Murphy, T.M. and Thompson, W.F. (1988). Molecular Plant Development. Prentice Hall, New Jersy.

31) Proctor,M. and Yeo,P. (1973). The Pollination of Flowers. William Collins Sons, London.

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33) Shivanna,K.R. and Sawhney,V.K. (eds) (1997). Pollen Biotechnology for crop production and Improvement, Cambridge University Press, Cambridge.

34) Shivanna,K.R. and Johri,B.M. 1985. The Angiosperm Pollen : Structure and Function. Wiley Eastern Ltd., New York.

35) The Plant Cell. Special issue on Reproductive biology of plants, Vol.5 (10) 1993. The American Society of Plant Physiologists, Rockville, Maryland, USA.

36) Weberling, F. (1989). Morphology of Flowers and Inflorescence, Cambridge University Press, Cambridge.

37) Ende, H.V.D. (1976) Sexual Interactions in Plants : The Role of Specific Substances in Sexual Reproduction. Academic Press, London.

38) Cresti,M. Tiezzi,A. (1992). Sexual Plant Reproduction, Springer-Verlag, Barlin.

39) Chailakyan,M.K. and Khrianin,V.N. (1989). Sexuality in plants and its Hormonal Regulation. Springer-Verlag, Barlin.

40) Meeuse,B.J.D. (1961). Story of Pollination. Renold Press Company, New York.

41) Faegri,K and Iverson, J. (1989). Text Book of Pollen Analysis. John Wiley & Sons, New York.

42) Bajaj, Y.P.S. (Ed.) (1989). Plant Protoplast and Genetic Engineering-II. Springer-Verlag, Barlin.

43) Wilson, M.F. (1983). Plant Reproductive Ecology. John Wiley and Sons, New York.

44) Richards, A.J. (1978). Pollintion of Flowers by Insects. Academic Press Inc.London.

45) Heslop Harrison, J. (1971) Pollen Development and Physiology. Butterworth and Co. London.

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48) Dafui, A, Kevan, P.G. and Husband, B.C. (2005), Practical Pollination Biology, Enviroquest Ltd., Cambridge.

49) Daroy, The anther: Form, Function and Phylogeny, Cambridge University Press.

50) Crosby. The poisoned weed: Plants toxic to skin, Oxford University Press.

51) Lovett-Doust. Plant Reproductive Ecology : Patterns and strategies. Oxford University Press.

52) De Netancourt, D. (1977), Incompatibility in Angiosperms Springer Verlag, New York.

53) Shivanna, K.R. (2002), Pollen Biology and Biotechnology Oxford and IBH Publishing Co. Pvt. Ltd.

54) Johri, B.M. (1984). Embryology of Angiosperm. Springer-Verlag, Berlin Heidel berg, New York.

55) Agashe S.N. (2005) Palynology and its Applications, Oxford and IBH Publ. Co. Pvt.Ltd. New Delhi.

56) Bhattacharya, K. S. Mujumdar & Bhattacharya (2006) : A Text Boook of Palynology, New Central Book Agency, Kolkata.

57) Nair P.K.K. (1970) Pollen Morphology of Angiosperms, Scholar Publi, Lucknow.

58) Tilak, S.T. (1982) : Aerobiology, Vaijayanti Prakashan, Aurangabad.

Laboratory Exercises:

1. Estimation of pollen protein concentration.
2. Separation of amino acids by TLC from pollen.
3. Separation of fats and lipids from pollen grains.
4. Study the effect of mutagens on pollen germination.
5. Induction of polyploidy in pollen grain.
6. Isolation of DNA from pollen grains.
7. DNA estimation in Pollen grains.
8. Plant regeneration through anther/pollen culture.
9. Analysis of honey for pollen spectrum.
10. Study of in- vitro pollen germination using different culture media.
11. Studies on databases pertaining to plant reproduction/Pollination/ Pollen studies.
12. Preparation of Power Point Programme on any aspect of plant reproduction.
13. Studies on e-Journals access
14. Visit to Institutes with electron microscope facilities.
15. Study of pollen wall development by preparation of anther sections.
16. Examination of reproductive mode and means.
17. Pollination experiments to demonstrate self and cross-pollination.
18. Field study on different pollination mechanism.
19. Estimation of pollen load carried out by bees / pollinator.
20. Field observations on pollinator visit, diversity and behaviour.
21. Estimation of pollen production and viability and its statistical analysis.
22. Study of in- vivo and in- vitro pollen germination.
23. Pollen preparation by acetolysis method and NPC examinations.
24. SEM studies and visits to Research laboratory having SEM facilities.
25. Observations on types of stigma and its structure.
26. Study of ovules from permanent preparations.
27. The study of microsporogenesis by section cutting.
28. Air monitoring by air sampler to assess pollen aerospora.
29. Chemical nature of allergenic pollen and test for allergy.
30. Regeneration of androgenic haploids.
31. Protoplast isolation
32. Histochemical analysis of pollen tube.
33. Estimation of pollen / ovule ratio in self and cross pollinated plants.
34. Study of protein profile in pollen / pollen tube by Gel - Electrophoresis.
35. Effect of Biochemical inhibitors on pollen tube growth.

36. Estimation of pollen tube length by computer loaded measurement softwares (Sigmascan by Jandel Scientific, Electronic digital pad).

Semester –III

PRACTICAL VI: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

PRACTICAL SCHEDULE

Time : 6 hrs. Max. marks. 40

Q.1 : Perform the major experiment on pollen preparation for morphological studies 08 Marks

Q.2 : Perform the minor experiment on pollen physiology 08 Marks

Q.3 : Perform the minor experiment on pollen release/ Production/ monitoring 05 Marks

Q.4 : Comment on the experiment based on anther/pollen culture.. 04 Marks

Q.5 : Spotting (Pollen morphology slide, floral reward, blossom type, pollinator, ovule types) 10 Marks

Q.6 : Viva-Voce 05 Marks

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Semester III

PAPER XI: APPLIED MYCOLOGY-I (Elective)

Unit - I: Fungal Symbiosis

1.1:Mycorrhizae Ectotrophic, endotrophic and Ectendotrophic mycorrhizae.

1.2 :Morphology and structure of Arbuscular mycorrhizal fungi.

1.3 :Phosphorus uptake of AM fungi.

1.4 :Role and importance of AM fungi in agriculture.

1.5 :Rhizosphere and phyllosphere General account and importance of rhizosphere and phyllosphere mycoflora.

Unit II: Medical mycology

2.1 : General account of dermatophytic fungi.

2.2 : Human diseases caused by dermatophytes viz. *Tinea pedis, Tinea capitis, Tinea barbae, Tinea corporis and Tinea manum*.

2.3: Birds and Animal dermatophytic fungi and the diseases caused by them.

Unit- III: Industrial mycology

3.1: Antibiotics - Penicillium, Cephalosposin & Griseofulvin.

3.2 : Industrial production of Penicillin.

3.3 : Organic acids - Citric acid, Gluconic acid, Lactic acid.

Unit -IV: Industrial and Nonindustrial fungal metabolites

4.1:Enzymes - Amylases, Proteases, Lipases, Pectinases, Cellulases.

4.2: Phytoalexins : General account, types and importance.

4.3: Mycotoxins _ General acount, types and importance.

4.4: Aflatoxins - General account, types & Importance.

Unit V: Fungi in Human Welfare

5.1: Role of microorganisms in Biodegradation of organic wastes.

5.2: Biodeterioration of noncellulosic and cellulosic materials.

5.3: Fungi in medicine-Mycoproteins & Food processing-Fungus fermented foods, fungi in cheese production.

5.4: Edible mushrooms and their cultivation practices.

Semester III

PAPER XII: PLANT PATHOLOGY-II (Elective)

Unit - I: Principles and Mechanism of Plant diseases.

1.1 :History, Classification and importance of plant pathology.

1.2 :Host parasite relationship, interaction and mechanism of infection.

1.3: Defence mechanism in plants - Biochemical defence mechanism of phenolic compounds, enzymes and toxins.

1.4: Koch's Postulate - Principles and method.

Unit - II: Disease management and Forecasting.

2.1: Chemical and Biological management of Plant disease control.

2.2: Integrated Pest management (IPM)

2.3: The Forms of epidemic conditions for decline of epidemics.

2.4: Methods used in disease Forecasting.

2.5: Forest Pathology and it's impact (General account)

Unit-III: Fungal diseases of cereals and oil seed crops.

3.1: Diseases of cereals - Rust and smuts of wheat, Blast and blight of rice, smuts and leaf spot of Jowar. Ergot, Green ear and downy mildew of Bajra.

3.2: Important diseases of oil seed crops -Soyabean, Groundnut, Sunflower, Safflower and Mustard.

3.3 General knowledge and importance of seed pathology.

Unit - IV: Important fungal diseases of vegetables & Fruits.

4.1: Diseases of vegetables - Brinjal, Tomato, Potato, Chilli, Bhindi, Cabbage and cucurbits.

4.2: Diseases of Fruit crops - Citrus, Papaya, Banana, Mango and grapes.

4.3: General account of post harvest diseases of vegetables and fruits and it's control.

Unit -V: Bacterial and Viral diseases.

5.1: Bacterial diseases, Blight of rice, Tundu disease of wheat, Angular leaf spot of cotton, soft rot of fruits and vegetables.

5.2: Viral diseases - Mosaic and leaf curl of Papaya, Yellow vein mosaic of Bhindi, Viral diseases of Tomato and Potato.

5.3: Phytoplasmal diseases - little leaf of Brinjal, Grassy shoot of sugarcane, & Sesamum Phyllody.

Suggested readings:

1) Agrios, G.N. (1980) Plant Pathology, academic Press, INC, New York.

2) Ainsworth, G.C. and A.S.Sussman (eds). The Fungi, An advance Treatise Vol.I, II, III & IV Academic Press, New York.

3) Alexopoulos, C.J. (1962). Introductory Mycology John Wiley Eastern Pvt.Ltd.

4) Alexopoulos, C.J. and Mims C.W. (1979). Introductory Mycology 3rd Edition, John Wiley and Sons, Inc. Wiley, New York.

5) Alexopoulos, C.J., Mims and Black well (1996) 4th ed. John Wiley and Sons, Inc. Wiley, New York.

6) Aneja, K.R. (1993) Experimental in Microbiology, Plant Pathology & Tissue Culture, Wiswa Prakashan, New Delhi.

7) Bessey, E.A. (1950) Morphology and Taxonomy of Fungi. The Blakiston co. Philadelphia.

8) Bharat Rai, D.K.Arora, N.K.Dube and P.D.Sharma (1994) : Fungal Ecology and Biotechnology, Rastogi Publication.

9) Bilgrami, K.S. and H.C.Dube (1985) A text Book of Modern Plant Pathology, Vikas Publication House, New Delhi.

10) Balkhande L.D. & L.V. Gangawane (2000) Production of auxins Phyollosphere mycoflora and wheat plant resource development, Saraswati Prakashan Aurangabad, P.160-165.

11) Barnett, J.H. (1968) Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.

12) Butler E.J. and S.J.Jones (1949) Plant Pathology, Macmillan & Co. New York.

13) Buckyng Pugh G.J.F. (1971) Auxin productions by phyllosphere fungi Nature Vol. 231 P.332.

14) Dickenson and Preece Mycology of aerial plant surfaces, Academic Press, New York,

15) Dube, R.C. and D.K.Maheshwari (1999) A.Text Book of microbiology, S.Chand & Co. Ltd.

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17) Gruen, H.E. (1959) The production of IAA by *Phycomyces blakesleanus* Mycol.57 683-694.
18) Gupta, V.K. and M.K.Behl (1994) Indian Plant Viruses and Mycoplasma Kalyani Publishers, 1/1, Rejinder Nagar, Ludhiana.
19) Jha, D.K. (1993) A Text Book of Seed Pathology, Vikas Publication House.
20) Manibhushan Rao, K. and A.Mahadevan - Recent Development in biocontrol of plant pathogenes. Today and Tomorrow publishers, New Delhi.
21) Mehrotra, R.S. and Aneja, K.R. (1990) An Introduction to Mycology, Willey Eastern Private Limited.
22) Mehrotra, R.S. (1989) Plant Pathology, Tata McGraw Hill.
23) Mehrotra, R.S. and K.R.Aneja (1998) An Introduction to Mycology, New Age Intermidiate Press.
24) Mukadam, D.S. (1997) The Illustrated Kingdom of fungi, Akshar Ganga Prakashan, Aurangabad.
25) Mukadam, D.S. and L.V.Gangawane (1978) Experimental Plant Pathology (edited) Marathwada University Aurangabad.
26) Pande, P.B. (1997) Plant Pathology, S.Chand & Co. New Delhi.
27) Pelzer, M.J., Jr.Cahn, E.C.S. and N.R.Krieg (1993) Microbiology, Tata McGraw Hill.
28) Preece and Dickeson. Ecology of leaf surface microorganism Academic Press, New York.
29) Rangaswamy, G. and A.Mahadevan (1999) Diseases of Crop Plant in India, Prentice Hall of India.
30) Raychoudhari, S.P. and Nariani, T.K. (1977) Virus and Mycoplasma Diseases of Plant in India, Oxford and IBH Publication Co.
31) Reddy, S.M. *et al* (1997) Microbial Biotechnology, Scientific publishers, Jodhpur.
32) Schlegel, H.G. (1996) General Microbiology, 7th Edition, Cambridge University Press.
33) Snowdon, A.L. (1991) A colour Atlas of Post harvest diseases & disorders of fruits & vegetables Vol.I & II Wolfe Scientific, London.
34) Sing, R.S. (1994) Plant Pathology, Oxford and IBH Publication Co. New Delhi.
35) Sunder Rajan, S. (2001) Tools and Techniques of Microbiology, Anmol Publ.New Delhi.
36) Thind, T.S. (1998) Diseases of field crops and their management, National Agricultural Technology, Information Centre, Ludhiana.
37) Vaidya, J.G. (1995) Biology of the fungi, Satyajeet Prakashan, Pune.
38) Walker, J.G. (1952) Diseases of Vegetables Crops. McGraw Hill, New York.

39) Walker, J.C. (1968) Plant Pathology, McGraw Hill, New York.
40) Geeta Sumbali (1998) and B.M. Johari, Narosa Publishing House, New Delhi
41) Eggins, H.O.W. and Allsop (1975) The Filamentous Fungi Vol. I Industrial Mycology (Biodetoriation and Biodegradation by Fungi) Eds. J.E. Smith and D.R. Berry Edward Arnold, London.
42) D.J. Bagyaraj (1992) Vesicular Arbuscular Mycorhiza application in Agriculture.
43) Emmons, C. W., C. H. Bin ford, J.P. Utz and Know Chung (1977) Medical Mycology, Lea and Febigo, Philadelphia.
44) Holliday, P. Fungus disease of tropical plants (1980), Cambridge University Press, Cambridge.
45) Booth C. (1972) Fusarium (lab guide to identification of major species C.M.I. Kew, Surrrey, England
46) Spencer D. M. (1972) The Powdery Mildew, Academic Press, London
47) Rose, A.H. (1981) Economic Microbiology Microbial biodetoriation Vol.6, Academic press, London and New York.
48) Dikison, C.H. and G.J.F. Pugh (1974) Biology of Plant Litter decomposition. Academic Press, London.
49) A.C. Gaur (1999) Microbial Technology for composition of Agricultural residues by improved methods, I.C.A.R., New Delhi.

Laboratory Exercises:

1. Principles & working of tools, equipments and other requirements in the Mycology & Plant Pathology laboratory.
2. Micrometry and measurement of organisms.
3. Sterilization Processes viz. moist heat, dry heat, chemical and radiation.
4. Drawing of Camera Lucida diagrams and knowledge of computer-based photomicrography and image processing.
5. Preparation of different cultural media for cultivation of Fungi and Bacteria.
6. Monitoring and analysis of Aeromycoflora.
7. Isolation & identification of Phyllosphere mycoflora.
8. Demonstration of dermatophytic Fungi.
9. Isolation of AM Fungi from rhizosphere 500%.
10. Demonstrate antifungal activities of different antibiotics and leaf, flower and root extract.
11. Study of hydrolytic enzymes of different fungi.
12. Study of toxicity of fungi in relation to seed germination, and seedling abnormality.

13. Cultivation of Mushroom.
14. Demonstration on biodegradation of organic waste.
15. Visit to Mushroom industry, Pharmaceutical industries & Pathological study center.
16. Isolation of Soil fungi by soil plate (War cup) and serial dilution (Walkman) method.
17. Isolation and identification of Rizosphere mycoflora.
18. Isolation of external and internal seed borne mycoflora by blotter and Agar Plate method. Cereals, pulses, oil seeds, fruit seeds.
19. Monographic study of locally available plant diseases caused by fungi (atleast 10).
20. Study of locally available crop plant diseases caused by Bacteria (Five)
21. Study of locally available plant diseases caused by viruses & Phytoplasma (Five)
22. Demonstration of morphological & physiological changes in disease plants.
23. Demonstration of Koch's Postulate.
24. Preparation and presentation of herbarium of pathological specimens available in the region (Atleast 30)
25. Preparation of Fungal spore atlas.
26. Field visit to different localities
27. Visit to Agriculture University, Plant Pathological research centers

Semester – III

ELECTIVE PRACTICAL -VI: APPLIED MYCOLOGY AND PLANT PATHOLOGY

PRACTICAL SCHEDULED

Time: 06 hrs. Maximum Marks: 40

Q.1) Identify and describe any two fungal plant diseases..... 08 Marks

Q.2) Identify and give salient features of two fungi from the mix culture. 08 Marks

Q.3) Identify, classify and describe any two fungi. from given seed borne mycoflora/soil mycoflora/Rhizosphere mycoflora..... 05 Marks

Q.4) Demonstrate Koch's postulate/pure culture technique..... 04 Marks

Q.5) Spotting (Specimen/Slide)
(01 - bacterial disease; 01-viral diseases, 01- Phytoplasmal disease; 01-Fungal disease, 01- Spore slide).....10 Mraks

Q.6) Viva-Voce 05 Marks

M.Sc. PART-II BOTANY

Semester – IV

PAPER - XIII: PLANT ECOLOGY

Unit I : Basic concepts and scope.

1.1 Concept, Classification and scope of ecology; Holocoenotic Environment.

1.2 Ecological factors: Climatic, Edaphic, Biotic; Law of limiting factors.

1.3 El -Nino and global warming.

1.4 Ozone layer, Ozone Depletion and its consequences.

Unit II: Population and Community Dynamics

2.1 Population characteristics; population dynamics, carrying capacity, various parameters and measurements.

2.2 Community concept; characteristic features of communities, analysis of communities (analytical and synthetic characters.)

2.3 Community coefficients; Ecotone and edge effects; ecological niche.

Unit III: Vegetation Development

3.1 Types and mechanism of ecological succession.

3.2 Plant Formation; Association, Consociation and Society.

3.3 Evolution of Ecosystem and oxygenic development.

Unit IV: Ecosystem Organization.

4.1 Structure and Functions of Ecosystem.

4.2 Abiotic and biotic components; decomposers role in ecosystem.

4.3 Primary productivity (methods of measurements, global pattern and controlling factors)

4.4 Energy Dynamics; Energy flow in Ecosystem, Trophic organization, ecological efficiencies; Ecomodelling.

Unit V: Ecosystem Functional aspects.

5.1 Biogeochemical cycles C, N, P, S; mineral cycles (Pathways, processes and budgets)

5.2 Ecosystem stability concepts, natural and anthropogenic disturbances.

5.3 Major Biomes of the world.

5.4 Terrestrial Biodiversity; Vegetation types of world and India, hot spots.

Suggested readings:

1) Krebs, C.J. 1989. Ecological Methodology. Harper and Raw, New York, USA.

2) Ludwig, J.A. and Reynolds, J.F. 1988. Statistical Ecology, Wiley, New York.
3) Magurran, A.E. 1988. Ecological Diversity and Its Measurement, Chapman and Hall, London.
4) Pielou, E.C. 1984. The Interpretation of Ecological Data, Wiley, New York.
5) Sokal, R.R. and Rohit, F.J. 1995. Biometry , W.H.Freeman & Co. San Francisco.
6) Murray P.W. and Chapman, S.B. 1986. Methods in Plant Ecology, Blackewell Scientific Publication.
7) Misra, R. 1968. Ecology Work Book, Oxford and IBH New Delhi.
8) APHA - Standard Methods for Examination of Water and Waste Water, American Public Health Association, Washington, D.C.
9) Smith, R.L. 1996. Ecology and Field Biology. Harper Colins New York.
10) Mular - Dombuis, D. and Ellenberg, H. 1974. Aims and Methods of Vegetation Ecology, Wiley, New York.
11) Charis Park - Environment - Principles and applications, Roultedge - London & New York.
12) Smith, R.L. 1996. Ecology and Field biology, Harper Collins, New York.
13) Begon, M., Harper, J.L. and Townsend, C.R. 1996. Ecology, Blackwell Science, Cambridge, U.S.A.
14) Odum, E.P. 1971. Fundamentals of Ecology. Saunders, Philadelphia.
15) Odum, E.P. 1983. Basic Ecology, Saunders, Philadelphia.
16) Barbour, M.G., Burk, J.H. and Pitts, W.D. 1987. Terrestrial Plant Ecology. Benjamin / cummings Publication Company, California.
17) Kormondy, E.J. 1996. Concepts of Ecology. Prentice Hall of India Pvt.Ltd., New Delhi.
18) Chapman, J.L. and Reiss, J\M.J., 1988. Ecology: Principles and Applications. Cambridge University Press. Cambridge, U.K.
19) Moldan, B. and Billharz,S. 1997. Sustainability indicators. John Wiley & Sons, New York.
20) Treshow, M. 1985. Air Pollution and Plant Life. Wiley Interscience.
21) Heywood, V.H. and Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge University Press.
22) Brady, N.C. 1990. The Nature and Properties of Soils, MacMillan.
23) Chandel, K.P.S., Shukla, G. and Sharma, N. 1996 - Biodiversity in Medicinal and Aromatic Plants in India : Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.

24) Walter, K.S. and Gillett H.J., 1998. 1997 IUCN Redlist of Threatened Plants. IUCN, The World Conservation Union, IUCN, Gland, Switzerland and Cambridge, UK.
25) Eldon, D. Enger and Bradley F. Smith (1995) Environmental sciences WBC Publishers, Boston.
26) K.C. Agrawal; (1993); Environmental Biology, Agro-botanical publishers, Bikaner.
27) P.S. Varma and V.K. Agrawal (1995) Environmental Ecology, WBC publishers, Boston

Laboratory exercises:

1) To measure rainfall.
2) To measure transparency of water.
3) To study the light intensity by lux meter.
4) To determine pH of water & soil.
5) To measure the total dissolved solids in water.
6) To evaluate the soil texture.
7) To determine the bulk density or apparent density (or value weight) and porosity (or pore space) of soil.
8) To determine water holding capacity of soil by rapid spot tests.
9) To analyze the chemical properties of soil by rapid spot tests.
10) To estimate exchangeable bases (Na, K, Ca) in soil.
11) To determine organic matter in soil by Walkley & Black's rapid titration method.
12) To assess the trophic status of aquatic habitat through algal count method.
13) To study bioindicators of polluted water.
14) To study the morphological, anatomical adaptations in Hydrophytes, Xerophytes, Halophytes, Epiphytes.
15) To determine the importance value Index IVI) of grassland species.
16) To prove the Biological spectrum of vegetation under study using Raunkiars life forms classification.
17) To study indices of similarity & dissimilarity in a community.
18) To determine P, S, K, Ca, Na in plants by chemical methods.
19) Study of freshwater plant communities.
20) Survey of key stone species.
21) Determination of minimum size of quadrat by species curve method.
22) Determination of minimum number of quadrat by curve methods.
23) Determination of quantitative characters of plant community by Random sampling method (Abundance, Density, frequency, basal cover, canopy cover etc) and determination of quantitative characters by belt transect, line transect method and study of biological spectrum.

24) **Field Survey-** 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 tree planted on a graph paper. They will identify the trees, mention their size, canopy shape, blossoming and fruiting period and their status (healthy, diseased, infected, mutilated, misused or dyeing) and report whether or not the conditions in which they are surviving are satisfactory. The individual reports will be combined to prepare a large map of the area, which can be used for subsequent monitoring either by the next batch of students / teachers / local communities / NGO's / or civic authorities.

25) The purpose is to make the students aware of the kinds of trees and value in urban ecosystem and ecological services.

26) To prepare ombrothermic diagram for different sites on the basis of given data set and to comment on climate.

27) To find out the relationship between two ecological variables using correlation and regression analysis.

28) To determine minimum size and number of quadrats required for reliable estimate of biomass in grasslands.

29) To find out association between grassland species using Chi-square test.

30) To compare protected and unprotected grassland stands using community coefficient (similarity indices).

31) To analyze plant community using Bra-Curtis ordination method.

32) To determine diversity indices (Shannon, Wiever, concentration of dominance, species richness, equitability and B-diversity) for protected and unprotected grassland stands.

33) To estimate IVI of the species in woodland using a point centered quarter method.

34) To determine grass and net phytoplankton productivity by light and dark bottle method.

35) To determine soil moisture content, porosity and bulk density of soils collected from varying depths at different locations.

36) To determine the water holding capacity of soils collected from different locations.

37) To determine present organic carbon and organic matter in the soil of cropland, grassland and forest.

38) To estimate the dissolved oxygen contained in eutrophic and oligotropic water samples by azide modification of Winkler's method.

39) To estimate chlorophyll content in SO2, fumigated and unfumigated plant leaves.

40) To estimate rate of carbon dioxide-evolution from different soils using soda lime or alkali absorption method.

41) To study environmental impact of a given developmental activity using checklist as a EIA method.

42) Visit to different forest areas to study ecosystem, bio diversity and biocomplexity. Visit to Molecular Biology laboratories.

Semester – IV

PAPER –XIV: ENVIRONMENTAL ECOLOGY

Unit I: Basic Concepts

1.1 Concept of Environment and its Scope; Lithosphere, Hydrosphere, Biosphere.

1.2 Energy resources; (i) Renewable and non-renewable (ii) Forest types in India and Maharashtra.

1.3 Environmental impact assessment.

1.4 Green House gases; their sources, trend and role.

1.5 Consequences of climate change.

Unit II: Environmental pollution

2.1 Definition types and sources.

2.3 Air pollution; Natural and man made sources of air pollution, primary and secondary pollutants, toxicity and its impact on environment.

2.4 Soil Pollution: courses of soil pollution, impacts of soil pollution on quality and soil biota.

2.5 Effect of solid waste disposal on soil.

Unit III: Water Pollution.

3.1 Distribution of water and water scarcity.

3.2 Major water pollutants

3.3 Sources of water pollution

3.4 Consequences of water pollution

3.5 Water pollution indicators.

3.6 Bioaccumulation and Biomagnifications of toxic elements in food chain.

Unit IV: Conservation strategies

4.1 Principles of conservation; extinction, environmental status of plants based on IUCN.

4.2 Strategies for conservation, International efforts and Indian initiation.

4.3 Wetlands, Mangrove and coral reefs with respect to conservation of biodiversity.

4.4 Disaster management.

Unit V: Sustainable Management.

5.1 Concept of sustainable development.

5.2 Impact of urbanization; Wasteland development.

5.3 General account of legislative measures for sustainable development and management

(i) Water Act, Prevention and control 1976. (ii) Environmental Protection Act, 1985

(iii)Wildlife Protection Act, 1972; WWF.

SUGGESTED READINGS:

1. Eldon D. Enger and Bradley F Smith (1995), Environmental Sciences, WBC publishers Boston.
2. Daniel Botkin and Edward Keller (1997), Environmental Sciences, John Wiley & Sons, Ne York.
3. R.K. Dixit, (1997), Environment, Forest Ecology and Man, Rastogi Publication.
4. Jorgeson S.E. *et al*. (1995), Handbook of Environmental and Ecological modeling, Levis publications, New York.
5. William P. Cunningham and Masy Ann Cunninghan, Principle of Environmental Science. Inquisity and applications, Tata McGraw Hill Pub. Co.Ltd., New Delhi.
6. Charis Park - Environment - Principles and applications, Roultedge - London & New York.
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9. Begon, M., Harper, J.L. and Townsend, C.R. 1996. Ecology, Blackwell Science, Cambridge, U.S.A.
10. Ludwig, J. and Reynolds, J.F. 198. Statistical Ecology, John Wiley & Sons.
11. Odum, E.P. 1971. Fundamentals of Ecology. Saunders, Philadelphia.
12. Odum, E.P. 1983. Basic Ecology, Saunders, Philadelphia.
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17. Treshow, M. 1985. Air Pollution and Plant Life. Wiley Interscience.
18. Mason, C.F. 1991. Biology of Freshwater Pollution, Longman.

19. Hill, M.K. 1997. Understanding Environmental Pollution. Cambridge University Press.
20. Brady, N.C. 1990. The Nature and Properties of Soils, MacMillan

Laboratory Exercises:

1. Study of rainguage and measurement of rainfall
2. To study hygrometer and measurement of relative humidity.
3. Measurement of minimum and maximum temperature.
4. Measurement of Soil temp by dry wet bulb method.
5. To study pH meter and estimation of pH of water and soil.
6. To determine soil moisture content.
7. Study of Phytoplankton from pond water.
8. Study of Zooplankton from pond/river.
9. Study of biomass from grassland ecosystem.
10. Study of species dominance by Quadrat method.
11. Study of plant biodiversity on Hill slopes by line transact method.
12. To study the pH of rainwater during pre monsoon and monsoon season.
13. To determine interaction between grassland species by chi-square test.
14. Comparative study of plant diversity indices.
15. Study of mean, variance, standard deviation, standard error, coefficient of variation and t-test for ecological data.

Semester – IV

PAPER – XV : PLANT BIOTECHNOLOGY

Unit- I : **Biotechnology: Basic concepts, Principle and scope.**

1.1 Cellular differentiation and totipotency

1.2 Plant Cell and tissue culture, Cell Clones, Callus culture.

1.4 Organogenesis and adventitive embryogenesis: Fundamental aspects of morphogenesis, Somatic embryogenesis and its applications.

1.4 Androgenesis: Mechanism, techniques and applications.

Unit-II : Somatic Hybridization:

2.1 Protoplast isolation, Protoplast fusion and protoplast culture limitation , achievement in protoplast research.

2.2 Cybrids and Hybrids, Selection of hybrids and regeneration, Somaclones.

2.3 Clonal propagation: Techniques and significance of artificial seeds.

2.4 Secondary metabolites: Production in tissue/s, enhancing the secondary metabolites by use of elicitors, hairy root cultures and types of elicitors (biotic and abiotic elicitors) .

2.5 Cryopreservation : Germplasm storage, methods, merits and demerits.

Unit-III: Plant transformation technology.

3.1 Mechanism of DNA transfers, role of virulence genes, use of Ti and Ri plasmid as binary vectors, features of Ti and Ri plasmid.

3.2 Vector less DNA transfer - Particle Bombardment, Electroporation, and microinjection.

3.3 Genetically modified organisms in the Environment

Unit-IV: Environmental Biotechnology

4.1 Heavy metals environmental modification, Bioleaching and Microbial leaching.

4.2 Bioremediation- General idea of Xenobiotics, Biodegradation of Xenobiotics and applications.

4.3 Phytoremediation: Needs, Metal and organic phytoremediation.

Unit –V: Applications

5.1. Microbial genetic manipulation.

5.2 Importance and application of microbes in Biotechnology

5.3 Vermicomposting

Suggested Readings:

1. Bhojwani, S.S. and Razdan, M.K. 1996. Plant Tissue Culture: Theory and Practice (a revised edition). Elsevier Science Publishers, New York, USA.
2. Bhojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, U.S.A.
3. Collins, H.A. and Edwards, S., 1998. Plant Cell Culture. Bios Scientific Publishers, Oxford, UK.
4. Jain, S.M., Sopory, S.K. and Veilleux, R.E. 1996. *In Vitro* Haploid Production in Higher Plants, Vols. 1-, Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherlands.
5. Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA.
6. Old, R.W. and Primrose, S.B. 1989. Principles of Gene Manipulation. Blackwell Scientific Publications, Oxford, U.K.
7. Primrose, S.B. 1995. Principles of Genome Analysis. Blackwell Science Ltd., Oxford, UK.
8. Raghavan, V. 1986. Embryogenesis in Angiosperms: A Developmental and Experimental Study. Cambridge University Press, New York. USA.

9. Raghavan, V. 1997. Molecular Biology of Flowering Plants. Cambridge University Press. New York, USA.
10. Shantharam, S. and Montgomery, J.F. 1999. Biotechnology, Biosafety, and Biodiversity. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
11. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers. The Netherlands.
12. Butanco, R.G. 2000. Plant Cell Culture, University Press of Pacific.
13. Collin, H.A. and Edward S., 1998. Plant Cell Culture. Bios-Scientific Publishers, Oxford, UK.
14. Dixon, R.A. (Ed.) 1987. Plant Cell Culture: A Practical approach. IRL Press, Oxford.
15. George, E.F. 1993. Plant Propagation by Tissue Culture. Part-I. The Technology, 2nd Edition, Exegetics Ltd., Edington, UK.
16. George, E.F. 1993. Plant Propagation by Tissue Culture. Part-II in practice, 2nd Edition, Exegetics Ltd., Edington, UK.
17. Hall, R.D. (Ed) 1999. Plant Cell Culture Protocols. Humana Press, Inc. New Jersy, U.S.A.
18. Smith R.H. 2000. Plant Tissue Culture: Techniques & Experiments. Academic Press, New York.
19. Butanco, R.G. 2000. Plant Cell Culture, University Press of Pacific.
20. Collin, H.A. and Edward S., 1998. Plant Cell Culture. BioScientific Publishers, Oxford, UK.
21. Dixon, R.A. (Ed.) 1987. Plant Cell Culture: A Practical approach. IRL Press, Oxford.
22. Gelvin, S.B. and Schilperoort, R.A. (Eds.) (1994) Plant Molecular Biology, Manual, 2nd Edition, Kluwer Academic Publishers, Dordrecht, The Netherlands.
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24. George, E.F. 1993. Plant Propagation by Tissue Culture. Part-II in practice, 2nd Edition, Exegetics Ltd., Edington, UK.
25. Glick, B.R. and Thompson, J.E. 1993. Methods in Plant Molecular Biology and Plant Biotechnology. CRC Press, Boca Raton, Florida.
26. Glover, D.M. and Hames, B.D. (Eds) 1995. DNA
27. Cloning 1: A Practical Approach; Core techniques, 2nd Edition, PAS, IRL Press at Oxford University Press, Oxford.
28. Hackett, P.B., Fuchs, J.A. and Messing, J.W. 1988. An Introduction to recombinant DNA Techniques. Basic Experiment in gene manipulation. The Benjamin / Cummings Publishing Company. Inc Menio Park, California.
29. Hall, R.D. (Ed) 1999. Plant Cell Culture Protocols. Humana Press, Inc. New Jersy, U.S.A.

30. Shaw, C.H. (Ed.) 1998. Plant Molecular Biology: A Practical Approach. IRL Press, Oxford.
31. Smith R.H. 2000. Plant Tissue Culture: Techniques & Experiments. Academic Press, New York.
32. Friberg L. 1974 Cadmium in the Environment CRC press, Cleveland, Ohio.
33. Nriagu,J.O. Nickel in the Environment ,John Wiley and Sons , New York.
34. Piver,W.T. 1983 Mobilization of Arsenic in the natural by industrial processes, in Biological and Environmental Effects of Arsenic,Vol.6FowlerB.A., Elsevier Science Publisher, Amsterdam.
35. Anderson L. 1999 Genetic Engineering, Food and Environment , Bristol:J.W.Arrowsmith Ltd.

Laboratory Exercises:

1. Preparation of stock solution and culture media.
2. Sterilization techniques
3. Preparation of Aseptic plant
4. Measurement of callus growth (fresh and dry)
5. Organogenesis via callus formation in any plant species.
6. Establishment and proliferation of axillary bud from different plant materials.
7. Isolation of protoplasts from various plant tissues.
8. Effect of physical (e.g. temperature) and chemical (e.g.osmoticum) factors on protoplast yield.
9. Demonstration of protoplast fusion employing PEG.
10. To check protoplast viability using Evan's Blue dye,Flourescent diacetate and phenosafranin
11. Isolation of protoplast from fungi.
12. Organogenesis and somatic embryogenesis using appropriate explants and preparation of artificial seed.
13. Demonstration of androgenesis in any plant species.
14. Electroporation of protoplasts and checking of transient expression of the reporter gene.
15. Co-cultivation of the plant material (e.g. leaf discs) with Agrobacterium and study GUS activity histochemically.
16. Embryogenesis in any plant material.
17. Preparation of artificial seeds.

Semester- IV

PAPER – XVI: GENETIC ENGINEERING

Unit-I : 1.1 Structure of Microbes: E.coli, Bacteriophage, Viruses
1.2 Genetic Recombination in Bacteria: Transduction,

Transformation and Conjugation.
1.3 Bacterial cultures and maintenance of Cell lines.
1.4 Genetic improvement of industrial microbes and nitrogen fixers.
1.5 Fermentation Technology.

Unit-II : 2.1 Methods of gene cloning; selection of markers, reporter genes, expression vectors.
2.2 Isolation of gene.
2.3 Construction of genomic/ cDNA libraries.
2.4 Factors affecting foreign gene expression.
2.5 DNA Synthesis and Automated. Sequencing; PCR

Unit-III : 3.1 Aims and strategies for transgenic development.
3.2 Agrobacterium mediated gene transfer.
3.3 T- transposon mediated gene tagging.
3.4 Chloroplast transformation.
3.5 Transgenic- ethical concerns and ecological risk.

Unit-IV : 4.1 Enzymes used in Recombinant Technology.
4.2 Types of vectors, their properties, choice of vectors.
4.3 Alien gene transfer: Whole genomic transfer eg. Wheat, Arachis, Brassica
4.4 Transfer of individual chromosome or chromosome segment.

Unit-V : 5.1 High throughput sequences and assembly.
5.2 Human Genome Project
5.3 Tools used in genetic Engineering, Blotting techniques, SSR's, VNTR's,STR's.
5.4 Gene Knockout Technologies.
5.5 Gene Therapy - Strategies, gene editing, silencing.

Suggested Reading:

1. Brown, T.A 1999. Genomes. John Wiley & Sons (Asia) Pvt.Ltd., Singapore.
2. Callow, J.A., Ford-Lloyd, B.V. and Newbury, H.J. 1997. Biotechnology and Plant Genetic Resources Conservation and Use. CAB International, Oxon, UK.
3. Chrispeels, M.J. and Sadava, D.E. 1994. Plants, Genes and Agriculture. Jones & Bartlett Publishers, Boston, USA.
4. Glazer, A.N. and Nikaido, H. 1995. Microbial Biotechnology. W.H.Freeman and Company, New York, USA.
5. Gustafson, J.P. 2000. Genomes. Kluwer Academic Plenum Publishers, New York, USA.

6. Henry, R.J. 1997. Practical Applications of Plant Molecular Biology. Chapman & Hall, London, UK.
7. Jain, S.M., Sopory, S.K. and Veilleux, R.E. 1996. *In Vitro* Haploid Production in Higher Plants, Vols. 1-5, Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherlands.
8. Jolles, O. and Jornvall, H. (eds.) 2000. Proteomics in Functional Genomics, Birkhauser Verlag, Basel, Switzerland.
9. Old, R.W. and Primrose, S.B. 1989. Principles of Gene Manipulation. Blackwell Scientific Publications, Oxford, U.K.
10. Primrose, S.B. 1995. Principles of Genome Analysis. Blackwell Science Ltd., Oxford, UK.
11. Raghavan, V. 1997. Molecular Biology of Flowering Plants. Cambridge University Press. New York, USA.
12. Gelvin, S.B. and Schilperoort, R.A. (Eds.) (1994) Plant Molecular Biology, Manual, 2nd Edition, Kluwer Academic Publishers, Dordrecht, The Netherlands.
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17. Shaw, C.H. (Ed.) 1998. Plant Molecular Biology: A Practical Approach. IRL Press, Oxford.

Laboratory Exercises:

1. Preparation of Bacterial Cultivation media
2. Bacterial cultivation and growth characteristics by streak and spread plate method
3. Isolation and estimation of Bacterial genomic DNA
4. Isolation and estimation of Onion DNA.
5. Isolation of Plasmid from E. coli strain DH5-a
6. Restriction enzyme digestion and analysis on Agarose Gel.
7. Isolation and estimation of Plant DNA.
8. Preparation of competent cells for transformation.
9. DNA ligation
10. RAPD Analysis.
11. Electro elution of DNA from Agarose Gels.
12. Test for antibiotics against bacteria.

13. Total proteins detection on Blotting Membranes.
14. Oligonucleotide purification from Metaphor R Agarose gel.
15. Alkaline Gel electrophoresis.
16. Purification of DNA for PCR amplification.
17. DNA fingerprinting of plant genomic DNA.
18. Transfer of Proteins from SDS PAGE to Nitrocellulose Membrane.
19. Detecting DNA with Acridine Orange or methylene Blue.
20. ELISA
21. Immunoassay
22. Antimicrobial sensitivity testing
23 PCR
24 Preparation of insert DNA

SEMESTER-IV

PRACTICAL- VII: PLANT ECOLOGY, ENVIRONMENTAL ECOLOGY, BIOTECHNOLOGY AND GENETIC ENGINEERING.

PRACTICAL SCHEDULE

Time : 8 hrs. Marks 40

Q.1. Setting and working of any of major plant Ecology Expt. — 08 Marks
Q.2. Setting and working of major Experiment on Biotechnology — 08 Marks
Q.3. Working of major experiment on Environmental Ecology — 07 Marks
Q.4. Major Experiment on Genetic Engineering — 07 Marks
Q.5. Comment on one minor Experiment on genetic Engineering/ Biotechnology. — 05 Marks
Q.6. Viva-Voce — 05 Marks

Important note: -

One long and two short Botanical Excursions and visits to Scientific Laboratories /Institutions /Universities/Botanical Gardens/ Forests within and out of state are compulsory for students of M.Sc. Botany.

PARCTICAL-VIII :

Project to the students will be distributed at the beginning of third Semester with the consent of HOD and shall be examined during the period of practical examination in IV Semester

Project 40 marks
Int. Assessment 10 Marks

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M.Sc.Part-I & Part-II (Semester I to IV) Examinations in Botany
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