

BAJAJ COLLEGE OF SCIENCE, WARDHA

Two Year Post Graduate Course (M. Sc.)

SEMESTER PATTERN SYLLABUS

(Proposed Under Autonomy)

SUBJECT – BOTANY (Distribution of Units)

Semester	Paper	Existing Syllabus			Proposed Syllabus		
		Unit No	Content of Unit	Allotted Hours	Unit No	Content of Unit	Allotted Hours
Semester I	Paper I	I-IV	Prokaryotes & Viruses, Phycology, Mycology and Plant Pathology	60	I-III	Prokaryotes & Viruses, Phycology, Mycology and Plant Pathology	48
					IV	Microscopy & Centrifugation	12
	Paper II	I-IV	Bryophytes, Pteridophytes	60	I-III	Bryophytes, Pteridophytes	48
					IV	Plant Microtechniques	12
	Paper III	I-IV	Paleobotany, Gymnosperms	60	I-III	Paleobotany, Gymnosperms	48
					IV	Instrumentation (Spectrophotometry & Chromatography)	12
	Paper IV	I-IV	Cytology, Genetics	60	I-III	Cytology, Genetics	48
					IV	Methods To Study Cell / Tissue Structure	12
Semester II	Paper V	I-IV	Plant Physiology, Biochemistry and Analytical Pharmacognosy	60	I-III	Plant Physiology, Biochemistry	48
					IV	Analytical Pharmacognosy	12
	Paper VI	I-IV	Plant Development, Reproduction and Phytochemistry	60	I-III	Plant Development, Reproduction	48
					IV	Phytochemistry	12
Paper VII	I-IV	Cell, Molecular Biology- I &	60	I-III	Cell, Molecular Biology- I	48	

			Data Collection, Documentation & Photography		IV	Data Collection, documentation & photography	12
	Paper VIII	I-IV	Angiosperms-I, Ethnobotany & Scientific Writing & its presentation	60	I-III	Angiosperms-I, Ethnobotany	48
					IV	Scientific Writing and Its Presentation	12

Semester III	IX	I-IV	Plant Ecology, Conservation Biology	60	IV	Plant Ecology, Conservation Biology	48
					IV	Herbal Cosmetics & Medicines	12
	Paper X	I-IV	Angiosperms-II	60	I-III	Angiosperms-II	48
					IV	Plant Nursery Management	12
	Special Paper XI	I-IV	Molecular Biology & Plant Biotechnology	60	I-IV	Molecular Biology & Plant Biotechnology	60
	Special Paper XI	I-IV	Mycology & Plant Pathology	60	I-IV	Mycology & Plant Pathology	60
Paper XII	I-IV	Aesthetic Botany	60	I-IV	Aesthetic Botany	60	
Semester IV	Paper XIII	I-IV	Cell and Molecular Biology-II	60	I-IV	Cell and Molecular Biology-II	60
	Paper XIV	I-IV	Plant Biotechnology & Bioinformatics	60	I-IV	Plant Biotechnology & Bioinformatics	60
	Special Paper XV	I-IV	Molecular Biology & Plant Biotechnology	60	I-IV	Molecular Biology & Plant Biotechnology	60
	Special Paper XV	I-III	Mycology & Plant Pathology	60	I-III	Mycology & Plant Pathology	60
	Paper XVI	I-IV	Plant Resources	60	I-IV	Plant Resources	60

Semester I
Paper I: Microbiology, Algae, Fungi, Microscopy & Centrifugation

Module I: Prokaryotes and viruses

General Microbiology: History- Contributions made by Koch's Postulates

Bacteria: Structure, morphology, reproduction.

Viruses: General account; Morphology and ultrastructure of TMV, Bacteriophage; **Archaea and bacteria:** General account; ultrastructure, nutrition and reproduction, biology and economic importance; Cyanobacteria: *Microcystis*, *Lyngbya*, *Nostoc*, *Gloeotrichia*.

Module II: Phycology, Lichen and Mycorrhiza

Classification of Algae up to Orders, recent classification, Algae in diversified habitats (terrestrial, freshwater, marine), Thallus organization: origin and evolution, fossil algae.

Study of the life cycle of following: *Volvox*, *Ulothrix*, *Gracillaria* and *Padina*. Techniques of culturing algae biofertilizers, algae causing biological hazards.

Lichen: Role of Lichen in biomonitoring type morphology and reproduction.

Mycorrhiza: Type, distribution and significance with reference to agriculture and forestry

Module III: Mycology

General account: Recent classification of Fungi,

Physiology of Fungi (with reference to biotrophs, hemibiotrophs symbionts) fungal Cytology.

Heterothallism, heterokaryosis, Parasexual cycle; General account of spore bearing organs and their arrangements in various groups of fungi, spore release and dispersal.

Study of following types *Penicillium*, *Plasmodiophora*, *Peronospora*, *Cunninghamella*, *Phyllactinia*, *Chaetomium*

Study of the following diseases with reference to symptoms, causal organism and disease cycle. Paddy blast, Wheat rust, Smut of Jowar, black arm of cotton, red rot of sugarcane, citrus canker, potato blight. Deuteromycetes: *Helminthosporium*, *Colletotrichum*.

Module IV: Microscopy & Centrifugation

Microscopy and microscopic techniques: light-bright field and dark field, phase contrast, fluorescence, electron, confocal microscopy. Micrometry.

Making solution: Moles and Molarity, Stock solution and dilution, pH measurements and preparation buffers.

Centrifugation techniques: principle and applications, sedimentation coefficient and Diffusion coefficient and zonal and differential centrifugation, high speed centrifuges, rotors, ultracentrifugation, density gradient, centrifugation

Practicals- Paper I: Microbiology, Algae, Fungi, Microscopy & Centrifugation

Classification and type study of the following classes:

Prochlorophyta: *Prochloron*, Chlorophyta: *Pandorina*, *Eudorina*, *Stigeoclonium*, *Ulva*, *Chlorella*, *Scenedesmus*, *Caulerpa*, *Valonia*, *Acetabularia*; Phaeophyta: *Spacellaria*, *Padina*, *Turbinaria*;

Rhodophyta: *Nemalion*, *Gelidium*, *Gracillaria*, *Corallina*, *Polysiphonia*; Euglenophyta: *Euglena*, *Phacus*; Bacillariophyta: *Cyclotella*, *Synedra*, *Cymbella*, *Navicula*, *Gomphonema*.

Morphological Studies of Fungi (any 15 of the following)

Stemonitites, *Peronospora*, *Phytophthora*, *Albugo*, *Mucor*, *Rhizopus*, *Yeast*, *Aspergillus*, *Penicillium*, *Chaetomium*, *Taphrina*, *Peziza*, *Erysiphe*, *Phyllactinia*, *Uncinula*, *Melamosora*, *Uromyces*, *Drechslera*, *Ravenallia*, *Ustilago*, *Polyporus*, *Morchella*, *Cyathus*, *Alternaria*, *Helminthosporium*, *Curvularia*, *Colletotrichum*, *Phoma*, *Plasmodiophora*, *Cercospora*, *Fusarium*, *Claviceps*.

Symptomology of some diseased plants (any 7 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, Potato blight, Leaf mosaic of bhindi/ papaya, Leaf curl of tomato/Potato/Papaya, Little leaf of brinjal.

Identification of Fungal cultures (Any 5)

Rhizopus, Mucor, Aspergillus, Penicillium, Drechslera, Curvularia. Phoma, Colletotrichum, Alternaria, Helminthosporium.

Field study: For collection and studying fungal flora

To prepare different laboratory stains.

To study different staining equipments.

To study procedure for staining different plant materials.

Suggested Readings:

1. Kumar HD (1988) Introductory Phycology. Affiliated East-West Press Ltd. New Delhi
2. Morris I (1986) Introduction to the Algae. Cambridge University Press, UK 12
3. Round FE 1986 The Biology of Algae. Cambridge University Press, UK
4. Mandahar CL 1978 Introduction to Plant Viruses. Chand & Co. Ltd., New Delhi
5. Agrios, G.N. (1980) Plant Pathology, academic Press, INC, New York.
6. Ainsworth, G.C. and A.S.Sussman (eds). The Fungi, An advance Treatise Vol.I, II, III & IV Academic Press, New York.
7. Alexopoulos, C.J. (1962). Introductory Mycology John Wiley Eastern Pvt.Ltd.
8. Alexopoulos, C.J. and Mims C.W. (1979). Introductory Mycology 3rd Edition, John Wiley and Sons, Inc. Wiley, New York.
9. Alexopoulos, C.J., Mims and Black well (1996) 4th ed. John Wiley and Sons, Inc. Wiley, New York
10. Aneja, K.R. (1993) Experimental in Microbiology, Plant Pathology & Tissue Culture, Wiswa Prakashan, New Delhi.
11. Bessey, E.A. (1950) Morphology and Taxonomy of Fungi. The Blakiston co. Philadelphia. 12.
12. Bilgrami, K.S. and H. C. Dube (1985) A text Book of Modern Plant Pathology, Vikas Publication House, New Delhi.
13. Barnett, J.H. (1968) Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.
14. Dube, R.C. and D.K.Maheshwari (1999) A.Text Book of microbiology, S. Chand & Co. Ltd. 15.
15. Dube, R.C. and D.K.Maheshwari (2000) Practical Microbiology -S.Chand & Co. Ltd.
16. Gupta, V.K. and M.K.Behl (1994) Indian Plant Viruses and Mycoplasma Kalyani Publishers, 1/1, Rejinder Nagar, Ludhiana.
17. Jha, D.K. (1993) A Text Book of Seed Pathology, Vikas Publication House.
18. Mehrotra, R.S. (1989) Plant Pathology, Tata McGraw Hill.
19. Mehrotra, R.S. and K.R.Aneja (1998) An Introduction to Mycology, New Age Intermediate Press.
20. Pelzer, M.J. , Jr.Cahn, E.C.S. and N.R.Krieg (1993) Microbiology, Tata McGraw Hill.
21. Preece and Dickeson. Ecology of leaf surface microorganism Academic Press, New York. 22.
22. Rangaswamy, G. and A.Mahadevan (1999) Diseases of Crop Plant in India, Prentice Hall of India.
23. Raychoudhari, S.P. and Nariani, T.K. (1977) Virus and Mycoplasma Diseases of Plant in India, Oxford and IBH Publication Co.
24. Schlegel, H.G. (1996) General Microbiology, 7th Edition, Cambridge University Press.
25. Snowdon, A.L. (1991) A colour Atlas of Post harvest diseases & disorders of fruits & vegetables Vol.I & II Wolfe Scientific, London.
26. On line Journals available on UGC -VSAT
27. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.

Semester I
Paper II: Bryophytes, Pteridophytes & Plant Microtechniques

Module I: Bryophytes

General characters, distribution, recent classification, ecology of Bryophytes, fossil history of bryophytes, cytology of bryophytes, regeneration in bryophytes, evolution of sporophyte-Retrogressive and Progressive theory.

General account of- Hepaticopsida: Sphaerocarpaceae, Takakiales; Anthocerotopsida: Anthocerotales; Bryopsida: Sphagnales, Polytrichales.

Module II: Pteridophytes

General characters, recent classification, distribution, evolution of stele.

Psilopsida : Salient features of Psilophytales, *Rhynia*

Lycopsida : Salient features of Lepidodendrales,

Sphenopsida

Module III: Pteridophytes

Salient features of Calamitales : *Calamites*, *Annularia*, *Calamostachys*.

Study of life cycles of : *Lycopodium*, *Osmunda*, *Marsilea*, *Ophioglossum*, *Azolla*.

Cultivation and maintenance of ornamental ferns & Life cycle of *Gleichenia*, *Dryopteris*.

Module IV : Plant Microtechniques

Staining procedures, classification and chemistry of stains. Reactive 32 dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags) Cytogenetic techniques with squashed plant materials.

Practicals:-

Bryophytes:

1. Study of morphological and reproductive characters of representative members mentioned in the syllabus using section preparations, dissections and sections.
2. Preparation of permanent slides is necessary.
3. Study of bryophytes in their natural habitats.
4. Botanical excursion outside the state is compulsory to study the bryophytes

Pteridophytes:

1. Study of fossil forms (specimens and permanent micropreparations).
2. Study of living forms: Morphological, anatomical and reproductive characters of the forms mentioned in the syllabus.
3. Anatomical characters to be studied either by taking free hand sections (t.s./l.s.) and by observing the permanent micropreparations.
4. Preparations of permanent slides are essential.
5. To prepare different laboratory stains
6. To study different staining equipments.
7. To study procedure for staining different plant materials.

Suggested Readings :

1. Andrews H.N. Jr. (1961) Studies in Paleobotany (John Wiley & Sons, New York)
2. Arnold C.A. (1947) An introduction to Paleobotany (McGraw Hill, New York)
3. Banks H.P. (1968) The early history of Land plants. In evolution and environment, ed. E.T. Drake. New Haven: Yale Univ. Press, pp, 73-107.
4. Banks H.P. (1970) Evolution and plants of past. (Belmont, California, Wadsworth).
5. Banks, H. P. (1975). Reclassification of Psilophyta, Taxon. 24, 401-13.
6. Berrie, G. K. (1963). Cytology and Phylogeny of liverwoets. Evolution 17, 347-357.
7. Bierhorst D.W (1971) Morphology of vascular plants, New York (Mac Millan)

8. Campbell, D. H. (1961). The evolution of the Land Plants (central Book Depot, Allahabad)
9. Cavers, F. (1910). The interrelationship of Bryophyta I-IV. *New Phytologist*.
10. Cavers, F. (1911). The interrelationship of Bryophyta VII-IX. *New Phytologist*.
11. Chrysler M.A. (1910) The fertile spike in Ophioglossaceae. *Ann. Bot.* 24:1-18.
12. Delevoryas T. (1962) Morphology and Evolution of fossil plants (Holt, Rinehart and Winston, New York).
13. Eames A.J (1936) Morphology of vascular plants, lower groups (McGraw Hill, New York).
14. Foster A.S. and E.M Gifford Jr. (1959) Comparative morphology of vascular plants Freeman, San Fransisco.
15. Grolle, R. (1963). Takakia in Himalayas, *Ost. Bot. Zeitscher*, 110:444-447.
16. Gupta K.M. (1962) Marsilea, Botanical monograph no. 2 (CSIR, New Delhi).
17. Ingold, C. T. (1939). Spores discharge in land plants (Oxford London)
18. Kashyap S.R. (1929). Liverworts of the western Himalayas and The Punjab Plain 1 (*Chronica Botanica*)
19. Kashyap S.R. (1933). Liverworts of the western Himalayas and The Punjab Plain 2 (*Chronica Botanica*)
20. Lacey, W. A. (1969). Fossil Bryophytes. *Biological Reviews*, 44,189-205.
21. Mehra, P.N. and O. N. Handoo (1953). Morphology of *Anthoceros erectus* and *A. himalayensis* and the phylogeny of the anthocerotales. *Bot. Gaz.* 114:371-382.
22. Parihar N. S. (1976). An introduction to Embryophyta, Bryophyta (Centaral Book House, Allahabad)
23. Parihar N.S. (1977) The biology and morphology of the Pteridophytes (Central Book Depot, Allahabad).
24. Pichi-Sermolli REG (1959) Pteridophyta in vistas in botany, WB Turrill, ed. (Pergamon Press, London) pp 421-493.
25. Proskauer J. (1951). Study in Anthocerotales, III, *The Bryologist* 53,165-172.
26. Puri Prem (1985) Bryophytes-A broad perspective.
27. Ramanujam CGK (1992) Origin and evolution of lycopods *Paleobotanist* 41, 51-57.
28. Rashid A. (1982) (4th edn) An introduction to pteridophyta (Vikas Publ House Pvt Ltd.)
29. Schuster R. (1966). The Hepaticae and Anthocerotae of North America. East of the Hundredth meridian, Newyork (Colombia University Press).
30. Scott D.H. (1908) Studies in fossil botany. London, Black Part 2.
31. Scott D.H. (1920-1923) Studies in fossil botany. (A & C Black London.)
32. Sharma O.P (1996) Textbook of pteridophyta (Mac Millan India Ltd, New Delhi)
33. Smith A. J. E. (1986). Bryophyte phylogeny fact or Fiction? *Journal of Bryology*, 14,83 89.
34. Smith G. M. (1955). *Cryptogamic Botany-vol. 2 Bryophyta and Pteridophyta* (McGraw Hill Book compony, Newyork)
35. Smith W. N. and G. W. Rothwell (1993). *Paleobotany and the evolution of plants* (Cambridge Univ. press)
36. Sporne K.R. (1962) The morphology of pteridophyta (Hutchinson Univ. Library, London)
37. Steil W.N. (1939) Apogamy, Apospory and Parthenogenesis in the pteridophyta, *Bot. rev*, 5, 433-453.
38. Steward W.N. (1983) *Paleobotany and the evolution of plants*. ed. New York, (Cambridge Univ. press)
39. Surange K.R and S. Chandra (1972) Fructification of Glossipteridae from India, *Paleobotanist* 21, 1-17.
40. Taylor T.N. (1988) the origin of land plants-Some answers more questions, *Taxon*, 37, 80533.
41. Udar Ram (1970) An introduction to bryophyte (Shashidhar malviya Prakashan, Lucknow)
42. Udar Ram, Srivastava S.C. and Kumar Dinesh (1970) Genus *Buxbaumia* in India, *Curr. Sci. (India)* 39, 14-15.
43. Walton J. (1925) Carboniferous Bryophyta I. Hepaticae. *Annals of Botany*, 39, 563-72.
44. Walton J. (1928) Carboniferous Bryophyta II. Hepaticae & Musci. *Annals of Botany*, 42, 707-16.
45. Walton J. (1940) An introduction to the study of fossil plants. A& C Black, London.
46. Watson E.V. (1967) *The structure and life of Bryophytes*, 2nd ed, London, Hutchinson.
47. Ruzin, S.E. (1999). *Plant Microtechnique and Microscopy*, Oxford University Press, New York. U.S.A.

Semester I

Paper III: Paleobotany, Gymnosperms, Spectrophotometry & Chromatography

Module I: Paleobotany

Introduction; Plant fossils- Preservation, preparation, age determination, geological time scale;

Fossil record- systematics, reconstruction and nomenclature; Applied aspects of paleobotany.

General account: distribution (living, Fossil); origin; APG systems of classification; economic importance.

Module II: Gymnosperms

Comparative morphology and evolutionary tendencies of:

Cordaitales, Caytoniales, Glossopteridales,

1. **Pteridospermales-** Lyginopteridaceae (*Calymotheca hoeninghausii*, *Heterangium*, *Spherostoma*); Medullosaceae (*Medullosa*, *Trignocarpus*).
2. **Cycadales-** Cycadaceae; Fossil history (*Baenia*, *Nilssonia*, *Androstrobus*)
3. **Cycadeoidales-** Williamsoniaceae, Cycadoeoidaceae

Module III: Gymnosperms

General account and relationships of- Pentoxylales, Gnetales, Ephedrales, Ginkgoales (*Ginkgo*, *Baiera*, *Trichopitys*); Coniferales (General characters, Embryogeny and phylogeny, evolution of ovuliferous scales, phylogeny)

Module IV: Instrumentation (Spectrophotometry & Chromatography)

Spectrophotometry: Principle and its application in biological research.

Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Laboratory exercise-

1. **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 micropreparations to be submitted by the students. *Ginkgo*: Morphology to be studied from Museum specimens & anatomy from permanent slides only.
2. Study of important fossil gymnosperms from material and permanent slides.
3. Visit to palaeobotanical Institutes, localities and collection of specimens.
4. Field visits to ecologically different localities to study living gymnosperms.
5. To study Beer-Lambert's law for spectrophotometry
6. To separate chlorophyll pigments by paper chromatography
7. To measure chlorophyll by spectrophotometer
8. To measure anthocyanin by spectrophotometer

Suggested Reading

1. Stewart, W.N. and Rothwell G.W. (1993), Palaeobotany and the Evolution of Plants, Cambridge University Press.
2. Foster A.S. & Gifford F.M. (1967): Comparative morphology of vascular plants, Freeman Publishers, San Francisco.
3. Eames, A.J.(1974): Morphology of Vascular Plants-lower groups, Tata Mc-Graw Hill publishing Co., New Delhi.
4. Arnold, C.A. (1947): Introduction to Palaeobotany, Mc-Graw Hill Book Co. Inc., New York and London.
5. Kubitzki K. (1990), The families and genera of vascular plants Pteridophytes and Gymnosperms, Springer Verlag, New York
6. Agashe, S.N. (1995), Palaeobotany, Oxford & IBH, New Delhi.
7. Biswas, C & Johri, B.N. (2004), The Gymnosperms, Narosa Publishing House, New Delhi.

8. Coulter J.M. & Chamberlain C.J.(1978): Morphology of Gymnosperms, Central Book Depot, Allahabad.
9. Kakkar, R.K.and Kakkar, B.R. (1995), The Gymnosperms (Fossils & Living), Central Publishing House, Allahabad.
10. Sharma O.P. (2002) Gymnosperms, Pragati Prakashan, Meerut.
11. Siddiqui, K.A. (2002) Elements of Palaeobotany, Kitab Mahal, Allahabad.
12. Bhatnagar, S.P. and Moitra A. (1996), Gymnosperms, New Age International Pvt. Ltd., New Delhi.
13. Singh, H. (1978), Embryology of Gymnosperms, Encyclopedia of Plant Anatomy X, Gebryder, Bortragear, Berlin.
14. Pant, D.D. (2003): Cycas and allied Cycadophytes, BSIP, Publications.
15. Bierhorst D.W. (1971): Morphology of vascular plants McMillan, New York.
16. Thomas, B.A. & Spicer R.A. (1987): The Evolution and Palaeobiology of land plants. Discordies Press, Fortland, USA.
17. Spicer, R.A. & Thomas, B.A. (1986) Systematic and taxonomic approaches in Palaeobotany. Systematic Association Special Volume.
18. Chamberlain C.J. (1986); Gymnosperms, structure and Evolution, CBS publishers and distributors, New Delhi.
19. On line Journals available on UGC -VSAT
20. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGrawHill Publishing Co. Ltd. New Delhi. 3rd edition.
21. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
22. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
23. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

Semester I
Paper IV: Cytology, Genetics & Methods To Study Cell / Tissue Structure

Module I

Mendel's laws of inheritance; penetrance, expressivity, multiple alleles and isoalleles (example Corn, *Drosophila* and *Nicotiana*), gene interactions (non-epistatic and epistatic), Modifiers, suppressors and pleiotropic genes; multigene families (globin, immunoglobulin genes);

Extrachromosomal inheritance: Inheritance of mitochondria and chloroplast genes, maternal inheritance and its effect.

Chromatin organization: rRNA genes, euchromatin and heterochromatin;; C-value paradox, Cot curve and its significance;

Module II

Karyotype analysis and evolution, banding patterns, specialized types of chromosomes: polytene, lampbrush, B-chromosome, sex chromosome; molecular basis of chromosome pairing.

Origin, breeding behaviour of duplications, deficiency, inversion and translocation heterozygotes; effect of aneuploidy on plants; transmission of trisomics and monosomics and their use in chromosome mapping; complex translocation heterozygotes, translocation tester sets; Robertsonian translocation.

Population genetics: HardyWeinberg equilibrium, factor affecting Hardy Weinberg Equilibrium

Module III

Mutations: Molecular basis of gene mutations; transposable genetic elements; site directed mutagenesis- definition, applications and PCR based oligonucleotide mutagenesis; role of mutations in crop improvement; induction of polyploidy.

Plant Genetic Resources: Importance of genetic diversity in crop improvement, and its erosion. Epigenetics: Introduction; histone code; base modification; paramutations in maize; Callipygh sheep; Epigenetics and Lamarckism; Epigenome and epigenomics (Introduction).

Module IV: Methods to study cell / Tissue Structure

Whole mounts, peel mounts, squash preparations-mitotic and meiotic chromosomes, staining of chromosomes, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, noncoagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin sections.

Practicals

1. To study cell division (mitosis and meiosis) in the given material.

2. To study the effect of mutagen treatment on germination and seedling height.
3. To study effect of mutagen on the rate of cell division.
4. To study effect of mutagen on genetic material by scoring the chromosomal aberrations.
5. To study the translocation heterozygote in *Rheo discolor* or any other suitable material.
6. To study polytene chromosomes in *Chironomas* larvae.
7. To solve the given problems on interaction of genes (at least five).
8. To study the karyotype of given organism.
9. To study the chiasma frequency in the given material.
10. To solve the given problem on population genetics (at least three).
11. To study methods of fixation, preservation and clearing
12. To study the methods of paraffin and plastic infiltration.
13. To study maceration and sectioning of infiltrated materials.

Suggested Reading

Gupta P K 2007 Genetics: Classical to Modern. Rastogi Publications, Meerut.

Hexter W and Yost Jr. H T 1977 The Science of Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.

Hartl D L and Jones E W 1998 Genetics: Principles and Analysis (4thed.). Jones and Barflett Publishers, USA.

Khush G S 1973 Cytogenetics of Aneuploids. Academic press, New York.

Snustad D P and Simmons M J 2000 Principles of Genetics (2nded.) John Wiley and Son Inc., USA.

Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.

Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

SEMESTER I

PRACTICAL I

Time: 6 Hours		Full marks : 100
Q. 1	To identify the given Cyanobacterial material A.	10
Q.2	To identify two algal forms B, C, from the given mixture.	10
Q.3	To identify the given fungal culture D	10
Q. 4	To identify the given plant pathogen in the given material E.	10
Q. 5	To prepare a temporary micropreparation of the given Bryophytic material F and identify it	10
Q. 6	Comment on the given spot G (Cyanobacteria/Bacteria), H (Algae), I (Fungi), J (Bryophyte) K. Microscopy & Centrifugation L. Plant Microtechniques	15

Q.7	Viva-voce	20
Q. 8	Practical Record and tour report	15

**SEMESTER I
PRACTICAL II**

Time: 6 Hours		Full Marks: 100
Q. 1	To prepare a double stained micropreparation of the given Pteridophytic material A and identify it.	10
Q.2	To prepare a double stained micropreparation of the given gymnospermic material B and identify it.	10
Q.3	Comment on the given fossil specimen C	10
Q. 4	One experiment from Cytology and Genetics D	10
Q. 5	Comment on the given spot- E. (Pteridophyte), F. (Gymnosperm), G. (Fossils), H (Cytology/Genetics) I. Spectrophotometry & Chromatography J. Cell/ Cell tissue structure	24
Q.6	Viva-voce	20
Q. 7	Practical Record and tour report	16

Semester II Paper-V

Plant Physiology, Biochemistry and Analytical Pharmacognosy

1. Module-I The Scope of plant physiology

Photosynthesis: pigments, Light, light harvesting complex, Mechanism of electron transport, Photo protective mechanism, CO₂ fixation, C₃, C₄ and CAM pathway, Photorespiration, the chemiosmotic-coupling hypothesis and ATP Synthesis,

Respiration:- introduction, Glycolysis, Citric acid cycle, oxidative pentose phosphate pathway, Plant mitochondrial electron transport and ATP synthesis (oxidative phosphorylation).

2. Module-II Plant hormones & Enzymes

Plant hormones:- biosynthesis, physiological effect and mechanism of action of hormones auxins, gibberellins and cytokinin

Sensory photobiology: - structure, function and mechanism of phytochromes, Photoperiodism and biological clock

Enzymes: Nomenclature and classification of Enzymes enzyme kinetics, Michaelis – Menten equation, mode and mechanism of Enzyme action (Regulation of Enzyme activity), Activators & Inhibitors of enzymes, properties of Enzymes, factors affecting Enzyme activity, isozymes.

3. Module-III Transport and Metabolism

Solute transport and photo-assimilate translocation:- uptake transport and translocation of water, ion, solutes and macromolecules from soil through cell, across membranes, through xylem and phloem, transpiration, mechanism of loading and unloading of photo –assimilates **Carbohydrate Metabolism:** Composition, structure and function of carbohydrates, synthesis of starch and Sucrose, catabolism (degradation) of starch and sucrose **Lipid Metabolism:** Composition, structure and function of lipids, fatty acid biosynthesis, membrane Storage lipids. **Protein metabolism:** Composition, structure (Ramchandra plot. secondary, tertiary and quaternary structure) and function of Proteins

Metabolism of amino acids: Composition, structure and function of amino acids, amino acid biosynthesis in Plants. **Nitrogen metabolism:** Nitrate and ammonium assimilation

4. Module –IV Analytical Pharmacognosy Identification of plants

Herbaria preparations

Methods of Herbal extraction:- Maceration, digestion, Decoction, extracts and tinctures.

Herbal Preparations: Churna, Asava, Arishta Products & uses of Aloe, Amla, Adathoda, Neem, Rose Turmeric, Ginger.

Practicals-

1. To study the effect of time and enzyme concentration on the rate of reaction of enzyme. (e.g. phosphatase, nitrate reductase).
2. To study the effect of substrate concentration on activity of enzyme and determination of its K_m value.
3. Demonstration of the substrate inducibility of the enzyme nitrate reductase.
4. Determination of succinate dehydrogenase activity, its kinetics and sensitivity to inhibitors.
5. To determine the total carbohydrate content in the given sample
6. Estimation of Pectic Substances-gravimetric method .
7. To prove Berr-Lambert's law using a suitable solution.
8. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophyll and carotenoids.
9. To determine the chlorophyll a/ chlorophyll b ratio in C3 and C4 plants.
10. Isolation of intact chloroplasts and estimation of chloroplast proteins by spot protein assay.
11. Preparation of standard curve of protein (BSA) and estimation of protein content in extracts of plant material by Lowry's or Bradford's method.
12. Preparation of Leaf Protein Concentrates from green vegetables.
13. Determination of reducing sugars by Nelson – Somogyi Method.
14. To study different methods of identification of drug adulteration.
15. To study the methods of biological testing of herbal drugs.
16. To study the screening tests for secondary metabolites.

Suggested reading (for laboratory exercises)

- Bajracharya, D. 1999. Experiments in Plant Physiology: A Laboratory Manual. Narosa Publishing House, New Delhi.
- Cooper, T.G. 1977. Tools in Biochemistry. John Wiley, New York, USA.
- Copeland, R.A. 1996. Enzymes: A Practical Introduction to Structure, Mechanism and Data Analysis. VCH Publishers, New York.
- Dennison C. 1999. A guide to Protein Isolation. Kluwer Academic Publishers, Dordrecht, The Netherlands. 23
- Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India.
- Dryer, R. L. and Lata, G. F. 1989. Experimental Biochemistry. Oxford University Press, New York.
- Hames, B.D.(Ed.).1998. Gel Electrophoresis of Proteins: A Practical Approach, 8th edition. PAS, Oxford University Press, Oxford, UK.

- Harborne, T.C. 1981. *Phytochemical Methods: A Guide to Modern Techniques of Plants Analysis*. Chapman & Hall, London.
- Moore, T.C. 1974. *Research Experiences in Plant Physiology: A Laboratory Manual*. Springer-Verlag, Berlin.
- Ninfa, A. J. and Ballou, D. P. 1998. *Fundamental Laboratory Approaches for Biochemistry and Biotechnology*. Fitzgerald Science Press, Inc., Maryland, USA.
- Plummer, D.F. 1988. *An Introduction to Practical Biochemistry*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- Scott, R.P.W. 1995. *Techniques and Practice of Chromatography*. Marcel Dekker, Inc., New York.
- Wilson, K. and Goulding, K.H.(Eds), 1986. *A Biologists Guide to Principles and Techniques of Practical Biochemistry*. Edward Arnold, London, UK.
- Wilson, K. and Walker, J. 1994. *Practical Biochemistry: Principles and Techniques*, 4th edition. Cambridge University Press, Cambridge, UK.
- Sadasivam and Manikum: *Biochemical Methods*, New Age International (p) Limited Publishers 4835/24, Ansari Road, Daryaganj, New Delhi-110002

Suggested readings (for theory)

- Buchanan, B. B., Gruissem, W. and Jones, R.L. 1989. *Biochemistry and Molecular Biology of plants*. American Society of Plant Physiologists, Maryland, USA.
- Dennis, D.T., Turpin, D. H., Lefebvre, D.D. and Layzell, D.B. (eds).1997. *Plant Metabolism (2nd Ed.)* Longman, Essex, England.
- Gaiston, A.W.1989. *Life Processes in Plants*. Scientific American Library, Springer-Verlag, New York, USA.
- Hooykass P.J.J., Hall, M. A. and Libbenga, K.R.(eds).1999. *Biochemistry and Molecular Biology of plant Horm.* Elsevier, Amsterdam, The Netherlands.
- Hopkins, W.G. 1995. *Introduction to Plant Physiology*. John Wiley & Sons, Inc., New York, USA.
- Jones R, Ougham H, Thomas H and Waaland S 2013 *The Molecular life of plants*. WileyBlackwell Publ., USA 24
- Lodish, H., Berk, A., Zipursky S.L., Matsudaira, P., Baltimore, D and Darnell, J. 2000. *Molecular Cell Biology (4th ed)*. W. H. Freeman and Company. New York, USA.
- Moore, T.C. 1989. *Biochemistry and Physiology of Plant Hormones (2nd ed)*. Springer Verlag, New York, USA.
- Nobel, P.S.1999. *Physicochemical and Environmental Plant Physiology (2nd ed)*. Academic Press, Diego, USA.
- Salisbury, F.B. and Ross, C.W.1992: *Plant Physiology (4th ed)*. Wadsworth Publishing Co., California, USA.
- Singhal G.S., Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee.1999: *Concepts in Photobiol Photosynthesis and Photomorphogenesis*. Narosa Publishing House, New Delhi. 11
- Taiz, L. and Zeiger, E. 1998: *Plant Physiology*. Sinauer Associates, Inc., Publishers, Massachusetts, USA.
- Thomas, B. and Vince-Prue, D.1997: *Photoperiodism in Plants (2nd ed)*. Academic Press, San Diego, USA.

- Westhoff, P. 1998: Molecular Plant Development: From gene to plant. Oxford University Press, Oxford, UK.
- Dey, P. M. And Harborne, J. B. 2000: Plant Biochemistry ,Harcourt Asia PTE Ltd. A HarcourtPublishers International Company, 583 Orchard Road 09-01 Forum Singapore
- Ranjan, purohit, Prasad 2003: Plant Hormones Action and Application, Agrobios (India), agrohouse, behind Nasrani cinema Chopasani Road, Jodhpur -34
- Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
- The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International BookDistributors.
- Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
- Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. OxfordIBH publishing Co.
- Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
- Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
- Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

Semester-II Paper-VI

Plant Development, Reproduction and Phytochemistry

Module I: Plant development

Plant growth kinetics and patterns of growth.

Seedling growth: Tropisms; Photomorphogenesis of seedling; hormonal control of seedling growth & control.

Shoot Development: Organization of shoot apical meristem (SAM); cytological and molecular analysis of SAM; regulation of cell fate in meristem; tissue differentiation in the shoot.

Leaf growth and differentiation: Determination; phyllotaxy; control of leaf form; differentiation of epidermis (with special reference to stomata & trichomes) and mesophyll.

Root Development: Organization of root apical meristem (RAM); vascular tissue differentiation; lateral root hairs; root microbe interactions.

Phytohormones: Classification, chemical nature and their role in plant development.

Module II: Plant development and reproduction

Flower Development: Physiology of flowering, florigen concept and photoperiodism, Genetics of floral organ differentiation; homeotic mutants in *Arabidopsis* and *Antirrhinum*.

Pollination mechanisms and vectors. Types of pollination, dispersal agencies.

Male Gametophyte: Structure of anther, microsporogenesis, tapetum; pollen development and gene expression; male sterility; sperm dimorphism; pollen germination; pollen tube growth and guidance.

Female Gametophyte: Ovule types; megasporogenesis; organization of embryo sac; types of embryo sacs, structure of polygonum embryo sac cells.

Module III: Reproduction

Pollen-pistil interaction, self-incompatibility and fertilization; Structure of the pistil; pollen-stigma interactions, double fertilization; *in vitro* fertilization.

Seed Development and fruit growth: Endosperm development; embryogenesis; ultrastructure and nuclear cytology; storage proteins of endosperm and embryo; polyembryony; apomixes **Fruit development and growth latent life:** Dormancy; Importance and types of dormancy; seed dormancy; overcoming seed dormancy; breaking of seed dormancy, bud dormancy.

Senescence and Programmed Cell Death (PCD): Basic concepts; types of cell death, PCD in life cycle of plants; metabolic changes associated with senescence and its regulations; influence of hormones and environmental factors on senescence.

Module IV: Phytochemistry

Active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on

nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster).

Practicals- / Field Exercises

(Any 12)

1. Tissue systems, meristem, vascular and cork cambium.
2. Internal structure of root, stem and leaf (dicot and monocot), advanced secondary growth in dicot stem and root.
3. Anomalies in primary and secondary structure of stem.
4. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and
5. *Hydrilla*.
6. 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.
7. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.
8. Study of alternate and distichous, alternate and superposed, opposite and superposed; opposite and decussate leaf arrangement.
9. Examination of rosette plants (*Launaea*, *Mollugo*, *Raphanus*, *Hyoscyamus* etc.) and induction of bolting under natural conditions as well as by GA treatment.
10. Microscopic examination of vertical sections of leaves such as *Cleome*, *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.
11. Study of epidermal peels of leaves such as *Coccinia*, *Gaillardia*, *Tradescantia*, *Thunbergia*, etc. to study the development and final structure of stomata and prepare stomatal index. Demonstration of the effect of ABA on stomatal closure.
12. 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*, *Jussiaea* etc.).
13. Origin of lateral roots.
14. Study of leguminous roots with different types of nodules.
15. Study of microsporogenesis and gametogenesis in sections of anthers.
16. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (Maize, Grasses, *Crotalaria*, *Tradescantia*, *Brassica*, *Petunia*, *Solanum melongena*, etc.)
17. Tests for pollen viability using stains and *in vitro* germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
18. Estimating percentage and average pollen tube length *in vitro*.
19. Role of transcription and translation inhibitors on pollen germination and pollen tube growth. 19. Pollen-pistil interaction, self-incompatibility, *in vitro* pollination.
20. Study of ovules in cleared preparations; study of monosporic, bisporic and tetrasporic types of embryo sac development through examination of permanent stained serial sections.
21. Field study of several types of flower with different pollination mechanisms (wind pollination, thrips pollination, bee/butterfly pollination, bird pollination).
22. Emasculation, bagging and hand pollination to study pollen germination, seed set and fruit development using self compatible and obligate outcrossing systems.
23. Study of cleistogamous flowers and their adaptations.
24. Study of nuclear and cellular endosperm through dissections and staining.
25. Isolation of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun (*Syzygium cumini*) etc. by dissections.
26. Study of seed dormancy and methods to break dormancy. 27. Identification and utilization of the medicinal herbs.
27. To study methods of testing different drugs.

28. To study the active principles of herbal drugs.

Suggested readings:

- Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Delhi.
- Fageri, K. and Van der Pol, L. 1979. The Principles of Pollination Ecology. Pergamon Press, Oxford.
- Fahn, A. 1982. Plant Anatomy, (3rd edition). Pergamon Press, Oxford.
- Fosket, D.E. 1994. Plant Growth and Development. A molecular Approach. Academic Press, San Diego.
- Howell, S.H. 1998, Molecular Genetics of Plant Development. Cambridge University Press, Cambridge.
- Leins, P., Tucker, S.C. and Endress, P.K. 1988. Aspects of Floral Development. J. Cramer, Germany.
- Lyndon, R.F., 1990. Plant Development. The Cellular Basis. Unwin Hyman, London.
- Murphy, T.M. and Thompson, W.F. 1988. Molecular Plant Development. Prentice Hall, New Jersey.
- Proctor, M. and Yeo, P. 1973. The Pollination of Flowers. William Collins Sons, London.
- Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
- Raghavan, V. 1999. Developmental Biology of Flowering Plants. Springer -Verlag, New York.
- Raven, P.H., Evert, R.F. and Eichhorn, S.E. 1992. Biology of Plants (5th Edition). Worth, New York.
- Steeves, T.A. and Sussex, I.M. 1989. Patterns in Plant Development (2nd edition). Cambridge University Press, Cambridge.
- Sedgely, M. and Griffin, A.R. 1989. Sexual Reproduction of Tree Crops, Academic Press, London.
- Waisel, Y., Eshel, A. and Kafkaki, U. (eds) 1996. Plant Roots: The Hidden Hall (2nd edition.) Marcel Dekker, New York.
- Shivanna, K.R. and Sawhney, V.K. (eds) 1997. Pollen Biotechnology for Crop Production and Improvement, Cambridge University Press, Cambridge. 27
- Shivana, K.R. and Rangaswamy, N.S. 1992. Pollen Biology: A Laboratory Manual. Springer-Verlag, Berlin.
- Shivana, K.R. and Johri, B.M. 1985. The Angiosperm Pollen: Structure and Function. Wiley Eastern Ltd., New York.
- The Plant Cell. Special issue on Reproductive Biology of Plants, Vol. 5(10) 1993. The American Society of Plant Physiologists, Rockville, Maryland, USA.
- On line Journals available on UGC -VSAT
- Glossary of Indian medicinal plants, R.N. Chopra, S.L. Nayar and I.C. Chopra, 1956. C.S.I.R, New Delhi.
- The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
- Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
- Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
- Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
- Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
- Pharmacognosy, Dr.C.K. Kokate et al. 1999. Nirali Prakashan.

Semester II Paper-VII

Cell, Molecular Biology- I & Data Collection, Documentation & Photography

Module I:

Cell wall: Structure; function; biogenesis and growth.

Plasma membrane: Membrane architecture (fluid mosaic model); sites for ATPases; membrane transport- ion carriers, channels, pumps and aquaporins; receptors;

Plasmodesmata: Structure, role in movement of molecules and macromolecules; comparison with gap junction.

Module II:

Cell shape and motility: The cytoskeleton; organization and role of microfilaments, intermediate filaments and microtubules; motor movements, implications in cell division, flagellar & other movements

Nucleus: Ultrastructure, nuclear pores, nucleolus, DNA structure A, B and Z forms, replication in prokaryotic and eukaryotic cells, DNA replication proteins, damage and repair.

Module III:

Stress biology: Definition and classification of stress.

Biotic stress: Plant defence mechanism (passive and active); HR and SAR; modulation of plant metabolism in response to biotic stress: early and late response; production of ROS, induction of enzymes; PR proteins; R-genes.

Abiotic stress: Effect of water, temperature, salt and light stress on plants; developmental and physiological mechanisms protecting plants against environmental extremes.

Module IV: **Data collection, documentation and Photography**

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

Practicals-

1. To study salivary gland chromosomes of *Chironomas* and *Drosophila*.
2. To isolate mitochondria and determine the activity of its marker enzyme SDH.
3. To isolate bacterial and plant DNA and quantify them by spectrophotometric method.
4. To demonstrate the semi-permeability of the plasma membrane.
5. To study the activity of Na/K ATPase.
6. To demonstrate different components of cytoskeleton in the suitable material.
7. To perform flagellar staining.
8. Isolation of DNA and preparation of Cot-curve.

9. Demonstration of vital structure and functions of cell
10. To study the activity of PAL in the seedlings challenged with elicitors.
11. To study the induction of antioxidant enzymes in the seedlings challenged with elicitors.
12. To study the effect of water stress on the seedling growth and its chlorophyll content.
13. To study the effect of temperature stress on the seedling growth and its chlorophyll content.
14. To study the effect of salt stress on the seedling growth and its chlorophyll content.
15. To study tabulation & generation of graphs.
16. To know the imaging of tissue specimen and application of scale bars.
17. To study the art of field photography.

Suggested readings

- Atherly, A.G., Griton, J.R. and Mc Donald, J. F. 1999. The Science of Genetics. Saunders CollegePub. Fort Worth, USA
- Buchanan, B.B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA.
- Bush, H. Rothblum, L. 1982. Vol. X. The Cell Nucleus RDNA part A. Academic Press. 30
- Dc, D. N. 2000 Plant cell vacuoles: An introduction. CSIRO Publication, Collingwood, Australia. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology 8Ed. B. I. Waverly Pvt. Ltd., New Delhi.
- Jones R, Ougham H, Thomas H and Waaland S 2013 The Molecular life of plants. WileyBlackwellPubl., USA
- Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.
- Kleinsmith, L.J. and Kish, V.M. 1995 Principles of Cell and Molecular Biology (2nd Edi.) HarperCollins Coll. Publisher, New York, USA.
- Krishnamurthy, K.V. 2000 Methods in Cell wall Cyto-chemistry. CRC Press, Boca Raton, Florida Lodish, H., Berk, A. Zipursky, S. L. Matsudaira, P., Baltimore, D. and Dar nell, J. 2000 Molecular Cell Biology Edi. W.H. Freeman and Co., New York, USA
- Russel, P. J. 1998 Genetics (5th Edi.) The Benjamin/ Cummings Publishing Com. Inc., USA Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA Taiz, L. and Zeiger, E. 1998: Plant Physiology. Sinaucr Associates, Inc., Publishers, Massachus, USA
- Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
- Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
- Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

Semester II Paper-VIII

Angiosperms-I, Ethnobotany & Scientific Writing and Its Presentation

Module I: Angiosperm Morphology

Angiosperm Morphology, structural units and floral symmetry, dicot and monocot flower; structure, diversity, origin and evolution of stamen, carpels; placentation types and evolution.

Floral adaptation to different pollinators

Module II: Angiosperm

Angiosperm Taxonomy: Relative merits and demerits of major systems of classifications.

Taxonomic structure: taxonomic hierarchy, concept of taxa, concept of species, concept of genus and family; Taxonomic character: HETEROBATHMY, ANALYTIC versus synthetic character, qualitative versus quantitative characters.

Taxonomic tools: herbarium, floras, monographs, botanical gardens, biochemical and molecular techniques, computers and GIS.

Module III: Biosystematics & Ethnobotany

Biosystematics: The population concept phenotypic plasticity, biosystematic categories, methods of biosystematics studies. Numerical taxonomy: principles, aims and objectives, cladistics in taxonomy, polarity of characters, homology, homoplasy, monophyly, polyphyly.

Plant nomenclature: Salient features of ICBN

Ethnobotany: Definition; scope and significance; Sacred groves and their role in conservation.

Module IV: Scientific Writing and Its Presentation

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Powerpoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Practicals-

1. To study the floral symmetry in various taxa.
2. To study and work out the differences in dicot and monocot flower.
3. To study the variation stamens and carpels.
4. To study placentation types in various taxa.
5. To study the floral adaptations for pollination.
6. To study anatomical features of various taxa.
7. To study embryological features of various taxa.

8. To study palynological features of various taxa.
 9. To study cytological features of various taxa.
 10. To prepare a cladogram on the basis of various morphological features of the species belonging to a genus.
 11. To understand and prepare reference list (e.g. Research papers, Reference books, websites, Ph.D./M. Sc. Thesis & research reports)
 12. To write and understand units, abbreviations and nomenclature used in scientific writing and prepare presentations in poster and power point template.
1. To prepare and scientific paper.

Suggested Readings

- Devis, P.H. and Heywood, V. H. 1973. Principles of angiosperms taxonomy. Robert E. Kreiger Pub. Co. New York.
- Grant, V. 1971. Plant Speciation, Columbia University press, London. Grant W. F. 1984. Plant Biosystematics. Academic press, London.
- Harisson, H.J. 1971. New concept in flowering plant Taxonomy. Hickman educational books Ltd. London.
- Hislop-Harisson, J. 1967. Plant Taxonomy. English Language Book Sco. And Edward Arnold Pub. Ltd, UK.
- Heywood, V. H. and Moore, D. M. 1984. Current concepts in Plant Taxonomy. Academic Press, London.
- Joncs, A. D. and Wibins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co. New York.
- Jones, S. B., Jr. and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw - Hill Book Co., New York.
- Nordentam, B., El Gazaly, G. and kassas, M. 2000. Plant systematic for 21st century. Portlandpress. Ltd, London.
- Radford, A. E. 1986. Fundamentals of plant systematic. Harper and Raw publication, USA. Solbrig, O.T. 1970. Principles and methods of plant Sytematics. The Macmillan Co. Publication Co. Inc., USA.
- Woodland, D. W. 1991. Contemporary Plant Syatematics, Pentice Hall, New Jersery. Takhtajan,
- L. 1997. Diversity and classification of Flowering Plants. Columbia University Press, New York. Stebbins, G. L. 1974. Flowering Plants-evolution Above species Level. Edvard Arnold Ltd, London. Joncs, A. D.; Wibins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co. Jones, S. B., Jr. and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw Hill Book Co., New
- Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
- Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

- Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

SEMESTER II PRACTICAL III

Time : 6 Hours		Full marks: 100
Q. 1	To perform the given physiological experiment A and report the findings	10
Q. 2	To quantify the given metabolite in the given sample B	5
Q. 3	To study the cytohistological zonation in SAM of given material C	10
Q. 4	To perform the given exercise based on plant development D	10
Q. 5	Write a note on given stage of micro- or megasporogenesis E	10
Q. 6	Spotting: F (Physiology), G (Plant development), H(Reproduction) I (Analytical Pharmacognosy) J (Phytochemistry)	20
Q. 7	Viva-voce	20
Q. 8	Practical Record	15

SEMESTER II PRACTICAL IV

Time : 6 Hours		Full marks : 100
Q. 1	To perform the given physiological experiment A and report the findings	10
Q. 2	To quantify the given metabolite in the given sample B	5
Q. 3	To study the cytohistological zonation in SAM of given material C	10
Q. 4	To perform the given exercise based on plant development D	10
Q. 5	Write a note on given stage of micro- or megasporogenesis E	10
Q. 6	Spotting: F (Physiology), G (Plant development), H(Reproduction) I (Analytical Pharmacognosy) J (Phytochemistry)	20
Q. 7	Viva-voce	20
Q. 8	Practical Record	15

Semester IIPaper-VIII

Angiosperms-I, Ethnobotany & Scientific Writing and Its Presentation

Module I: Angiosperm Morphology

Angiosperm Morphology, structural units and floral symmetry, dicot and monocot flower; structure, diversity, origin and evolution of stamen, carpels; placentation types and evolution.

Floral adaptation to different pollinators

Module II: Angiosperm

Angiosperm Taxonomy: Relative merits and demerits of major systems of classifications. **Taxonomic structure:** taxonomic hierarchy, concept of taxa, concept of species, concept of genus and family; Taxonomic character: HETEROBATHMY, ANALYTIC versus synthetic character, qualitative versus quantitative characters.

Taxonomic tools: herbarium, floras, monographs, botanical gardens, biochemical and molecular techniques, computers and GIS.

Module III: Biosystematics & Ethnobotany

Biosystematics: The population concept phenotypic plasticity, biosystematic categories, methods of biosystematics studies. Numerical taxonomy: principles, aims and objectives, cladistics in taxonomy, polarity of characters, homology, homoplasy, monophyly, polyphyly.

Plant nomenclature: Salient features of ICBN

Ethnobotany: Definition; scope and significance; Sacred groves and their role in conservation.

Module IV: Scientific Writing and Its Presentation

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. PowerPoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Practicals-

13. To study the floral symmetry in various taxa.
14. To study and work out the differences in dicot and monocot flower.
15. To study the variation stamens and carpels.
16. To study placentation types in various taxa.
17. To study the floral adaptations for pollination.

18. To study anatomical features of various taxa.
19. To study embryological features of various taxa.
20. To study palynological features of various taxa.
21. To study cytological features of various taxa.
22. To prepare a cladogram on the basis of various morphological features of the species belonging to a genus.
23. To understand and prepare reference list (e.g. Research papers, Reference books, websites, Ph.D./M. Sc. Thesis & research reports)
24. To write and understand units, abbreviations and nomenclature used in scientific writing and prepare presentations in poster and power point template.
25. To prepare and scientific paper.

Suggested Readings

- Devis, P.H. and Heywood, V. H. 1973. Principles of angiosperms taxonomy. Robert E. Kreiger Pub. Co. Newyork.
- Grant, V. 1971. Plant Speciation, Columbia University press, London. Grant W. F. 1984. Plant Biosystematics. Academic press, London.
- Harisson, H.J. 1971. New concept in flowering plant Taxonomy. Hickman educational books Ltd. London.
- Hislop-Harisson, J. 1967. Plant Taxonomy. English Language Book Sco. And Edward Arnold Pub. Ltd, UK.
- Heywood, V. H. and Moore, D. M. 1984. Current concepts in Plant Taxonomy. Academic Press, London.
- Joncs, A. D. and Wibins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co. New York.
- Jones, S. B., Jr. and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw -Hill Book Co., New York.
- Nordentam, B., El Gazaly, G. and kassas, M. 2000. Plant systematic for 21st century. Portland press. Ltd, London.
- Radford, A. E. 1986. Fundamentals of plant systematic. Harper and Raw publication, USA.
- Solbrig, O.T. 1970. Principles and methods of plant Sytematics. The Macmillan Co. Publication Co. Inc., USA.
- Woodland, D. W. 1991. Contemporary Plant Syatematics, Pentice Hall, New Jersey.
- Takhtajan, L. 1997. Diversity and classification of Flowering Plants. Columbia University Press, New York.
- Stebbins, G. L. 1974. Flowering Plants-evolution Above species Level. Edvard Arnold Ltd, London.
- Joncs, A. D.; Wibins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co. Jones, S. B., Jr. and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw Hill Book Co., New
- Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
- Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development

Association, Hong Kong.

- Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

SEMESTER II

PRACTICAL III

Time : 6 Hours		Full marks: 100
Q. 1	To perform the given physiological experiment A and report the findings	10
Q. 2	To quantify the given metabolite in the given sample B	5
Q. 3	To study the cytohistological zonation in SAM of given material C	10
Q. 4	To perform the given exercise based on plant development D	10
Q. 5	Write a note on given stage of micro- or megasporogenesis E	10
Q. 6	Spotting: F (Physiology), G (Plant development), H(Reproduction) I (Analytical Pharmacognosy) J (Phytochemistry)	20
Q. 7	Viva-voce	20
Q. 8	Practical Record	15

SEMESTER II PRACTICAL IV

Time : 6 Hours		Full marks : 100
Q. 1	To perform the given physiological experiment A and report the findings	10
Q. 2	To quantify the given metabolite in the given sample B	5
Q. 3	To study the cytohistological zonation in SAM of given material C	10
Q. 4	To perform the given exercise based on plant development D	10
Q. 5	Write a note on given stage of micro- or megasporogenesis E	10
Q. 6	Spotting: F (Physiology), G (Plant development), H(Reproduction) I (Analytical Pharmacognosy) J (Phytochemistry)	20
Q. 7	Viva-voce	20
Q. 8	Practical Record	15

**Semester III
Paper-IX**

Plant Ecology, Conservation Biology and Herbal Cosmetics & Medicines

Module I:

Vegetation organization: Interspecific associations, concept of ecological niche;

Vegetation development: Temporal changes (cyclic and non-cyclic); mechanism of ecological succession (relay floristics and initial floristic composition; facilitation, tolerance and inhibition models);

Community function: Dynamics and succession, laboratory model, trends in succession, climax concept, General introduction to autecology.

Module II:

Ecosystem organization: Structure and functions; primary production (methods of measurement, global pattern, controlling factors); ecological efficiencies; litter fall and decomposition (mechanism, substrate quality and climatic factors); Nutrient budget in forest and aquatic ecosystem.

Ecosystem stability: Concept (resistance and resilience); Ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecology of plant invasion; environmental impact assessment; ecosystem restoration;

Ecological management: Concepts; sustainable development; sustainability indicators.

Module III:

IUCN- General account, categories, Commissions, role in conservation; Red Data Book

Protected areas- Sanctuaries, National parks, Biosphere reserves; Wetlands and Mangroves

Coral Reefs- Types, importance, artificial reefs, conservation measures;

Botanical gardens, Seed Banks; *In-vitro* repositories; Cryobanks,

Module IV: Herbal Cosmetics & Medicines

Pharmacognosy - Identification, Flora, Collection, Herbarium, Preparations and storage.

Organoleptic

Drug adulteration - types, methods of drug evaluation

Standardization of herbal cosmetics

Modern herbal cosmetics: Indian systems of medicines

Semester III Paper-IX

Practicals- Based on Biostatistics-

1. Calculate mean, variance, standard deviation and coefficient of variation for comparing two means related to given ecological data.
2. Calculate mean, variance, and to use t-test for comparing two means related to given ecological data.
3. To find out association between important grassland species from the given data using chi-square test.
4. To find out relationship between two ecological variables using correlation analysis.
5. To perform the one-way ANOVA from the given data.

Based on Ecology

1. A trip to the grass land/ forest/ water body to get acquainted with their plant species.
2. Distribution pattern of different plant species determined by Quadrant/Transect/ Point

centred Quarter methods.

3. To determine minimum size and number of quadrats required to study grassland.
4. Qualitative parameters of distribution of plant species, Frequency, Density, Basal cover, dominance, Abundance and IVI.
5. To determine diversity indices (Shanon-Weiner, species richness, B-diversity) from given data.
6. To estimate DO content in the eutrophic and oligotrophic water samples by azide modification of Winklers method.
7. To determine gross and net phytoplankton productivity by light and dark bottle method.
8. To estimate chlorophyll content in SO₂ fumigated and unfumigated leaves.
9. Analysis of soils of two different areas i.e. Cropland and forest/ grassland for certain nutrients, CO₃, NO₃, Base deficiency.
10. To study ecological adaptations of the given plants

Based on Herbal Cosmetics & Medicines-

1. Identification of useful herbal plants.
2. To study different methods of herbal extractions.
3. To prepare different products. (Churna, Asava, Arishta)

Suggested readings

1. Ambasht R.S. 1968. Freshwater ecosystem-Manual of Ecology 123-137 (See Misra KC et al 1968)
2. Ambasht R.S. 1966 Conservation Ecology, Abs Proc School on Plant Ecol (Full paper in press Oxford and IBH Calcutta).
3. Ambasht R.S. 1995 A text book of plant ecology Student and co. Varanasi-5
4. Anderson JM Ecology for environmental sciences: biosphere ecosystems and man
5. Billings WB 1964 Plants and the ecosystem Macmillan & co, London. 36
6. Clements FE 1916 Plant succession, An analysis of the development of vegetation. Carnegie Institute of Washington.
7. Cragg JB 1968 The theory and practice of conservation, IUCN Publ, New Series No. 12, 2535.
8. Dash MC 1993 Fundamentals of Ecology WB Saunders and co. Philadelphia USA.
9. Deangelis DL Energy flow, nutrient cycling and ecosystem resilience. Ecology 56, 23843.
10. Dwivedi Rama Shankar 1968. The decomposer system manual of ecology See Misra KC et al 1970)
11. Frankel OH, Soule ME, 1981, Conservation and Evolution, Cambridge Univ Press.
12. Grace J 1983, Plant atmosphere relationships. Champman & Hall.
13. Greig Smith P 1983, Quantitative plant ecology, Univ California Press, California.
14. Hutchings MJ (ed) 1988, Plant population biology, Blackwell.
15. Hutchinson GE 1978, An introduction to population ecology. Yale Univ. Press.
16. Kochhar PL 1986 Plant Ecology Ratan prakashan, Mandi, Agra.
17. Krebs GJ 1972 Ecology Harper and Row Publ, New York.
18. Kumar HD 1994 Modern concepts of ecology. Vikas publishing house pvt ltd, New Delhi.
19. May RM (ed) 1981 Theoretical Ecology, Blackwell.
20. Odum EP 1963 Ecology Holt Reinhart and Winston Inc.
21. Odum EP 1983 Basic Ecology, Saunders Publ Philadelphia.
22. Reynolds CS 1984 The ecology of phytoplankton, Cambridge Univ Press
23. Silvertown JW 1982 Introduction to plant population ecology, Longman.
24. Southwick CH 1983 (ed) Global Ecology Sinauer.

25. Chromatography Raman

26. Whittaker RH 1975 Communities and Ecosystems (2nd ed) MacMillan, New York.

27. Standardization- WHO guidelines

Semester III
Paper-X
Angiosperms-II and Plant Nursery Management

Module I Angiosperms Families-I

General account, distinguished characters, floral variation and evolution, affinities of:-Magnoliidae, Hamamelidae, Dilleniidae, Rosidae, Asteridae, circumscription as per Cronquist, 1968.

Module II Angiosperms Families-II

Alismatidae, commelinidae, Aracidae, Lilidae; Interesting features and systematic position of Cucurbitaceae, Cactaceae, Asteraceae, Amentiferae, Lemnaceae, Palmae, Orchidaceae.

Module III Biodiversity

IUCN : categories , Threat, distribution and global pattern of biodiversity.

Biological diversity concept and levels, role of biodiversity in ecosystem functions and stability, Endemism, hotspots and hottest hotspots, invasions and introductions, local plant diversities and its socioeconomic importance.

Module IV Plant Nursery Management

Nursery : Concept, types & infrastructure requirements. Indoor and outdoor plants

Seed propagation : Germination, Collection, Storage & testing of seeds

Vegetative Propagation : Natural and Artificial (Cutting, budding, grafting and layering)

Compost : Vermiwash, Vermicompost, organic compost

Practicals-

1. Description of specimens from representative, locally available families.
2. Description of a species based on various specimens to study intra specific variation: collective exercise.
3. Description of various species of a genus, location of key characters and preparation keys at generic level.
4. Location of key characters and use of keys at family level.
5. Field trips within and around the campus; compilation of field notes and preparation herbarium sheets of such plants, wild or cultivated as are abundant.
6. Training in using floras herbaria for identification of specimens described in the class.
7. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.
8. To study effect of biotic and abiotic factors on seed germination of tomato and groundnut.
9. To study factors affecting vegetative propagation (rooting and new shoot formation) by cutting of plant species (*Duranta plumeria* and *Hibiscus rosa-sinensis*).
10. To study T-shaped budding of rose plants.

Suggested readings

- Devis, P.H. and Heywood, V. H. 1973. Principles of angiosperms taxonomy. Robert E. Kreiger Pub. Co. Newyork.
- Grant, V. 1971. Plant Speciation, Columbia University press, London.
- Grant W. F. 1984. Plant Biosystematics. Academic press, London.
- Harisson, H.J. 1971. New concept in flowering plant Taxonomy. Hickman educational books Ltd. London.
- Hislop-Harisson, J. 1967. Plant Taxonomy. English Language Book Sco. And Edward Arnold Pub. Ltd, UK.
- Heywood, V. H. and Moore, D. M. 1984. Current concepts in Plant Taxonomy. Academic Press, London.
- Joncs, A. D. and Wibins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co. New York.
- Jones, S. B., Jr. and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw -Hill Book Co., New York.
- Nordentam, B., El Gazaly, G. and kassas, M. 2000. Plant systematic for 2ft century. Portlant press. Ltd, London.
- Radford, A. E. 1986. Fundamentals of plant systematic. Harper and Raw publication, USA.
- Solbrig, O.T. 1970. Principles and methods of plant Sytematics. The Macmillan Co. Publication Co. Inc., USA.
- Woodland, D. W. 1991. Contemporary Plant Syatematics, Pentice Hall, New Jersery.
- Takhtajan, A. L. 1997. Diversity and classification of Flowering Plants. Columbia University Press, New York.
- Stebbins, G. L. 1974. Flowering Plants-evolution Above species Level. Edvard Arnold Ltd, London.
- Joncs, A. D. and Wibins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co.
- Jones, S. B., Jr. and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw Hill Book Co., New Delhi.
- Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
- Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
- Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
- Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
- Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

Semester III
Special Paper- XI
Molecular Biology & Plant Biotechnology

Module I Plant cell and Tissue culture

Basic concepts, Principle and scope. Cellular differentiation (dedifferentiation, undifferentiation, and redifferentiation) and totipotency, Application of Plant Cell and tissue culture. Organogenesis (direct and indirect regeneration) and adventitive embryogenesis: Fundamental aspects of morphogenesis, Somatic embryogenesis and its applications. Factors affecting somatic embryogenesis, Synthetic seeds, Methods of preparing synthetic seeds, Application of synthetic seeds. Micropropagation: Techniques. Factor affecting micropropagation, Applications of micropropagation

Module II rDNA Technology

- a. **Tools of rDNA technology:** DNA manipulation enzymes- Nucleases, polymerases, ligases, kinases and phosphatases; methods of gene isolation.
- b. **Molecular probing:** Recombinant DNA libraries (gDNA and cDNA, oligonucleotide probes); nucleic acid hybridization (southern, northern, dot-blot and slot-blot); antibodies as probe for proteins (immunoblotting or western blotting, immunoprecipitation, southwestern screening).

Module III Cloning Vector

- a. **Vectors for prokaryotes and eukaryotes:** plasmids, cosmids, bacteriophages, insertion and replacement vectors, TAC, BAC, ligation Process.
- b. **Introduction of foreign DNA into host cell:** Transformation; transfection; transgenesis
- c. **Isolation of genes or protein products from clones:** Expression vectors- Characteristics; vectors producing fusion proteins
- d. **Polymerase chain reaction:** The basic techniques and its modifications; applications of PCR in molecular biology

Module IV Sequence Alignment and Phylogenetic Trees

Sequence Analysis: Overview, Concepts and tools. Similarity Searches: BLAST, FASTA, PSI-BLAST and PHIBLAST.

Scoring Matrices: PAM, BLOSSUM and PSSM.

Pairwise Sequence Analysis: Needleman and Wunch; Smith and Waterman. Sequence alignment and Pairwise (dot-matrix method, dynamic programming method, Word or k-tuple method) and multiple alignment, Local and global alignment,

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

Practicals-

Group A

1. To detect molecular polymorphism in different species using a suitable technique.
2. To demonstrate the presence of a particular polypeptide by Western blotting.
3. To design PCR primers to isolate the given gene for cloning it in the given vector.
4. To amplify and sequence the nrDNA by PCR
5. To find the sequences of a given protein in the protein database

6. To work out the sequence from given autoradiogram and to identify it from GeneBank by BLAST method.
7. To download the DNA sequences from databases and generate pairwise and multiple sequence alignment.
8. To download the protein sequences from databases and generate pairwise and multiple sequence alignment.
9. To generate phylogenetic tree using given sequences.
10. To predict a protein from given sequence by using online tools from NCBI.

Group B

11. To demonstrate *Agrobacterium tumefaciens* mediated gene transfer in a suitable plant.
12. To raise the suspension culture using a callus and plot the growth curve.
13. To induce the secondary metabolite synthesis in suspension culture.
14. To demonstrate the use of molecular markers to detect polymorphism in different varieties of plants/strains of microbes.
15. To isolate and develop the protein profile of different plant species by SDS-PAGE.
16. To demonstrate bacterial transformation and selection of transformed cells.
17. To perform DNA ligation and analysis of ligated DNA on agarose gel.
18. To study of expression of inducible genes at biochemical level.
19. To demonstrate Organogenesis using appropriate explants.
20. To demonstrate somatic embryogenesis using appropriate explants and prepare artificial seeds.
21. To demonstrate preparation of artificial seeds.
22. To demonstrate the anther culture.
23. To study the effect of heavy metals on the growth of plants.
24. To initiate micropropagation protocol of suitable plant species.

Suggested readings

- Alberts, Bruce; Johnson Alexander; Lewis, Julian; Raff, Martin; Roberts, Keith; Walter, Peter, C. 2002 Molecular Biology of the Cell, Garland Science, New York and London.
- Baxevanis, A. D. and Ouellate, B. F. F. 2009 Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.
- Baxevanis, A. D., Davison, D. B.; Page, R. D. M.; Petsko, G. A.; Stein, L. D. and Stormo, G. D. 2008 Current Protocols in Bioinformatics
- Bergman, N.H 2007 Comparative Genomics. Humana Press Inc., Part of Springer Science+ Business Media
- Brown, T. A. 1999. Genomes, John Wiley & Sons(Asia) Pvt. Ltd., Singapore
- De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology 8th Ed. B. I. Waverly Pvt. Ltd., New Delhi.
- Glover, D.M. and Hames, D.B 1995 DNA Cloning : A practical approach, R.L. Press, Oxford.
- 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.
- Jolles, O. and Jornvall, H. (eds) 2000. Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
- Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.

Lehninger. Principles of biochemistry-Nelson, Cox, 4th Edn., W.H.Freeman and Co.,2005.
 Lewin, B. 2000 Gene VII Oxford Univ. press, New York.
 Lewin, B. 2010 Gene X Oxford Univ. press, New York.
 Lodish, H., Berk, A. Zipursky, S. L. Matsudaira, P., Baltimore, D. and Darnell, J. 2000 Molecular Cell Biology Edi. W.H. Freeman and Co., New York, USA
 Mount W. 2004 Bioinformatics and sequence genome analysis 2nd Edi. CBS Pub. New Delhi
 Old and Primrose , 1994, Principles of gene manipulation. Blackwell Scientific Publ.
 Raymond Schuler and Zielinski, E. 2005, Methods in plants Molecular biology. Acad. Press.
 Russel, P. J. 1998 Genetics (5th Edi.) The Benjamin/ Cummings Publishing Com. Inc., USA
 Sambrook and Russel. 2001. Molecular cloning Vol. 1-3 CSH press.
 Shaw, C.H. 2006, Plant Molecular Biology: A practical approach. Panima Pub. Corp.
 Stryer, Berg, Biochemistry-6th Edition, W. H. Freeman and Co., 2007.
 Voet, D.; Voet, J.; Biochemistry – 3rd Edn. John Wiley and sonsInc., 2004. Wilson Keith and Walker John 2005 Principles and techniques of biochemistry and molecular biology, 6th Ed. Cambridge University Press, New York.
 Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA

Semester III
Special Paper-XI
Mycology & Plant Pathology

Module I: General account of fungi

General characters, classification, distribution and reproduction

Fungal diversity in different ecosystems, effect of environment on fungal growth and behaviour.

Medical Mycology - Dermatophytic fungi -Knowledge of common dermatophytes and human diseases caused by them viz. *Tinea pedis*, *Tinea capitis*, *Tinea barbae*. *Tinea corporis* and *Tinea manuum*; Aspergillosis, fungi allergic to human beings.

Module II: Mycorrhiza

1. **Kinds of mycorrhizae** : Ectotrophic and endotrophic mycorrhizae, their morphology and anatomy. V A- mycorrhiza. Mycorrhiza in plant growth promotion, mycorrhiza in plant disease control.

2. **Rhizosphere and phyllosphere** : General concept and importance.

Module III: Production of Metabolites by Fungi

A) Industrial Fungal Metabolites:

i) Antibiotics -Penicillin, Cephalosporin, Griseofulvin, Industrial production of Penicillin ii) Enzymes -. Amylase, proteases, Lipases, Pectinases, Cellulase and xylanases.
 iii) Organic acids -Citric acid, Gluconic acid, lactic acid, kojic acid. Itaconic acid. **B) Non**

Industrial Fungal Metabolites:

i) Phytoalexins, ii) Mycotoxins

Module IV: Fungi as welfare to human beings

i) **Fungi in food processing**: Soybean products, cheese, fermented milk, other fermented foods.

ii) **Fungal metabolites** : General account of production and application; Primary metabolites (vitamins, proteins), Secondary metabolites (antibiotics, pigments, alkaloids)

- iv) **Fungi as food** : edible mushrooms, methods of their cultivation
- v) **Role of fungi in biodeterioration and Biodegradation (Cellulosic and Non-cellulosic material, organic compounds)**

Practicals-

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. Demonstrate antifungal activities of different antibiotics and leaf, flower and root extract.
9. Study of toxicity of fungi in relation to seed germination, and seedling abnormality.
10. Cultivation of Mushrooms.
11. Demonstration on biodegradation of organic waste.
12. Isolation of Soil fungi by soil plate (War cup) and serial dilution (Walksman) method.
13. Isolation and identification of Rizosphere mycoflora.
14. Isolation of external and internal seed borne mycoflora by blotter and Agar Plate method. Cereals, pulses, oil seeds, fruit seeds.
15. Demonstration of Koch"s Postulate.
16. Calculation of spore count using haemocytometer.
17. Qualitative estimation of enzymes – cellulases, amylases.
18. Estimation of sugars, proteins and aminoacids in fungal mycelium and culture filtrate.
19. Study of mycorrhiza (VAM)
20. Monographic study of locally available plant diseases caused by fungi (atleast 10).
21. Study of locally available crop plant diseases caused by Bacteria (Five)
22. Study of locally available plant diseases caused by viruses & Phytoplasma (Five)
23. Demonstration of morphological & physiological changes in disease plants.
24. Preparation and presentation of herbarium of pathological specimens available in the region (Atleast 15)
25. Field visit to different localities Visit to Agriculture University, Plant Pathological research centers

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. Bilgrami, K.S. and H.C.Dube (1985) A text Book of Modern Plant Pathology, Vikas Publication House, New Delhi.
9. Barnett, J.H. (1968) Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.
10. Dube, R.C. and D.K.Maheshwari (1999) A.Text Book of microbiology, S.Chand & Co. Ltd.
11. Dube, R.C. and D.K.Maheshwari (2000) Practical Microbiology -S.Chand & Co. Ltd.
12. Gupta, V.K. and M.K.Behl (1994) Indian Plant Viruses and Mycoplasma Kalyani Publishers, 1/1, Rejinder Nagar, Ludhiana.
13. Jha, D.K. (1993) A Text Book of Seed Pathology, Vikas Publication House.
14. Mehrotra, R.S. (1989) Plant Pathology, Tata McGraw Hill.
15. Mehrotra, R.S. and K.R.Aneja (1998) An Introduction to Mycology, New Age Intermediate Press.
16. Pelzer, M.J. , Jr.Cahn, E.C.S. and N.R.Krieg (1993) Microbiology, Tata McGraw Hill.
17. Preece and Dickeson. Ecology of leaf surface microorganism Academic Press, New York.
18. Rangaswamy, G. and A.Mahadevan (1999) Diseases of Crop Plant in India, Prentice Hall of India.
19. Raychoudhari, S.P. and Nariani, T.K. (1977) Virus and Mycoplasma Diseases of Plant in India, Oxford and IBH Publication Co. 50
20. Schlegel, H.G. (1996) General Microbiology, 7th Edition, Cambridge University Press.
21. Snowdon, A.L. (1991) A colour Atlas of Post harvest diseases & disorders of fruits & vegetables Vol.I & II Wolfe Scientific, London.
22. Sunder Rajan, S. (2001) Tools and Techniques of Microbiology, Anmol Publ. New Delhi.
23. Thind, T.S. (1998) Diseases of field crops and their management, National Agricultural Technology, Information Centre, Ludhiana.
24. Vaidya, J.G. (1995) Biology of the fungi, Satyajeet Prakashan, Pune.
25. Walker, J.G. (1952) Diseases of Vegetables Crops. McGraw Hill, New York.
26. Walker, J.C. (1968) Plant Pathology, McGraw Hill, New York.
27. 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.
28. Emmons, C. W., C. H. Bin ford, J.P. Utz and Know Chung (1977) Medical Mycology, Lea and Febigo, Philadelphia.
29. Holliday, P. Fungus disease of tropical plants (1980), Cambridge University Press, Cambridge.

On line Journals available on UGC -VSAT

Semester III
(Foundation Course I /Subject Centric-I)
Paper XII – Aesthetic Botany

Module I – General aspects of Aesthetic plants

Phytogeographical regions of India: Climate, Vegetation and Floristic regions; Endemism; Concept of hotspots, hot spots of the world. Forest types of India

Aesthetic plants : Outdoor and Indoor plants

Module II – Gardening

Garden Design: Scope and objectives of gardening; Style of gardens (Formal, Informal); Types of gardens (English, Mughal and Japanese); Components of garden;

Planning of outdoor gardens- Small, Residential, Larger Home Garden, Roof Garden, Terrace Garden, Industrial garden, Housing complex, Indoor gardening;

Garden Features and Ornamentation: Water, Garden pool, Stream, Waterfall, Fountain, Rocks, Roads, Walks, Pavements and Steps, Walls fences and Gates, Hedges, Edges, Arches, Statues, Towers.

Module III– Floriculture

Nursery production and management: Scope, Site, Soil, Environment, Layout, Manure, Fertilizers, Maintenance, Garden tools, Culture and Garden calendar, Types, Nursery beds, **Pest & Disease management:** Propagation of ornamental plants by seeds, bulbs, layering, cuttings, grafting, budding & tissue culture; Plant disorders including nutrition, pests and diseases, and chimaeras.

Ornamental ferns and their propagation; herbaceous perennials, Annuals & Biennials: Important Genera and Species, their importance in garden designs.

Module IV – Landscaping

Landscape Design: Definition, objectives and scope, Landscape elements of construction and designing of Residential, Commercial, Bungalow, Public area, Hotel, Educational Institute and religious places

Palms and Cycas: Characteristics, propagation, culture, pest and disease, importance and uses, genera and species of palms and Cycads.

Bamboo and conifers: Genera, species and varieties; Lawns & Grasses: Planting methods, maintenance, pest management

Ornamental succulents, Cacti; Polyhouse technology: Scope and objectives of floriculture.

References :

Randhawa GS and Mukhopadhyay A. 2004. Floriculture in India. Allied Publishers Pvt. Limited. 72

Swarup Vishnu. 2003. Garden Flowers. National Book Trust

Hartmann HT, Kester DE, Davies FT and Geneve RL. 2002. Plant Propagation – Principles and Practices. Prentice Hall India Ltd.

Royal Horticultural Society's Encyclopedia of Gardening.

SEMESTER III**PRACTICAL V**

Time : 6 Hours		Full marks : 100
Q. 1	To perform the given ecological exercise A	15
Q.2	To solve the given statistical problem B	15
Q.3	To describe the given plant in technical language with floral formula and floral diagram C	10
Q. 4	To prepare the generic/family key D	5
Q. 5	To identify species of the given plant using Flora	5
Q. 7	Spotting- E(Paper IX), F(paper IX), G(Paper X), H(Paper X), I(Herbal Cosmetics & medicines), J(Plant Nursery Management)	15
Q. 8	Viva-voce	20
Q. 9	Practical Record	15

SEMESTER III**PRACTICAL VI****MYCOLOGY AND PLANT PATHOLOGY**

Time: 6 Hours		Full Marks: 100
1.	Identify giving salient characters of fungi from the given culture. (A)	10
2.	Identification of given diseased material, their symptoms and characters. (B)	10
3.	Effects of different concentrations of sugar solutions on the conidial germination and presentation of data on graph paper.	10
4.	Drawing of camera lucida diagram of the given fungus/microorganism.	10
5.	Demonstration of pure culture techniques /transfer techniques.	10
6.	Spotting (two spots)	10
7.	Practical record, Herbarium and field report	20
8.	Viva-voce	20

**SEMESTER III
PRACTICAL VI
MOLECULAR BIOLOGY AND PLANT BIOTECHNOLOGY**

Time: 6 Hours		Full Marks: 100
1.	One Major Experiment from Group A	15
2.	One Minor Experiment from Group A	10
3.	One Major Experiment from Group B	15
4.	One Minor Experiment from Group B	10
5.	Identification and comments on given two spots	10
6.	Practical record	20
7.	Viva-voce	20

Semester IV Paper XIII
Cell and Molecular Biology-II

Module I: Ribosomes: Structure and function **Transcription:** Transcription in prokaryotic and eukaryotic cells, plant promoters, transcription factors, types of RNA and their function, RNA splicing, mRNA transport

Translation: In prokaryotic and eukaryotic cells, structural levels of proteins, post-translational modification; structure and role of rRNA and tRNA.

DNA damage and repair: Types of DNA damage, factors for DNA damage, Repair system: Single base change, direct repair, mismatch repair, SOS response.

Module II: Gene structure

Gene structure: Chemical nature & Fine structure of gene, Classical and modern concept of gene, Cis-trans test; fine structure analysis in eukaryotes; introns and their significance, RNA splicing **Regulation of gene expression:** Prokaryotes- Positive & negative control, inducible and repressible operons, lac operon, trp operon, attenuation, riboswitch; Eukaryotes- Regulation at DNA, transcription, translation & post translational level

Epigenetic regulation: Protein sorting: Protein glycosylation; vesicles involved in protein transport; protein targeting to plastids, mitochondria, peroxisomes, nucleus, vacuoles; modification during transport

Module III: Genome Organization & Genetic Mapping

Genome organization in prokaryotes and eukaryotic organelles: Phage genome, genetic recombination in phage and mapping phage genes; mapping of bacterial genes through transformation, conjugation and transduction; genome of mitochondria and chloroplast.

Genetic recombination and genetic mapping: Recombination; independent assortment and crossing over; molecular mechanism of recombination; role of RecA and RecBCD enzymes; homologous, non-homologous and site-specific recombination; chromosome mapping- linkage group, genetic markers, types of maps

Module IV: Cell cycle and Apoptosis

Cell cycle and apoptosis: Control mechanisms, role of cyclins and cyclin dependent kinases; retinoblastoma and E2F proteins; cytokinesis and cell plate formation; Apoptosis and its pathway

Signal transduction: Overview, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascades, diversity in protein kinases and phosphatases;

Techniques in cell biology: Electrophoresis, immunotechniques, FISH, GISH, confocal microscopy.

Practicals-

1. Isolation and separation of plant cytosolic proteins by SDS-PAGE
2. To perform the restriction digestion of the DNA & analyse the digest over agarose gel.
3. To study transformation in bacterial cells.
4. To detect the presence of specific antigen by ELISA
5. Isolation of RNA and quantification by spectrophotometric method.
6. To map the genes on the basis of given cross-over data.

Suggested readings:

- Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell, Garland Publishing, Inc., New York.
 - Buchanan, B.B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA.
 - De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology 8th Ed. B. I. Waverly Pvt.Ltd., New Delhi.
 - Jones R, Ougham H, Thomas H, Waaland S 2013 The Molecular life of plants. WileyBlackwell, USA
 - Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.
 - Khush, G.s. 1973 Cytogenetics of Aneuploids, Academic Press, New York, London
 - Kleinsmith, L.J. and Kish, V.M. 1995 Principles of Cell and Molecular Biology (2 nd Edi.) Harper Collins Coll. Publisher, New York, USA.
 - Lewin, B. 2000 Gene VII Oxford Univ. press, NewYork.
 - Lodish, H., Berk, A. Zipursky, S. L. Matsudaira, P., Baltimore, D. and Darnell, J. 2000 Molecular Cell Biology Edi. W.H. Freeman and Co., New York, USA.
 - Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3rd Edi.) Jones and Bartiet Pub. Inc., London.
 - Russel, P. J. 1998 Genetics (5th Edi.) The Benjamin/ Cummings Publishing Com. Inc., USA
 - Sunstad, D. P. and Simmons, M. J. 2000 Principles of Genetics (2nd Edi.) John Wiley & Sons Inc., USA.
 - Tamarin, R. H. 2001 Principles of Genetics 7th Edi. The McGraw-Hill Companies.
 - Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA.
- References: Online journals available on UGC V-SAT programme

Semester IV Paper XIV
Plant Biotechnology & Bioinformatics

Module I: Recombinant DNA Technology

a. Recombinant DNA technology: Gene cloning- Principles and technique; vectors- types (cloning & expression; plasmid & viral) and their properties; construction of DNA libraries (gDNA and cDNA); splicing of insert into the vector; screening of DNA libraries and introduction of the recombinant DNA into the host cells.

b. Genetic engineering of plants: Aims, strategies for development of transgenics (with suitable examples); *Agrobacterium*- the natural genetic engineer; T-DNA and transposon mediated gene tagging.

Module II: Genetic Engineering

a. Microbial genetic manipulation: Bacterial transformation, selection of recombinants and transformants,

b. Genomics and proteomics: high throughput sequencing; functional genomics; Protein profiling and its significance.

c. DNA : synthesis; DNA sequencing; basic polymerase chain reaction and applications of PCR; DNA fingerprinting

Module III: Plant Tissue Culture

Plant tissue culture: Basic concepts; Principles and scope; tissue culture media; callus induction and cell suspension; aspects of morphogenesis; haploid and triploid production; production of somatic embryos; applications of plant tissue culture; protoplast isolation and culture; production of cybrids

Transgenic production: Methods to introduce gene in plants; selection of transformed plants/explants; salient achievements in crop biotechnology.

Module IV: Bioinformatics

Bioinformatics: Introduction, History, Definition and applications of bioinformatics; Database: Sequences (nucleotide and amino acid); nomenclature- IUPAC symbols, nomenclature of DNA & protein sequences, Definitions, types and classification of databases- Primary Databases, Secondary databases. **Emerging areas in bioinformatics**

Practicals-

1. To study the growth characteristics of *E. coli* using plating and turbidimetric methods.
2. To isolate the plasmid from *E. coli* and quantify it with suitable method.
3. To perform restriction digestion of the given plasmid DNA and to estimate of the size of various DNA fragments.
4. To Clone the given DNA fragment in a plasmid vector.
5. To prepare competent cells from the given bacterial culture.
6. To prepare the media for plant tissue culture.

7. To surface sterilize the given seeds/explant for tissue cultural manipulation.
8. To isolate protoplast and determine its viability.
9. To workout the DNA sequence from the given autoradiogram and identify the gene using online tools.
10. To search literature database of different organisms.
11. To search the genes in the Genbank.
12. To use the various tools to retrieve information available from NCBI
13. To locate gene(s) on chromosomes for a given disease/disorder.

Suggested readings

- Baxevanis, A. D., Davison, D. B.; Page, R. D. M.; Petsko, G. A.; Stein, L. D. and Stormo, G. D. 2008 Current Protocols in Bioinformatics, John-Wiley and Sons Publications, New York.
- Baxevanis, A. D. and Ouellate, B. F. F. 2009 Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.
- Brown, T. A. 1999. Genomes, John Wiley & Sons (Asia) Pvt. Ltd., Singapore. Callow, J. A., Ford-Lloyed, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetic Resources: Conservation and Use, CAB International, Oxon UK. Chrispeels, M. J. and Sadava, D. E. 1994, Plants, Genes and Agriculture. Jones & Barlett Publishers, Boston, USA.
- Dubey, R. C. 2014 Advanced Biotechnology. S. Chand & Co. Pvt. Ltd., New Delhi.
- Glazer, A. N. and Nikaido, H. 1995. Microbial Biotechnology. W. H. Freeman & Company, New York, USA.
- Gustafson, R. J. 2000. Genomes. Kluwer Academic Plenum Publishers, New York, USA.
- Henry, R. J. 1997. Practical Applications of Plant Molecular Biology. Chapman & Hall, London, UK.
- 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.
- Jolles, O. and Jornvall, H. (eds) 2000. Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
- Kartha, K. K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida USA.
- Kingsman, S. M. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, Blackwell Scientific Publications, Oxford, 1998 Mount W. 2004 Bioinformatics and sequence genome analysis 2nd Edi. CBS Pub. New Delhi
- Old, R. W. and Primrose, S. B. 1989. Principles of Genome Analysis. Blackwell Scientific Publications. Oxford, UK.
- Primrose, S. B. 1995. Principles of Genome Analysis. Blackwell Scientific Ltd., Oxford, UK.
- Raghavan, V. 1997. Molecular Biology of Flowering Plants. Cambridge University Press, New York, USA. 78

Semester IV Special Paper-XV Molecular Biology & Plant Biotechnology

Module I: **Plant Tissue Culture**

Cell culture, isolation of single cell, techniques; factors affecting single cell culture, Induction of callus. Cell suspension culture: techniques and maintenance of suspension culture. Use and Types of bioreactors for enhanced multiplication of cell suspensions
Isolation and purification of protoplast, culture of protoplast and regeneration of protoplast. Somatic Hybridization; culture and selection system for hybrids. Cybridization and production of cybrids. Role of somatic hybrids and cybrids in plant improvement, Haploid production and its significance. Factors affecting Anther and pollen culture technique, monoplod and polyploid culture *in-vitro*.

Module II: **Transgenic Plants**

Transgenic plants: Cloning vectors for higher plants; Methods for gene transfer, *Agrobacterium tumefaciens* mediated gene transfer- Basis of tumour formation, features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes;

Direct DNA transfer: particle bombardment, electroporation, microinjection, liposomes, pollen transformation; PEG method; transformation of monocots; transgene stability and gene silencing; chloroplast transformation.

Module III: **Applications of Transformation**

a. Applications of transformation: Herbicide resistance; insect resistance; Bt genes, disease resistance; Nutritional quality; biopesticides and biofertilizers; hazards and safety regulations for transgenic plants.

b. Transgenics and molecular farming: Production of secondary metabolites; industrial enzymes; biodegradable plastics (PHB); edible vaccines; antibody production and other important drugs.

Module IV: **DNA Fingerprinting and global gene expression**

a. DNA fingerprinting and marker assisted breeding: DNA based markers definition and properties of molecular marker, Hybridisation based marker- RFLP and its applications PCR based markers: RAPDs, ISSRs, STS, SSR (microsatellites); SCAR (sequence characterized amplified regions); SSCP (single strand conformational polymorphism); AFLPs; SNPs, molecular marker assisted selection

b. Techniques used to study gene expression at transcription level: Northern hybridization, differential display of mRNA, ESTs, cDNA-AFLP, DNA microarrays

Suggested readings

Alberts, Bruce; Johnson, Alexander; Lewis, Julian; Raff, Martin; Roberts, Keith; Walter, Bhojwani SS and Rajdhan MK 1996 Plant tissue culture: Theory and Practice. Elsevier Sci. Publ., New York
Peter 2002 Molecular Biology of the Cell, New York and London: Garland Science.

Callow, J. A., Ford-Lloyed, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetic

Resources: Conservation and Use, CAB International, Oxon UK.

Charlwood, B. Y. and Rhodes, M.V. 1999 Secondary products from plant tissue culture, Clarendon Press. Oxford.

Chrispeels, M. J. and Sadava, D. E. 1994, Plants, Genes and Agriculture. Jones & Barlett Publishers, Boston, USA.

Collins HA and Edwards S 1998 Plant cell culture. BIOS Sci. Publ., Oxford UK

Dicosmo F and Misawa, M. 1996 Plant Cell culture: Secondary metabolism towards industrial application, CRC press, Boca Raton, NewYork.

Glazer, A. N. and Nikaido, H. 1995. Microbial Biotechnology. W. H. Freeman & Company, New York, USA.

Gustafson, R. J. 2000. Genomes. Kluwer Academic Plenum Publishers, New York, USA.

Henry, R. J. 1997. Practical Applications of Plant Molecular Biology. Chapman & Hall, London, UK.

Jain SM, Sopory SK and Veilleux RE 1996 In vitro haploid production in higher plants. Vols. 1-5. Kluwer Acad. Publ., The Netherlands

Kurz, W.G.W 1989 Primary and Secondary metabolism of plant and Cell cultures, SpringerVerlag, Berlin.

Old, R. W. and Primrose, S. B. 1989. Principles of Genome Analysis. Blackwell Scientific Publications. Oxford, UK.

Primrose, S. B. 1995. Principles of Genome Analysis. Blackwell Scientific Ltd., Oxford ,UK.

Raghavan, V. 1997. Molecular Biology of Flowering Plants. Cambridge University Press, New York, USA.

Shantharam, S. and Montgomery, J. F. 1999. Biotechnology, Biosafety, and Biodiversity. Oxford & IBH Publication Co., Pvt., Ltd., New Delhi.

Semester IV Special Paper-XV
Mycology and Plant Pathology

Module I: Phytopathology

History: Milestones in phytopathology with particular reference to India. Major epidemics and their social impacts. Historical developments of chemicals, cultural and biological protection measures; Altered metabolism of plants under biotic and abiotic stresses. Koch's Postulates Epidemiology and forecasting of plant diseases Indian Institutes and their research activities in Mycology and Plant Pathology

Module II: Principles of Plant pathology

- i. Principles of plant pathology-Importance, nature, classification and general symptoms of plant diseases.
- ii. Pathogenicity of microorganisms and pathogenesis.
- iii. Host parasite relationship and Interaction; Signal transduction.
- iv. Defence mechanism in host plants against pathogens: morphological, structural defence mechanism; Biochemical defence mechanisms role of phenolic compounds, enzymes & toxins,
- v. Principles and methods of plant disease control -cultural methods, chemical methods, Biological control, transgenic approach for plant disease control, integrated pest management (IPM), Biopesticides.

Module III: Fungal Diseases

A Detailed study of the Diseases of the following crops caused by fungal pathogens with effective control measures: Diseases of Cereals: Seedling blight of cereals, Smut of wheat, Foot rot of wheat, Covered smut of Barley, False smut of rice, Downey mildew of jowar, Green ear disease of Bajra, Ergot of Bajra, Downey mildew of maize;

Diseases of Vegetable crops with special reference to the important diseases of the following: Chilli, Brinjal, Tomato, Onion, Bhindi; General knowledge of post harvest diseases of fruits and vegetables and their control.

Diseases of Oil Seed Crops viz. *Linum*, *Seasamum*, Groundnut, Mustard and Sunflower

Diseases of Fruit Trees- With special reference to important diseases of the following Citrus, Apple, Mango, Banana and Grapes.

Module-IV: Bacterial Diseases

Bacterial diseases of plants - Bacterial blight of rice, Tundu disease of wheat, Angular leaf spot of cotton, stalk rot of maize, Fire blight of Apple, Bacterial soft rot of fruits and Vegetables.

Viral Diseases of Plants- Bunchy top of Banana, Leaf curl of Papaya, Yellow vein mosaic of Bhindi. Mosaic of Cucurbits, Viral diseases of Tobacco, Potato and Tomato.;

Mycoplasma/Phytoplasma (PPLD) Diseases of Plants- Citrus greening, Rice yellow dwarf: Little leaf of Brinjal, Sandal Spike; Nematode Diseases of Plants: General knowledge of plant parasitic nematodes and important nematode diseases viz. Root knot of Vegetables, Ear cockle of wheat.

Suggested readings

- Agrios, G.N. (1980) Plant Pathology, Academic Press, INC, New York.
- Ainsworth, G.C. and A.S. Sussman (eds). The Fungi, An advanced Treatise Vol. I, II, III & IV Academic Press, New York.
- 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.
- Alexopoulos, C.J., Mims and Blackwell (1996) 4th ed. John Wiley and Sons, Inc. Wiley, New York
- Aneja, K.R. (1993) Experimental in Microbiology, Plant Pathology & Tissue Culture, Wiswa Prakashan, New Delhi.
- Bessey, E.A. (1950) Morphology and Taxonomy of Fungi. The Blakiston Co. Philadelphia.
- Bilgrami, K.S. and H.C. Dube (1985) A text Book of Modern Plant Pathology, Vikas Publication House, New Delhi.
- Barnett, J.H. (1968) Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.
- Dube, R.C. and D.K. Maheshwari (1999) A Text Book of microbiology, S.Chand & Co. Ltd.
- Dube, R.C. and D.K. Maheshwari (2000) Practical Microbiology -S.Chand & Co. Ltd.
- Gupta, V.K. and M.K. Behl (1994) Indian Plant Viruses and Mycoplasma Kalyani Publishers, 1/1, Rejinder Nagar, Ludhiana.
- Jha, D.K. (1993) A Text Book of Seed Pathology, Vikas Publication House. 86
- Mehrotra, R.S. (1989) Plant Pathology, Tata McGraw Hill.
- Mehrotra, R.S. and K.R. Aneja (1998) An Introduction to Mycology, New Age Intermediate Press.
- Pelzer, M.J. , Jr. Cahn, E.C.S. and N.R. Krieg (1993) Microbiology, Tata McGraw Hill.
- Preece and Dickeson. Ecology of leaf surface microorganism Academic Press, New York.
- Rangaswamy, G. and A. Mahadevan (1999) Diseases of Crop Plant in India, Prentice Hall of India.
- Raychoudhari, S.P. and Nariani, T.K. (1977) Virus and Mycoplasma Diseases of Plant in India, Oxford and IBH Publication Co.
- Schlegel, H.G. (1996) General Microbiology, 7th Edition, Cambridge University Press.
- Snowdon, A.L. (1991) A colour Atlas of Post harvest diseases & disorders of fruits & vegetables Vol. I & II Wolfe Scientific, London.
- Sunder Rajan, S. (2001) Tools and Techniques of Microbiology, Anmol Publ. New Delhi.
- Thind, T.S. (1998) Diseases of field crops and their management, National Agricultural Technology, Information Centre, Ludhiana.
- Vaidya, J.G. (1995) Biology of the fungi, Satyajeet Prakashan, Pune.
- Walker, J.G. (1952) Diseases of Vegetables Crops. McGraw Hill, New York. 26. Walker, J.C. (1968) Plant Pathology, McGraw Hill, New York.
- Eggins, H.O.W. and Allsop (1975) The Filamentous Fungi Vol. I Industrial Mycology (Biodegradation and Biodegradation by Fungi) Eds. J.E. Smith and D.R. Berry Edward Arnold, London.
- Emmons, C. W., C. H. Binford, J.P. Utz and Know Chung (1977) Medical Mycology, Lea

andFebigo, Philadelphia.

- Holliday, P. Fungus disease of tropical plants (1980), Cambridge University Press, Cambridge. On line Journals available on UGC -VSAT

Semester IV

Foundation Course II /Subject Centric - IIPaper XVI - Plant Resources

Module 1: Economic Botany

Food plants: History, origin, distribution, and nature

Morphology and anatomy of: Fiber yielding plants, forest resources (timber and non-timber plants), gum and resin yielding plants, fumitories and masticatories, spices and condiments; **Food adulteration**

Module 2: Pharmacognosy

Introduction, classification of crude drugs, plant anatomy (stomata, trichomes, xylem, phloem, ergastic substances); Evaluation of drugs: organoleptic, microscopic, chemical, physical and biological; Drug adulteration.

Module 3: Phytochemistry

Structure, classification, properties, importance and plant sources of: alkaloids, terpenoids, phenolics, steroids, glycosides

Module 4: Industrial Botany

Paper and pulp industry: Paper making, raw materials, manufacture of wood pulp, paper manufacture, kinds of paper and paper products.

Beverages: Source, plant description, cultivation, manufacturing, chemical composition- Tea Coffee and Cocoa.

Dyes: Plant sources (Description, chemical nature, extraction of dyes).

Essential oil: Occurrence, extraction, essential oils used in perfumery and other industries.

Rubber and latex: Classification of rubber, Natural rubber- source, cultivation, collection of latex, processing, uses of rubber.

Suggested Readings:

- Sharma O P 1996 Hill's Economic Botany. TMH Publi., New Delhi.
- Ali Mohammed 1998 Textbook of Pharmacognosy. CBS Publi., New Delhi.
- Sabnis S D and Daniel M 1990 A Phytochemical approach to Economic Botany. Kalyani Publi., NewDelhi.

**SEMESTER IV
PRACTICAL VII**

Time : 6 Hours	Full marks : 100
Q. 1 One experiment from Paper XIII A	15
Q. 2 One experiment from Paper XIII B	10
Q. 3 One experiment from Paper XIV C	15
Q. 4 One experiment from Paper XIV D	10
Q. 5 Spotting from Elective Paper II	10
Q. 6 Viva-voce	20
Q. 7 Practical record	20

SEMESTER IV	
PRACTICAL VIII Project	Full marks : 100