

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 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 (Central 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*, *Nilssonina*, *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 spectrophotom

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.
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- Harborne, T.C. 1981. *Phytochemical Methods: A Guide to Modern Techniques of Plants Analysis*. Chapman & Hall, London.
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- 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.
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- 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.

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- 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
- Shivanna, K.R. and Rangaswamy, N.S. 1992. Pollen Biology: A Laboratory Manual. Springer-Verlag, Berlin.
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- 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
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- 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 in 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. Newyork.
- Grant, V. 1971. Plant Speciation, Columbia University press, London. Grant W. F. 1984. Plant Biosystematics. Academic press, London.
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- Heywood, V. H. and Moore, D. M. 1984. Current concepts in Plant Taxonomy. Academic Press, London.
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- 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.

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- 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
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- 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